UNIVERSITY of the WESTERN CAPE

Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town Fire and Rescue Service

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DECLARATION

I hereby declare that *"Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town Fire and Rescue Service"* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full name.......**Jaron Ras**...... Date............**23 June 2020**......

Signed..

DEDICATION

This was dedicated to my parents, Jerome Christian Ras and Verena Michelle Ras and all my family members, thank you for your unconditional love and support. To Tammy, thank you for your continuous support, sacrifices and for always motivating me to give 100% towards my studies.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SCIENTIFIC ABBREVIATIONS

BMI	=	body mass index
CAD	=	coronary artery disease
CHD	=	coronary heart disease
CVD	=	cardiovascular disease
DBP	=	diastolic blood pressure
HC	=	hip circumference
HDL-C	=	high-density lipoproteins cholesterol
LDL-C	=	low-density lipoproteins cholesterol
NFBG	=	non-fasting blood glucose
SBP	=	systolic blood pressure
TC	=	total cholesterol
$\dot{V}O_{2max}$	=	maximal volume of oxygen consumed per minute
WC	=	waist circumference
WHR	=	waist-to-hip ratio

LIST OF ACRONYMS

CoCT	=	City of Cape Town
US	=	United States

UNITS OF MEASUREMENT

cm	=	centimetres
kg	=	kilogram
$kg \bullet m^{-2}$	=	kilograms per square metre
m	=	metre
min	=	minutes
mm	=	millimetres
$mmol \bullet L^{-1}$	=	millimoles per litre
mm Hg	=	millimetres of mercury

STATISTICAL UNITS

%	=	percentage
CI	=	confidence interval
OR	=	odds ratio
p	=	significance level
SD	=	standard deviation
$\bar{x}$	=	mean
H	=	Kruskal-Wallis H
U	=	Mann-Whitney U

χ^2 = Chi-Square

ABSTRACT

Over 45% of firefighter deaths are due to a sudden cardiac event caused by underlying coronary artery disease (CAD) risk factors that can be prevented through adequate CAD risk factor screening and management. The aim of the study was to determine the prevalence of CAD risk factors in firefighters in the City of Cape Town and the relationship between the various CAD risk factors. This study used a quantitative cross-sectional, descriptive and correlational design. A total of 124 full-time firefighters of the City of Cape Town (CoCT) Fire and Rescue Service were conveniently recruited to participate in the study, including males and females of all ethnicities. Coronary artery disease risk factor information was obtained with a CAD risk factor assessment form, including, past medical history, smoking status, physical activity behaviour, ethnicity/race, age and gender. Standard equipment and procedures were used to measure blood pressure, cholesterol, body mass and stature. The data was analysed using SPSS version 26. Descriptive and inferential statistics (Spearman's correlation), Kruskal-Wallis H and Chi-square tests were used to analyse the data. The results showed that the most prevalent CAD risk factors were hypertension (33.06%), obesity (37.10%), cigarette smoking (39.52%), and dyslipidemia (40.32%). A total of 86.29% of firefighters had one risk factor, 56.45% had two and 36.29% had three or more risk factors. Significant relationships were found between age and BMI ($r = 0.42$, $p < 0.001$), age and waist circumference ($r = 0.52$, $p < 0.001$), and age and waist-to-hip ratio ($r = 0.52$, $p < 0.001$). There were significant associations between family history and age [$\chi^2(1) = 4.17$, $p = 0.041$, OR = 2.59 (95% CI: 1.02, 6.62)], family history and central obesity [$\chi^2(1) = 3.96$, $p = 0.047$, OR = 2.41 (95% CI: 0.99, 5.79)], and physical inactivity and obesity [$\chi^2(1) = 4.33$, $p = 0.038$, OR = 2.94 (95% CI: 1.03, 8.37)]. In conclusion, the majority of firefighters had at least one CAD risk factor, with the most frequent risk factors being hypertension, obesity, cigarette smoking and dyslipidemia. Significant relationships were found between age, obesity and hypertension. The CoCT Fire and Rescue Service should promote education on CAD risk factors, regular screening of CAD risk factors, and preventative behavioural strategies related to poor lifestyle choices.

Key words:
Coronary artery disease, cardiovascular, heart, firefighters, risk factor, fire rescue

CHAPTER ONE: INTRODUCTION

1.1. Introduction

Over 45% of firefighter deaths are due to sudden cardiac death (SCD), with many of these deaths attributed to comorbidities (Smith, DeBlois, Kales, & Horn, 2013; Smith, Barr & Kales, 2016; Smith, Haller, Korre et al., 2019; Yang, Teehan, Farioli et al., 2013). Firefighting is a hazardous occupation that involves firefighters in life-threatening situations, where they are exposed to severe temperatures, tremendous cardiovascular workloads and hazardous chemicals and fumes (Seyedmehdi, Attarchi, Cherati et al., 2016; Smith et al., 2013; Smith et al., 2019;). These severe conditions necessitate that firefighters wear protective clothing and rescue equipment that is heavy and insulated, which puts tremendous strain on the cardiovascular system (Seyedmehdi et al., 2016; Smith et al., 2016).

The majority of firefighters (67% – 85%) have at least one CAD risk factor (Gendron, Lajoie, Laurencelle, & Trudeau, 2018a; Yang et al., 2013). Many firefighters have multiple risk factors occurring simultaneously, thus, increasing the risk of CAD or mortality while on duty (Farioli, Yang, Teehan et al., 2014; Martin, Schlaff, Hemenway et al., 2019; Seyedmehdi et al., 2016; Smith et al., 2013). In addition, an alarmingly large number of firefighters have cardiovascular disease (CVD), and some have previously suffered a sudden cardiac event (Farioli et al., 2014; Seyedmehdi et al., 2016; Smith et al., 2013; Kales, Soteriades, Christophi, & Christiani, 2007;).

Obesity, diabetes, dyslipidemia and hypertension often occur cumulatively among firefighters that further increase the likelihood of a sudden cardiac event while on-duty (Farioli et al., 2014; Seyedmehdi et al., 2016; Smith et al., 2013). Numerous studies found that an alarming number of firefighters were hypertensive (27%), dyslipidemic (33.3%), cigarette smokers (38%), physically inactive (49%) and obese (63%) (Durand, Tsismenakis, Jahnke et al., 2011; Jitnarin, Poston, Haddock, Jahnke, Day, 2015; Martin et al., 2019; Savall, Charles, Binazet et al., 2018;

Soteriades, Liarokapis, Christoudias, Tucker, & Christiani 2002; Yang et al., 2013). Increased body fat places excessive strain on the cardiovascular system, resulting in an increase in blood pressure (Fiuza-Luces, Santos-Lozano, Jitnarin et al. 2015; Joyner et al., 2018). Hypertension combined with increased body fat are indirect causes of diabetes and dyslipidemia, all of which significantly increase the risk of on-duty mortality (Jitnarin et al., 2015; Yang et al., 2013, Smith et al., 2013; Smith et al., 2016). Viewed collectively, the hazardous conditions of firefighting, together with the excess weight of the firefighting equipment and the multiple CAD risk factors present in many firefighters, increase the likelihood of a sudden cardiac event.

1.2. Statement of the Problem

Most firefighters are not adequately informed about the major risk factors of CAD (Carpenter, Carpenter, Kimbrel et al., 2015). There is little research currently on CAD risk factors among firefighters, especially in the City of Cape Town Fire and Rescue Service (Schmidt & Mckune, 2012). The majority of firefighters do not know their individual risk factors of CAD, and many do not fully understand the negative impact of CAD risk on health and job performance (Schmidt & Mckune, 2012). Many of the CAD risk factors, especially obesity, physical inactivity, diabetes and hypertension, significantly lower work performance, and increase the risk of on-duty fatalities (Durand et al., 2011; Jitnarin et al., 2015; Martin et al., 2019; Savall et al., 2018; Seyedmehdi et al., 2016; Smith et al., 2013; Soteriades et al. 2002; Yang et al., 2013). Proper screening of these CAD risk factors will highlight the firefighters at risk, and aid in reducing firefighter casualties and the associated loss of property (Poston, Haddock, Jahnke, Jitnarin, & Day, 2013).

1.3. Aim of the Study

The aim of the study is to determine the prevalence of the major CAD risk factors in firefighters in the City of Cape Town and the relationship between the various CAD risk factors.

1.4. Objectives of the Study

The objectives of the study are to:

- Determine the prevalence of CAD risk factors in firefighters in the City of Cape Town Fire and Rescue Service.
- Determine the relationship between the various CAD risk factors in firefighters.
- Determine the relationship between CAD risk factors and various demographic characteristics, such as age, gender, and ethnicity.

1.5. Hypotheses of the Study

The hypotheses of the study are the following:

- There will be a high prevalence of CAD risk factors in firefighters in the City of Cape Town Fire and Rescue Service.
- CAD risk will increase with age, especially in male firefighters.
- There will be significant relationships between cigarette smoking, physical inactivity, obesity, hypertension, dyslipidaemia and diabetes.

1.6. Significance of the Study

Coronary artery disease is a major contributor of morbidity and premature mortality in firefighters that needs urgent attention (Fiuza-Luces et al., 2018; Smith et al., 2013; Smith et al., 2016; Yang et al., 2013). Firefighters are put under tremendous physical and mental stress, and having multiple CAD risk factors prevalent may escalate the health burden, thereby, resulting in significant morbidity and mortality (Carpenter et al., 2015; Smith et al., 2013; Smith et al., 2016; Soteriades Smith, Tsismenakis, Baur, & Kales, 2011).

Due to firefighting being a physically demanding and stressful occupation, continuous and early CAD risk factor screening and detection, combined with the appropriate interventions, will have a substantial immediate and long-term impact on the productivity and longevity of firefighters. A comprehensive intervention strategy may also help diminish the potential loss of life of firefighters and, thereby, decrease the potential damage to commercial, public or private property.

There are few studies investigating the prevalence of CAD risk factors in firefighters, as well as the relationship between the various CAD risk factors in firefighters (Schmidt & Mckune, 2012). The scarce literature on the health and CAD risk factors of firefighters is a cause of concern and requires urgent attention. Therefore, the identification of CAD risk factors among firefighters is an important first step in addressing the problem and, hopefully, will highlight the need for effective behaviour modification in order to ameliorate the risk in firefighters.

1.7. Delimitations of the Study

1.7.1. Inclusion Criteria

The following inclusion criteria were applied in the study, namely:

- Full-time firefighters permanently employed in the City of Cape Town.
- Male and female firefighters between the ages of 18 and 65 years.

1.7.2. Exclusion Criteria

The following exclusion criteria were applied in the study, namely:

- Administrative staff who were not active firefighters.
- Volunteer firefighters or workers on a part-time basis (i.e., contracted for the peak season only).
- Firefighters who were hospitalized or on leave during the period of the study.

1.8. Definitions of Terms

Age, as a risk factor, is defined as men aged 45 years or older and women aged 55 years or older (ACSM, 2018, p. 44).

Cigarette smoking, as a risk factor, is defined as being a current cigarette smoker or individuals who have quit smoking in the last 6 months or individuals exposed to second-hand tobacco smoke (ACSM, 2018, p. 44).

Coronary artery disease risk factors are a group of factors that contribute to the development of heart disease or SCD (Smith et al., 2016; Smith et al., 2013).

Diabetes is a disease in which the ability of cells to produce or respond to insulin is impaired, causing abnormally elevated levels of glucose in the blood (Emdin, Khera, Natarajan et al., 2017; King & Grant 2016; Newsholme, Cruzat, Arfuso, & Keane, 2014). Diabetes is defined as an impaired fasting glucose (IFG) of between 7.77 and 11.04 mmol•L^{-1} or an impaired glucose tolerance (IGT) of 11.1 mmol•L^{-1} or above, confirmed on at least two separate occasions (ACSM, 2018, p. 44).

Dyslipidemia is defined as a low-density lipoprotein cholesterol (LDL-C) concentration equal to or more than 3.37 mmol•L^{-1}, a high-density lipoprotein cholesterol (HDL-C) concentration equal to or less than 1.04 mmol•L^{-1} or a total serum cholesterol concentration equal to or more than 5.18 mmol•L^{-1} (ACSM, 2018, p. 44).

Family history of heart disease, as a risk factor, is defined as myocardial infarction, coronary revascularization or SCD before the age of 55 years in the father or other male first-degree relative, or before the age of 65 years in the mother or other female first-degree relative (ACSM, 2018, p. 44).

Physical Inactivity is defined as individuals not participating in thirty minutes of moderate-intensity physical activity on three days of the week for at least three months, consecutively (ACSM, 2018, p. 44).

Hypertension is defined as a resting systolic blood pressure (SBP) equal to or more than 140 mm Hg and/or a resting diastolic blood pressure (DBP) equal to or more than 90 mm Hg that is confirmed on at least two different days of testing (ACSM, 2018, p. 44).

Obesity is the excessive accumulation of adipose tissue that is directly related to an imbalance in energy intake that exceeds energy expenditure (Gadde, Martin, Berthoud, & Heymsfield, 2018). Obesity is defined as a body mass index (BMI) of 30 kg•m^{-2} or more. (ACSM, 2018, p. 44). Central obesity is defined as a waist circumference (WC) of more than 102 cm for men and 88 cm for women, as well as a waist-to-hip ratio of more than 0.95 in males and 0.86 in females (ACSM, 2018, p. 44; Alpert, Lavie, Agrawal, Aggarwal, & Kumar, 2014).

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Firefighting is a physically demanding occupation, and requires peak physical fitness in order to fulfil the on-duty emergencies (Choi & Kojaku, 2017; Seyedmehdi et al., 2016; Smith et al., 2019; Smith et al., 2013). Coronary heart disease is the cause of death in over 45% of firefighters when on-duty (Savall et al., 2019; Smith et al., 2013; Soares & Porto, 2019). The major CAD risk factors include age, a family history of heart disease, cigarette smoking, physical inactivity, obesity, hypertension, dyslipidemia, and diabetes (ACSM, 2018, p. 44). These risk factors are categorized as non-modifiable and modifiable. Non-modifiable risk factors cannot be altered by a change in behaviour, and include age, and a family history of heart disease (Dahlöf, 2010; Popa, Petresc, Cătană et al., 2020). Modifiable risk factors are managed by altering lifestyle choices and implementing lifestyle changes (Dahlöf, 2010; Foody, Huo, Ji et al., 2013; Popa et al., 2020). These include hypertension, dyslipidaemia, obesity, physical inactivity, diabetes, and cigarette smoking (Dahlöf, 2010; Foody et al., 2013; Frohlich & Al-Sarraf, 2013; Popa et al., 2020).

This literature review will discuss the development of atherosclerosis, leading to CAD, how each CAD risk factor influences the development and progression of CAD, and the prevalence of CAD risk factors in firefighters.

2.2. Development of Coronary Artery Disease

Cardiovascular disease, particularly CAD, is one of the leading causes of morbidity and mortality worldwide, and the incidence of SCD from these diseases is steadily increasing (Ambrose & Singh, 2015). Acute myocardial infarction (AMI) and SCD are life-threatening and amongst the most serious manifestations of CAD (Ambrose & Singh, 2015). Additionally, CAD is not limited to AMI and SCD, but can take the form of less severe manifestations, such as stable and unstable angina, silent ischemia, and congestive heart failure (Ambrose & Singh, 2015; Sayols-Baixeras, Lluís-Ganella, & Elosua, 2014). Many individuals experiencing AMI or heart attack, due to CAD, have often suffered permanent disability or even death (Ambrose & Singh, 2015; Sayols-Baixeras et al., 2014).

The underlying pathophysiologic mechanism of CAD can be attributed to the process of atherosclerosis (Ambrose & Singh, 2015; Bobryshev, Ivanova, Chistiakov, Nikiforov, & Orekhov, 2016; Sayols-Baixeras et al., 2014). The process of atherosclerosis can be described as a low-grade inflammatory process in which the intima (inner lining) of the arteries become inflamed and gradually start to thicken, causing progressive narrowing (Ambrose & Singh, 2015; Bobryshev et al., 2016; Sayols-Baixeras et al., 2014). The process is accelerated by major CAD risk factors, such as age, family history, diabetes, hypertension, cholesterol, and cigarette smoking (Ambrose & Singh, 2015).

2.3. Coronary Artery Disease Risk factors

Various studies show that individuals who develop CAD have at least one CAD risk factor present, and multiple risk factors accelerate the process of atherosclerotic plaque formation (Brown, Gerhardt, & Kwon, 2020; Foody et al., 2013; Popa et al., 2020).

2.3.1. Non-Modifiable Risk Factors

2.3.1.1. Family History

A family history of CAD can be considered a genetic disease (Herrera & Lindgren; 2010; Nordestgaard & Benn, 2017). It is well understood that having first-degree relatives with heart disease in conjunction with other positive CAD risk factors can predispose an individual to suffering an acute coronary event, AMI or SCD (Nordestgaard & Benn, 2017).

Participants who reported a positive family history of CAD, also had a higher prevalence of traditional risk factors, such as hypertension, diabetes mellitus, dyslipidemia, and cigarette smoking (Valerio, Peters, Zwinderman, & Pinto-Sietsma, 2016). A study also found that among hypertensive individuals with a family history of CAD, vascular diseases appeared almost twice as often (Valerio et al., 2016). A positive family history significantly increased the risk of hypertension, obesity, central obesity, and metabolic syndrome (Ranasinghe, Cooray, Jayawardena, & Katulanda, 2015).

2.3.1.2. Age

Aging negatively affects the body's metabolic and cardiovascular functioning, and is considered the most important factor influencing cardiovascular homeostasis (Costantino, Paneni, & Cosentino, 2016; Paneni, Cañestro, Libby, Lüscher, & Camici, 2017). The prevalence of metabolic disease and diabetes in older persons has significantly increased, further contributing to cardiovascular disease (CVD) morbidity and mortality, with approximately 40% of deaths in persons over the age of 65 years related to atherosclerotic disease (Costantino et al., 2016; Lakatta, 2002).

For every 9 to 10 years increase in age, the risk of hypertension doubles (Poorolajal, Farbakhsh, Mahjub, Bidarafsh, & Babaee, 2015). Aging disrupts cholesterol homeostasis, and negatively affects insulin sensitivity of cells (Morgan, Mooney, Wilkinson, Pickles, & Mc Auley, 2016; Shulman, 2014). In addition, as individuals age, the arteries become progressively stiffer and inelastic (Costantino et al., 2016). Age-related increases in reactive oxygen species (ROS) causes a decrease in nitric oxide which further reduces vascular elasticity (Costantino et al., 2016; Paneni et al., 2017). The loss of elasticity contributes to increased systolic and diastolic blood pressure that causes decreased perfusion in myocardial cells and increased myocardial ischemia (Costantino et al., 2016; Paneni et al., 2017; Steenman & Lande 2017).

In addition, increased systolic blood pressure causes an increase in left ventricular afterload, and pathological left ventricular hypertrophy (Paneni et al., 2017; Steenman & Lande 2017). Coronary atherosclerotic plaque formation progresses with age and, coupled with an increase in myocardial oxygen demand, forms a lethal combination for a sudden cardiac event (Paneni et al., 2017).

2.3.2. Modifiable Risk Factors

2.3.2.1. Diabetes Mellitus

When blood glucose is elevated for prolonged periods, cells become resistant to insulin and gradually require higher levels of insulin to stimulate glucose uptake. This eventually leads to insulin resistance and, subsequently, diabetes mellitus (Emdin et al., 2017; Newsholme et al., 2014). Diabetes causes an increase in low-grade inflammation, which exacerbates atherosclerotic plaque formation (King & Grant, 2016; La Sala, Prattichizzo, & Ceriello, 2019; Poznyak, Grechko, Poggio et al., 2020).

There is a distinct relationship between an increase in adipose tissue, as seen in obesity, and the development of insulin resistance (Shulman, 2014). Insulin resistance and diabetes are directly linked to and promote other CAD risk factors, such as dyslipidemia and central obesity (Edmin et al., 2017; Poznyak et al., 2020; Tangvarasittichai, 2015). Emdin et al. (2017) reported that diabetes was significantly associated with an increased waist-to-hip ratio (WHR) that increased the risk of coronary heart disease (CHD).

Tsujimoto, Kajio, and Sugiyama (2016) reported that diabetes was significantly associated with CHD, and diabetic patients with signs of CHD are at significantly increased risk for sustaining a life-threatening cardiac event. Turin, Okamura and Rumana et al. (2017) investigated the lifetime risk (LTR) of diabetes and CHD in 40 year-olds, and reported that, when diabetes was present, the LTR of CHD was 4.45% higher in males and 5.03% higher in females. Similarly, Junttila Kiviniemi, Lepojärvi et al. (2018) reported that SCD was significantly higher in diabetic (4.1%) compared to non-diabetic (1.4%) patients.

2.3.2.2. Physical Inactivity

Approximately 80% of CHD is caused by physical inactivity and associated risk factors (Maddison, Rawstorn, Shariful Islam et al, 2015). Physical inactivity in conjunction with obesity leads to the development and progression of diabetes, dyslipidemia, and hypertension, especially in aged adults (Alves, Viana, Cavalcante et al., 2016; Biswas, Oh, Faulkner et al., 2015; Gaetano, 2016; González, Fuentes, & Márquez, 2017; Oktay, Lavie, Kokkinos et al., 2017). In addition, it has been associated with reduced endothelial function, increased oxidative stress and arterial stiffening (González et al., 2017; Guerrero, Sun, & Kwon, 2020; (Lessiani, Santilli, Boccatonda et al., 2015).

Sedentary individuals have a higher BMI, a larger WC, a higher blood pressure, an abnormal lipid profile with higher C-reactive proteins, an abnormal index of insulin resistance, and a worse triglyceride/HDL-C ratio and higher blood glucose. A sedentary lifestyle was also associated with a 75% increase in all-cause mortality related to heart failure (Park, Dracup, Whooley et al., 2019). Matthias, de Silva, Indrakumar and Gunatilake (2018) reported that acute coronary syndromes (ACS) were present in 56.7% of physically inactive participants, and 17.1% of minimally active participants.

2.3.2.3. Hypertension

Many factors influence the onset of hypertension, including a high sodium intake, a sedentary lifestyle, obesity, high alcohol consumption, psychological stress, and low potassium and calcium intake (Garfinkle, 2017; Mann, 2018; Schäfer, Myers, Brown et al., 2016). When left untreated, hypertension leads to organ damage, atherosclerosis and CAD (Garfinkle, 2017; Schäfer et al., 2016).

Hypertensive blood pressures destroy the endothelial lining of smooth muscle tissue in arteries through altered shear forces and oxidative stress (Hurtubise, McLellan, Durr et al., 2016; Schäfer et al., 2016). The combination of shear forces and oxidative stress causes inflammation, cell proliferation, vascular remodelling, apoptosis, and an increase in the cellular permeability for adhesion molecules and LDL-C, thus triggering the cascade of monocytes and macrophages, resulting in the formation of atherosclerotic plaque (Higgins & Adeli, 2017; Hurtubise et al., 2016; Schäfer et al., 2016). When hypertension is combined with dyslipidemia, the excess cholesterol and LDL-C molecules accentuate the atherosclerotic plaque build-up (Higgins & Adeli, 2017; Hurtubise et al., 2016; Peters, Singhateh, Mackay, Huxley, & Woodward, 2016).

Zhang, Yang and Xiao et al. (2018) reported that hypertension was significantly associated with the incidence of stroke and CHD, especially when diabetes was present. Gosmanova, Mikkelsen and Molnar et al. (2016) also reported that a higher SBP, with or without hypertension, was significantly associated with CHD, stroke, and all-cause mortality. Biswas, Singh and Singh (2017) reported that hypertension was significantly associated with CHD, and that adults who were hypertensive were eleven times more likely to have CHD.

2.3.2.4. Obesity

Obesity is a risk factor for CAD, but also has a catalytic effect in the development and progression of other modifiable risk factors (De Schutter, Lavie, & Milani, 2014; Kim, Després & Koh, 2016). The catalytic effect can be seen globally in the progression of type-II diabetes and other cardiometabolic conditions (De Schutter et al., 2014; Kim et al., 2016; Ortega, Lavie, Blair, 2018). Obesity is associated with insulin resistance and type-II diabetes mellitus, caused by poor dietary practices that are high in refined carbohydrates and sugars, and pro-inflammatory adipocytokines (De Schutter et al., 2014; Liberale, Bonaventura, Vecchiè et al., 2017).

Furthermore, blood pressure is elevated in obese individuals through a combination of adipose-related disruption in endocrine function (i.e., aldosterone, cortisol, and insulin) and an increase in blood volume and peripheral resistance that are caused by an increase in body mass (De Schutter et al., 2014; Kim et al., 2016; Ortega et al., 2018). Over 80% of patients with CHD are overweight and obese, and are significant predictors of AMI and ischemic heart disease (IHD), with or without cardiometabolic disorders (Ades & Savage, 2018; Thomsen & Nordestgaard, 2014). Obesity also plays an important role in the development and progression of cardiometabolic syndromes (Kodama Horikawa, Fujihara et al., 2014). In addition, early-life weight-gain is a significant predictor of type-2 diabetes mellitus (Kodama et al., 2014). For every five $kg{\bullet}m^{-2}$ increase in BMI, mortality risk of CHD increases by 30% (Antonopoulos, Oikonomou, Antoniades, & Tousoulis, 2016).

2.3.2.5. Cigarette Smoking

Tobacco use is the leading cause of non-communicable diseases worldwide and, compared to obesity, is responsible for more deaths in high-income countries (Jha & Peto, 2014; de Ronde, Kok, Moerland et al., 2017; Kamceva, Arsova-Sarafinovska, Ruskovska et al., 2016). Older individuals who start smoking early in adulthood are at higher risk (Jha & Peto, 2014). The exact mechanism by which cigarette smoking causes atherosclerosis has not been fully identified yet (de Ronde et al., 2017; Jha & Peto, 2014). However, it is well known that many cells, including monocytes, undergo phenotypical changes when exposed to cigarette smoke, caused by oxidative stress, leading to their transformation into foam cells, and subsequent accumulation into arteriolar walls contributing to the formation of atherosclerotic plaques (de Ronde et al., 2017; Hecht, Arheart, Lee, Hennekens, & Hlaing, 2016; Kamceva et al., 2016; King, Piper, Gepner et al., 2017). There is a direct link between an increase in oxidative stress and an increase in the number of cigarettes smoked per day (Hecht et al., 2016; Kamceva et al., 2016; King et al., 2017).

Coronary artery disease risk advancement for cigarette smokers is 5.50 years, and for smoking cessation 2.16 years (Mons, Müezzinler, Gellert et al., 2015). There is a dose-response relationship, where an increase in the number of cigarettes smoked per day increases CAD risk (Mons et al., 2015). Ding, Sang, Chen et al. (2019) reported that cigarette smoking was significantly associated with CHD, peripheral artery disease (PAD) and stroke, and that even after smoking cessation, the risk for CHD was significantly elevated up to 20 years.

2.3.2.6. Dyslipidemia

Dyslipidemia is a major risk factor for CAD and, similar to hypertension, is insidious in its onset and progression (Alphonse & Jones, 2016; Higgins & Adeli, 2017). Increasing the intake of saturated fatty-acids reduces LDL-receptor activity in the liver, resulting in an increase in circulating LDL-C and, subsequently, lowers cholesterol synthesis (Alphonse & Jones, 2016; Peters et al., 2016). When overweight or obese, the rate of cholesterol synthesis increases to a level that causes malabsorption, which highlights a distinct relationship between body mass, cholesterol synthesis and absorption (Alphonse & Jones, 2016; Higgins & Adeli, 2017; Peters et al., 2016). An inverse relationship exists between LDL-C and HDL-C. When HDL-C levels are low in the blood, it leads to an increase in LDL-C, and vice versa (Bodoff, 2016; Higgins & Adeli, 2017). A ratio of HDL-C to LDL-C that is skewed towards LDL-C, increases an individual's risk of developing atherosclerotic plaque (Higgins & Adeli, 2017; Hao & Friedman, 2014).

For every one millimole per litre (mmol•L^{-1}) increase in total cholesterol (TC), the risk of CHD increased by 20% in women and by 24% in men (Peters et al., 2016). High TC concentrations are accountable for 2.6 million deaths worldwide, and a third of all CHD may be attributed to high cholesterol (Peters et al., 2016). Ariyanti and Besral (2018) reported that among the participants who had CHD, 50% had dyslipidemia, and those with dyslipidemia were 2.5 times more likely to suffer CHD. The study also reported that individuals with dyslipidemia and hypertension, were eighteen times more likely to develop CHD. Furthermore, dyslipidemia was significantly associated with CAD, regardless of whether other CAD risk factors was present or not (Goyfman, Chaus, Dabbous et al., 2018).

2.4. Prevalence of Coronary Artery Disease

2.4.1. Global Prevalence of Coronary Artery Disease and Coronary Artery Disease Risk Factors

Globally, it is estimated that 470.8 million people have CVD, an increase of 26.7% compared to 2006 (Benjamin, Muntner, Alonso et al., 2019). Jagannathan, Patel, Ali and Venkat Narayan (2019) reported 17.8 million deaths were related to CVD, and increased from 1990 to 2017. The study also reported that although age-standardized death related to CVD decreased, the overall CVD-related deaths increased by 5.9%. Globally, it is estimated that the prevalence of obesity, diabetes, cigarette smoking, physical inactivity, hypertension and dyslipidemia were, 12.9%, 24.8%, 26%, 31.1%, 35%, and 41.7%, respectively (Benjamin et al., 2019; Jagannathan et al., 2019).

Half of the occurrences in CVD are estimated to occur in Asia, however, CAD mortality among nine Asian countries showed a dissimilar pattern (Benjamin et al., 2019; Shah, Abbas, Hanif et al., 2019). In East Asian countries, encompassing Japan, South Korea and China, CAD mortality was considerably lower than in Western countries (Benjamin et al., 2019; Kalra, Kumbhani & Hill, 2020; Shah et al., 2019). However, in South Asian countries, the mortality rates of stroke and CAD were much higher than in Western countries (Benjamin et al., 2019; Kalra, et al., 2020; Shah et al., 2019). Furthermore, South Asian countries, including India, Bangladesh and Pakistan, had the highest mortality due to CAD (Benjamin et al., 2019).

In Europe, heart disease and CAD are still major health concerns, and many deaths occur due to these conditions being left untreated (Benjamin et al., 2019; Jagannathan et al., 2019; Timmis, Townsend, Gale et al., 2020). In Europe, it is estimated that 108.7 million people have CVD, with males having a lower prevalence than females (52.9 vs 55.7 million, respectively) (Timmis et al., 2020). Furthermore, CVD-related deaths were more prevalent in females than in males (47% vs. 29%, respectively) (Timmis et al., 2020). The study estimated a prevalence of diabetes, dyslipidemia, cigarette smoking, obesity, hypertension and physical inactivity in 6.8%, 14.9%, 21%, 22.6%, 24.8%, 31% of the general European population (Timmis et al., 2020).

2.4.2. Prevalence of Coronary Artery Disease Risk Factors in Africa and South Africa

In Africa, 38% of all deaths related to non-communicable disease (NCD) was attributed to CVD, and is expected to rise (Keates, Mocumbi, Ntsekhe, Sliwa and Steward, 2017). Keates et al. (2017) reported the following CAD risk factor prevalence, i.e., diabetes estimated to be

3.8%, obesity between 2 and 29%, dyslipidemia between 15 to 35%, hypertension between 15 and 70%, cigarette smoking/tobacco use between 43 and 60%, and physical inactivity between 50 and 60%. Hyle, Mayosi, Middelkoop et al. (2017) reported that CVD was present in 12 to 33% of sub-Saharan Africans, with a prevalence of the following CAD risk factors, diabetes in 1 to 12%, smoking in 0.6 to 15%, hypertension in 6 to 22%, and dyslipidemia in 5 to 70%, of the general population.

Cardiovascular disease is a considerable burden in South Africa, responsible for one in five deaths (Roozen, Vos, & Tempelam et al., 2019). South Africa is reported to have the highest prevalence of obesity, diabetes, cigarette smoking and dyslipidemia (Keates et al., 2017; Sliwa, Acquah, Gersh, & Mocumbi, 2016). In South Africa, the prevalence of family history, diabetes, dyslipidemia, cigarette smoking, hypertension, obesity and physical inactivity is 3.15%, 15.3%, 17.5%, 20.6%, 24.8%, 35.4% and 44.9%, respectively (Basu, Wagner, Sewpaul, Reddy, & Davies, 2019; Roozen et al., 2019). In the population of the Western Cape, 26% were cigarette smokers, 28% were aged 45 years or older, 32.7% had systolic hypertension, 34.6% had diastolic hypertension, 36% were obese, 62.2% had elevated TC and 64% were physically inactive (George, McGrath, & Oni, 2019; Schouw, Mash, & Kolbe-Alexander, 2018).

2.5. Prevalence of Coronary Artery Disease Risk Factors in Firefighters

2.5.1. Diabetes in Firefighters

A study reported that 50% of firefighters had prediabetes and 2% had diabetes (Ratchford, Carson, Jones, & Ashen, 2014). Gendron et al. (2018a) reported a similar prevalence of diabetes in 3% of firefighters. Other studies reported a similar low prevalence of diabetes, with the majority having a prevalence under 5% (Mehrdad, Movasatian, & Momenzadeh, 2013; Plat, Frings-Dresen, & Sluiter, 2012; Savall et al., 2018; Winter, Seals, Martin, & Russel, 2017).

Wolkow, Netto, Langridge et al. (2014) reported that female firefighters had a slightly lower prevalence of diabetes compared to male firefighters (3.6% vs 6.8%, respectively). In contrast, Gendron et al. (2018a) and Gendron, Lajoie, Laurencelle, & Trudeau (2018b) reported that females had a slightly higher prevalence than males (3% vs 1.7%, respectively). However, the prevalence for both genders was equally low and only differed marginally. With regard to ethnicity, Poston, Haddock, Jahnke et al. (2014) reported that diabetes prevalence was low and similar for the various ethnicities. In Asian firefighters, blood glucose correlated to obesity, but not ethnicity.

Lee and Kim (2017) found that 31.1% of firefighters had hyperglycaemia, 33.5% had hypertension and 36.2% had high triglyceride levels. Superko, Momary, Pendyala et al. (2011) found that 3.72% of firefighters were diabetic that was associated increased BMI and blood pressure. Damacena, Batista, Ayres, Zandonade and Sampaio (2020) reported 30.72% of firefighters had elevated blood glucose that was associated with central obesity. Similarly, Eastlake, Knipper, He, Alexander and Davis (2015) reported that 4.5% of firefighters had high blood glucose that it was significantly associated with age. Soteriades, Kales, Liarokapis and Christiani (2003) reported 4.11% of firefighters had diabetes, with no significant associations to other risk factors. Smith et al. (2013) reported that firefighters who had diabetes were 10.2 times more likely to suffer an on-duty fatality attributed to CAD.

2.5.2. Physical Inactivity in Firefighters

Durand et al. (2011) found that 49% of firefighters exercised less than three times a week for 30 minutes per session, and could be considered sedentary. The mean BMI of the group was 29.3±4.5 kg•m^{-2}, showing that the majority were overweight and bordering on obesity. Mehrdad et al. (2013) found that 23.8% of firefighters were physically inactive. Martin et al.

(2019) reported a higher prevalence of physical inactivity in 45.9% of firefighters. Similarly, Risavi and Staszko (2015) and Amodeo and Nickelsin (2020) reported a high prevalence of physical inactivity in 47.3% and 46.7% of firefighters, respectively. Cavalcante-Neto, Calheiros, Calheiros et al. (2019) reported that 55.7% of firefighters were inactive. Baur, Christophi, Cook, Kales et al. (2012a) reported that 56.9% of firefighters exercised 30 minutes or less per session, 14.7% exercised for 15 minutes or less per session, 21% exercised at light intensity or did not exercise at all, and 16.2% exercised once or less per week. The study also found that firefighters with a BMI equal to or above 30 $kg \cdot m^{-2}$, exercised less than 150 minutes per week that was related to poor cardiorespiratory fitness and obesity. Chappel, Aisbett, Vincent and Ridgers (2016) found that firefighters spent the majority of a shift (average length 10.4 hours) engaged in light physical activity. During the month, firefighters spent on average 39.8 minutes being sedentary, 430.1 minutes engaged in light-intensity physical activity, 252 minutes engaged in moderate-intensity physical activity and 2 minutes engaged in vigorous-intensity activity. Gendron, Lajoie, Laurencelle, Lemoyne and Trudeau (2020) found that 11% of firefighters were physically inactive that negatively correlated to BMI, WC, WHR and DBP.

Gendron et al. (2018a; 2018b) reported that 62% of female firefighters were physically inactive, compared to 70% of male firefighters. Kirlin, Nicholas, Rusk, Parker and Rauh (2017) found that the maximum metabolic equivalents (METs) expended weekly by firefighters were significantly higher in the younger 25-34 year group compared to the older 35-44 and 45-54 year groups. Also, 43% of female firefighters over 45 years of age fell below the required 12 METs (Kirlin et al., 2017). Poston et al. (2014) reported that the prevalence of physical inactivity in firefighters of different ethnicities was similar.

2.5.3. Family History of Coronary Artery Disease in Firefighters

Savall et al. (2018) reported that 11.1% of French firefighters had a positive family history of CAD. Similarly, Smith, Fehling, Frisch et al. (2012) reported a low prevalence of family history in 5.17% of firefighters. Martin et al. (2019) reported that 25.7% of firefighters had a family history of CAD.

Ratchford et al. (2014) reported a positive family history in 32% of firefighters, but no significant association to other risk factors. Korre, Porto, Farioli et al. (2016) found that 40% of firefighters had a family history of CAD, that was significantly associated increased left ventricular mass. Glueck, Kelley, Wang et al. (1996) found that firefighters who reported a positive family history were significantly associated with CHD as they aged.

2.5.4. Aging in Firefighting

Mehrdad et al. (2013) reported a prevalence of age as a risk factor in 11.6% of firefighters. Martin et al (2019) reported a slightly higher prevalence in 35.1%. Choi, Steiss, Garcia-Rivas et al. (2016c) reported that 44.7% of firefighters had age as a risk factor. Burgess, Kurzius-Spencer, Gerkin et al. (2012) and Smith et al. (2012) reported a similar high prevalence of age as a risk factor in firefighters, i.e., 47.23% and 47.4%, respectively.

Baur et al. (2012a) found that there was a decline in cardiorespiratory fitness with advancing age, and that nearly half the firefighters were overweight, with 36% being obese. The increase in age and BMI were significantly associated, with a concomitant decrease in cardiorespiratory fitness. Perroni, Cignitti, Cortis and Capranica (2014) found that younger firefighters between the ages of 26 to 30 years, showed a decrease in maximal volume of oxygen consumed per minute ($\dot{V}O_{2max}$) of 13.4%, while firefighters aged 41 and 42 years showed the largest decrease of 20.5%. The decline in cardiorespiratory fitness with age, along with the increase in obesity, predisposes many firefighters to sudden cardiac events (Perroni et al., 2014; Seyedmehdi et al., 2016).

In American firefighters, an increase in age resulted in a significant increase in the number of CAD risk factors (Zachmeier, Han, King et al., 2018). Similarly, Burgess et al. (2012) found that older firefighters were significantly associated with increased LDL-C and atherosclerotic plaque. Li, Ochoa, Lipsey, and Nelson (2018) reported that body fat percentage (BF%) was significantly associated with age, and that overall metabolic syndrome prevalence increased as firefighters aged. Similarly, Walker, Driller, Argus, Cooke and Rattray (2014) found that as firefighters aged, BMI increased significantly and aerobic capacity decreased significantly. Choi et al. (2016c) also reported that age was significantly correlated with body composition in firefighters, specifically BMI, WC and BF%.

Li, Lipsey, Leach and Nelson (2017) found that the prevalence of metabolic syndrome increased as the firefighters aged. Furthermore, older firefighters showed more positive risk factors, i.e., hypertension, hyperglycemia, central obesity, high triglycerides, and low HDL-C. Lee and Kim (2017) found that the risk factors for metabolic syndrome increased as firefighters aged.

Poston, Haddock, Jahnke et al. (2011) reported that male firefighters had a higher mean age than female firefighters. Gendron et al. (2018a; 2018b) reported that 45.3% of male firefighters had age as a risk factor compared to only 10% of female firefighters. Smith, Graham, Stewart and Mathias (2020) reported that as male and female firefighters aged, both genders had a significant increase in BMI, but only male firefighters had a significant increase in hypercholesterolemia, hypertension, and hyperglycaemia. Previous studies showed that when firefighters are divided into different age categories, the 45 years or older category was significantly associated with BMI, SBP, DBP and dyslipidemia (Burgess et al., 2012; Damacena et al., 2020; Davis, Jankovitz & Rein, 2002; Ide, 2000; Perroni et al., 2014).

2.5.5. Hypertension in Firefighters

Hypertension is a common occurrence with age, due to an increase in body fat, as well as arterial weakening, a loss of arterial elasticity and an increase in arterial stiffening (Choi et al., 2016c; Gendron et al., 2018a; Paneni et al., 2017). Soteriades et al. (2003) reported a prevalence of hypertension in 20% of male firefighters that steadily increased with age. Previous literature indicated that hypertension is significantly associated with age and obesity, and significantly increased the risk of on-duty mortality and hospitalisation in firefighters (Davis et al., 2002; Eastlake et al., 2015; Nor, lee, Park et al., 2019; Soteriades, Hauser, Kawachi, Christiani, & Kales, 2008).

Gendron et al. (2018a) found that 12.2% of Québec firefighters were hypertensive that was associated with BMI. Risavi and Staszko (2015) found that 44.3% of firefighters were hypertensive that was also significantly associated with BMI. Female firefighters were shown to have a consistently lower prevalence of hypertension than males (Gendron et al., 2018a; Gendron 2018b; Li et al., 2017; Wolkow et al., 2014). Choi, Schnall and Dobson (2016b) reported that 10.9% of male firefighters had hypertension, whereas none of the females had hypertension. Both SBP and DBP were significantly higher in older firefighters, and the prevalence of hypertension increased proportionately with age-group by 1.2% in the 25-34 year group, 6.7% in the 35-44 year group, 17.2% in the 45-54 year group and 35.0% in the 55-61 year group (Choi et al., 2016b). The study also found that White firefighters had a higher (12.3%) prevalence of hypertension compared to Hispanic/Asian/Other (4.9%) firefighters.

Choi et al. (2016c) reported that blood pressure was significantly correlated with ethnicity, especially DBP in Hispanic firefighters and SBP in Asian firefighters.

Yang et al. (2013) found that when hypertension was combined with left ventricular hypertrophy, it increased the incidence of SCD twelvefold. This illustrates why SCD is relatively common among firefighters, especially when compounded by obesity and physical inactivity (Kales et al., 2007; Smith et al., 2013; Smith et al., 2019).

Significant factors that influence the development of hypertension are psychosocial and work-related stress (Liu, Li, Li, & Khan, 2017; Yook, 2019). Firefighting is a very stressful occupation, and studies show a direct relationship between increased stress and subsequent increased arterial stiffness and resultant hypertension (Liu et al., 2017; Yook, 2019). Choi et al. (2016b) reported that blood pressures were higher in firefighters who reported 12 to 21 shifts per month than those who worked a standard of 8 to 11 shifts per month, and was associated with increased stress and workload.

2.5.6. Obesity in Firefighters

In the United States (US), firefighters had the third highest prevalence of obesity among 41 male-based occupation groups (Choi, Schnall, Dobson et al., 2011). The prevalence of obesity ranged from 22% to 60% (Soares & Porto, 2019). Choi et al. (2016c) found that 28.87% of firefighters were obese, with 23.94% exhibiting abdominal obesity. The study further found significant correlations between BMI, WC, SBP, DBP, TC and fasting glucose. Nogueira, Porto, Nogueira et al. (2016) reported that 0.2% of firefighters were underweight, 30.8% were normal weight, 54.3% were overweight, and 14.7% were obese. The study found a significant negative correlation between body composition and cardiorespiratory fitness. Gendron et al. (2018a) found that the number of modifiable risk factors was significantly associated with BMI, and increased as BMI increased. Damacena et al. (2020) and Smith et al. (2012) reported a much higher prevalence of obesity among firefighters, wherein 51.7% were obese, and obesity was significantly associated with WC. Various studies indicate that obesity prevalence in firefighters ranged from 14.7 to 51.7%, and that obesity had significant associations with most of the other CAD risk factors (Gendron et al., 2018a; Smith et al., 2012; Choi et al., 2016c; Nogueira et al., 2016).

Previous literature consistently indicated that more male firefighters were obese than female firefighters (Crespo-Ruiz, García, Fernández-Vega, Crespo-Ruiz, & Rivas-Galan, 2020; Gendron et al., 2018a, Gendron et al., 2018b; Jahnke, Poston, Haddock et al., 2012; Li et al., 2017). In addition, obesity in firefighters significantly increased as firefighters aged (Damacena et al., 2020; Ide, 2000; Perroni et al., 2014; Soteriades et al., 2008; Soteriades, Hauser, Kawachi et al., 2005; Walker et al., 2014; Wilkinson, Brown, Poston et al., 2014). Damacena et al. (2020) found that central obesity increased as firefighters aged, with an obesity prevalence of 9.64% in the group below 30 years, 11.75% in the 30-39 year group, 34.40% in the 40-49 year group, and 36.59% in the 50-59 year group. This was supported by Choi, Dobson, Schnall and Garcia-Rivas (2016a), where obesity, especially central obesity, increased through the age categories.

Poston et al. (2014) found that Hispanic firefighters had significantly higher BMIs and BF% compared to White firefighters, and 59% of the former group were more likely to be obese. Other studies reported that a higher percentage of White firefighters were obese, and that all ethnic groups were associated with obesity (Choi et al., 2016c; Choi et al., 2016b).

Obesity results in a decrease in physical fitness and increased the workload placed on the cardiovascular system, both at rest and when performing duty-related activities (Smith et al., 2013; Sternfeld, Ngo, Satariano, & Tager, 2002). When firefighters were obese, they were 3.1 times more likely to suffer a fatality related to heart disease (Smith et al., 2013). Obesity also affected the incidence of injuries sustained by firefighters (Choi et al., 2016a; Choi et al., 2016c, Gendron et al., 2018a; Kaipust, Jahnke, Poston et al., 2019; Nogueira et al., 2016). Kaipust et al. (2019) found a significant association between sleep deprivation and on-duty injuries in obese firefighters.

2.5.7. Cigarette Smoking in Firefighters

Regular tobacco use is a major CAD risk factor amongst firefighters worldwide (Jitnarin et al., 2015; Seyedmehdi et al., 2016). A study conducted in Central America found that smoking rates for career firefighters was 13.6%, and for volunteer firefighters 17.4% (Haddock, Jitnarin, Poston, Tuley, & Jahnke, 2011). Similarly, Mehrdad et al. (2013) reported a low smoking prevalence of 11.6% in firefighters. Jitnarin et al. (2015) reported that 21% of firefighters were regular tobacco users, and that tobacco users were significantly younger. Similarly, Seyedmehdi et al. (2016) found that 21.7% of firefighters were smokers, and that cigarette smoking was negatively correlated with aerobic fitness levels. Planinc, Kokalj-Kokot, Pajk, and Zupet (2016) found that 38% of firefighters were smokers, with 42% being overweight, and 21% obese. Smith et al. (2013) showed that the relative risk of on-duty fatalities related to CHD increased 8.5 times when firefighters were cigarette smokers. Smoking leads to premature fatigue in firefighters, and thereby endangering not only the lives of the firefighters, but also the lives of the public they serve to protect (Anthonisen, Connett, & Murray, 2002; Nikolakaros, Vahlberg, Auranen, et al., 2017).

Previous literature indicated that female firefighters had a higher prevalence of cigarette smoking compared to their male counterparts (Gendron et al., 2018a; Gendron et al., 2018b; Jahnke et al., 2012; Li et al., 2017). Yoo and Franke (2009) reported that tobacco use decreased as firefighters aged, and was most prevalent in the youngest age-group of 16-30 years (40%), compared to the older groups of 31-42 years (32%) and 43-69 years (19%). This was supported by Jitnarin et al. (2015), Jitnarin, Poston, Haddock and Jahnke (2019) and Ide (2000) who all reported that cigarette smoking was most prevalent in younger firefighters, and that smoking prevalence decreased with age. Jitnarin, Haddock, Poston and Jahnke (2013) reported that fewer White firefighters were smokers. Lima, Assunção and Barreto (2013) found that firefighters of mixed-ethnicity were most likely to be smokers (25%) compared to White (18%) and Black (9%) ethnic groups. In contrast, Poston et al. (2014) reported that cigarette smoking was similar between ethnic groups.

2.5.8. Dyslipidemia in Firefighters

Savall et al. (2018) reported dyslipidemia in 19.5% of French firefighters, and that 48% were overweight. Smith et al. (2012) reported that 13.79% of firefighters had high cholesterol. Burgess et al. (2012) reported that 26.97% of firefighters had high LDL-C levels, and that LDL-C in combination with increased age and hypertension were significantly associated with atherosclerotic plaque development. Similarly, another study reported that 29.7% of firefighters had dyslipidemia (Martin et al., 2019). Eastlake et al. (2015) reported a higher prevalence of hypercholesterolemia in 35% of firefighters, and that it was significantly associated with BMI and age. Leary, Takazawa, Kannan and Khalil (2020) reported that 46.7% of firefighters had high triglycerides, and 31.1% had low HDL-C levels. Cohen, Zeig-Owens, Joe et al. (2019) reported a prevalence of high cholesterol in 56.5% of firefighters and that it was significantly associated with age.

Wolkow et al. (2014) reported that 42.1% of Australian male firefighters had elevated LDL-C compared to 26.9% of female firefighters. The study also noted that 31.3% of male firefighters had low HDL-C compared to 8.1% of female firefighters. Gendron et al. (2018a; 2018b) also reported that male firefighters had a higher prevalence of dyslipidemia than females (17.4% vs

5%, respectively). Similarly, Santora, Pillutla, Norris et al. (2013) reported that hypercholesterolemia was present in 46% of male firefighters and 11% of female firefighters. Triglycerides were also reported to be higher in male firefighters compared to females (32.3% and 26.9%, respectively) (Wolkow et al., 2014). Strauß, Foshag, Przybylek et al. (2016) reported that 36.1% of firefighters had abnormal triglyceride levels. The majority of studies reported a high prevalence of dyslipidemia in older firefighters, between 26.97% and 73% that was associated with obesity (Burgess et al., 2012; Davis et al., 2002; Eastlake et al., 2015; Smith, et al., 2016b; Soteriades et al., 2002; Soteriades et al., 2008). Choi et al. (2016c) reported that LDL-C and obesity were significantly correlated in Hispanic firefighters. Another study reported that White and Black firefighters had a similar prevalence of high cholesterol levels (Glueck, Kelley, Gupta et al., 1997).

2.6. Conclusion

Firefighters show a relatively high prevalence of CAD risk factors, with the most prevalent being obesity, dyslipidemia and physical inactivity, especially in aged male firefighters, and the least prevalent being diabetes and family history. Certain CAD risk factors occur concurrently, such as age, obesity, diabetes, dyslipidemia, hypertension and physical inactivity and are significantly associated.

CHAPTER THREE: RESEARCH METHODS

3.1. Introduction

This chapter presents how the study was designed and conducted. It starts with the study design and recruitment of participants, followed by the research procedures and statistical analysis of data. The testing procedures were based on the standardized testing procedures according to the American College of Sports Medicine (ACSM, 2018).

3.2. Research Design

This study utilized a quantitative cross-sectional, descriptive and correlational design.

3.3. Sampling of Participants

A total of 124 full-time firefighters from the City of Cape Town Fire and Rescue Service were conveniently recruited to participate in the study, including firefighters of all ages, genders, and ethnic groups.

3.4. Research Procedures

3.4.1. Participant Preparation, Selection and Screening

The participants were given pre-test instructions at least 72 hours prior to testing. Testing was scheduled for 15-20 minutes per participant. In the event of a public emergency arising, while the participants were being tested, the firefighters were excused and retested on the following shift. Since the testing occurred during winter and during late morning to early afternoon, the incidence of public emergencies was infrequent (less than 5 times).

3.4.2. Age, Gender, Family History, Cigarette Smoking and Physical Activity

A CAD risk factor assessment questionnaire (Appendix C) was used to record the participant's age, gender, ethnicity, family history of CAD, and smoking history. The tool used to measure physical activity was the International Physical Activity Questionnaire (IPAQ).

3.4.3. Blood Pressure

A data recording form was used for measuring resting blood pressure, fasting blood glucose, total blood cholesterol, waist and hip circumferences, stature and body mass. Blood pressure was measured using a standard blood pressure sphygmomanometer (Goodpro International Co., Limited, China) and stethoscope (Sprague Rappaport stethoscope, Medical Supplies and Equipment Company, Houston, Texas, USA). The standard auscultatory method of blood pressure measurement was used (ACSM, 2018, pp. 48-49). In preparation for taking blood pressure, the participant was asked to sit quietly for five minutes. The blood pressure cuff was inflated to 20 – 30 mm Hg above the first Korotkoff sound, thereafter, the pressure was gradually released at 2-3 mm Hg per second, until the sound disappeared. Systolic blood pressure was recorded on the first Korotkoff sound, and diastolic blood pressure was recorded at the disappearance of the Korotkoff sound. All measurements were recorded to the nearest 2 mm Hg, and the average of three measurements were taken as the final measurement. The participants' systolic and diastolic blood pressures were recorded thrice to ensure accuracy, with a recovery interval of at least 1 minute between measurements.

3.4.4. Blood Glucose and Total Cholesterol

Total cholesterol and non-fasting blood glucose (NFBG) were measured using an AcuTrend® Plus GC meter. The tester followed the recommended testing procedure by Roche Diagnostics equipment manual. The participant was seated in a private testing room. The test included a finger prick, wherein the initial blood droplet was wiped off and a second drop of blood used for testing purposes. The blood was placed on the glucose test strip and analysed in the AcuTrend® meter. Cholesterol was taken thereafter, following the same procedure. The manufacturers accuracy rating for the glucose and cholesterol measurements were y = 1.057x – 14.9; r = 0.920 and y = 0.973 – 0.4; r = 0.988, respectively. All biological waste was collected and disposed of by the UWC biokinetics practice.

3.4.5. Anthropometry

3.4.5.1. Stretch Stature

Stature was measured using a portable stadiometer (Charder HM200P Portstad Portable Stadiometer), standing barefoot on the level plastic plate with the heels together, and the heels, buttocks and upper back touching the stadiometer rod. The participants were measured without shoes. The participant's head was placed in the Frankfort plane (horizontal plan aligned by placing the tips of the tester's thumbs on the orbitale, and tips of the index fingers on the trigion). The participant was asked to inhale and hold, and the stadiometer rod was lowered onto the top of the participants head (vertex), compressing the hair as much as possible. The participant's height was recorded to the nearest 0.1 cm (Baharudin, Ahmad, Naidu et al., 2017; Ulijaszek & Kerr, 1999). Height was measured twice, and the average of the two measurements was recorded as the final measurement.

3.4.5.2. Body Mass

Body mass was measured privately, with the participant wearing light (minimal) clothing, i.e., males in shorts only, and females in shorts and a light top or swim suit. Body mass was measured to the nearest 50 grams using a precision electronic scale (Salter Ultimate Accuracy Digital Analyser). The participants stood on the scale with their weight evenly distributed across both feet. Body mass was taken twice and the average recorded as the final measurement, provided that the measurements were within 0.1 kg of each other (Geeta, Jamaiyah, Safiza et al., 2009; Ulijaszek & Kerr, 1999). If measurements varied more than 0.1 kg, then additional measurements were taken until the required accuracy was obtained.

3.4.5.3. Body Mass Index

Obesity was measured by BMI, which was calculated by dividing the participants body mass in kilograms by stature in metres squared, and described as kilograms per square metre, and expressed as kg•m^{-2} (ACSM, 2018, pp. 64-67).

3.4.6. Waist and Hip Circumferences

Waist circumference was measured horizontally above the point of the umbilicus and below the xiphoid process (ACSM, 2018, pp. 64-67), which is the narrowest part of the torso, between the lower costal (10th rib) border and top of the iliac crest, perpendicular to the long axis of the trunk. The cross-hand technique was used to measure all circumferences (ACSM, 2018, p. 64-67). The measuring tape was measured perpendicular (at an angle of 90˚ to a given line, plane or surface) to the body segments being measured, with the hook tab held in the right hand and the stub held in the left hand. The left hand was used to manipulate the tape to the correct level and then passed underneath the casing to grasp the stub again. The middle fingers of both hands were used to locate the tape at the precise landmark for the measurement and to orientate the tape so that the zero was easily read, with the tester's eyes level with the tape measure. Hip circumference (HC) was taken at the level of the greatest posterior protuberance of the buttocks that was, anteriorly, parallel to the level of the symphysis pubis, and the widest part of the hips. Waist and hip circumference were measure to the nearest 0.1 cm at the end of normal expiration (Geeta et al., 2009; Ulijaszek & Kerr, 1999). Measurements were taken twice and the average was recorded as the final measurement, provided they varied less than 3 mm (Geeta et al., 2009; Ulijaszek & Kerr, 1999).

3.4.7. Waist-to-Hip Ratio

The waist-to-hip ratio measurement was calculated by dividing the WC by the HC (Bacopoulou Efthymiou, Landis, Rentoumis, & Chrousos, 2015). This measurement represents how the participant's fat is distributed over the body, i.e., central (android) or peripheral (gynocoidal) fat-patterning.

3.4.8. Instrument and Tester Reliability and Validity

The research instruments used for data collection were calibrated by the department specifically for research purposes. In order to ensure intra-tester reliability and validity, only one tester was be used in the study (Geeta et al., 2009). A pilot study on five participants was conducted. Five successive measurements were taken, on all measurable study variables using standard and precision research equipment (AcuTrend® Plus GC meter, blood pressure cuff and weight scale) and reliability coefficients were calculated. The technical error of measurement (TEM) was within acceptable parameters for the research being conducted (Beharudin et al., 2017; Perini, de Oliveira, Ornellas, & de Oliveira, 2005). A test-retest reliability coefficient of 0.8 minimum was required prior to the commencement of the study to ensure tester reliability, and was standardized across all measurements (Beharudin et al., 2017; Geeta et al., 2009; Koo & Li, 2016, Perini et al., 2005). The IPAQ was used to measure physical activity, which was shown to be a reliable and valid tool (Bohlmann, Mackinnon, Kruger et al., 2001; Rai, Asif, & Malhotra, 2018; Sanda, Vistad, Haakstad et al., 2017).

3.5. Statistical Analysis

All data was captured by double-entry into a Microsoft Office Excel spreadsheet, and then cleaned of errors. Thereafter, it was exported to the Statistical Package for the Social Sciences (SPSS) version 26 for data analysis. All electronic back-up copies of the data were stored on computer, against password protected files, with access controlled by the researcher. Each participant was allocated a code to protect their identity, when collecting and capturing the data onto the spread sheets (Microsoft Excel and SPSS).

Descriptive statistical analysis (mean, standard deviation and frequencies) and inferential statistics (Spearman's r correlation coefficient, Pearson's Chi Square and Kruskal-Wallis H) were generated. A p-value of less than 0.05 was used to indicate statistical significance. The data was checked for normality using a Shapiro-Wilks test.

Spearman's coefficient was used to assess statistically significant correlations between continuous CAD risk factors (age, BMI, WC, HC, WHR, SBP, DBP, blood glucose and TC), and the strength of all correlations were reported using Akoglu (2018) and Mukaka (2012). The Chi-square test was used to determine statistically significant associations between the categorical risk factors (family history, cigarette smoking, physical inactivity, hypertension and obesity, gender, age, and ethnicity). The Kruskal-Wallis H test was used to determine statistically significant differences between continuous variables. The Mann-Whitney U test was applied post hoc with a Bonferroni correction, so that all effects were reported at a significance level of less than 0.0083 (0.05 ÷ 6 comparative groups), and all effects for ethnic groups were reported at a 0.016 (0.05 ÷ 3 comparative groups) critical level of significance.

3.6. Ethical Considerations

Ethics clearance to conduct the study was obtained from the Biomedical Research Ethics Committee (BMREC) at the University of the Western Cape (Appendix E). Permission to test the firefighters was obtained from the Chief Fire Officer, as well as the City of Cape Town.

All participants were given detailed information about the aim and objectives of the study, the methods, as well as the risks and benefits (Appendix A). Thereafter, written consent was obtained from the participants (Appendix B). Participation in the study was voluntary with the option of withdrawing at any stage, without any negative consequences. The participants' information and measurements were collected privately and an alpha-numeric coding system was used to ensure confidentiality, with due respect for the participants' dignity and autonomy at all times.

All the information obtained from the participants remained anonymous, and if the results are to be published, all the participants' personal information will remain confidential. No personal information of the participants will be disclosed to the Fire Department that could compromise the confidentiality of the participants. All information regarding this research is stored securely in the SRES department, with access available to the researcher and supervisor only. All participant information will be destroyed after a period of five years.

CHAPTER FOUR: RESULTS

4.1. Introduction

This chapter presents the results of the data analysis, and an interpretation of the results. In this study, a total of 124 firefighters, with a mean age of 37.53±9.05 years, participated from various fire stations in the City of Cape Town (CoCT) Fire and Rescue Service. The majority of firefighters were male (79.03), and 20.97% were female. The mean ages of male and female firefighters were 37.84±9.80 years and 36.38±5.36 years, respectively. When all participants were separated into age-group categories, the age-group 20-29 years represented 19.35% of the participants in the study, the age-group 30-39 years had the highest with 44.35%, the age-group 40-49 years had 24.19%, and the age-group 50-65 years had the lowest with 12.09%. The majority of firefighters were Coloured (56.45%), with a mean age of 37.67±8.79 years, followed by Black firefighters (25.81%), with a mean age of 36.38±8.01 years, and then White firefighters (16.94%), with a mean age of 39.38±11.31 years.

4.2. Prevalence of Coronary Artery Disease Risk Factors

4.2.1. Diabetes

Diabetes was the CAD risk factor least prevalent (8.87%) in firefighters (Figure 4.1), and amongst male firefighters only (Table 4.1). The results showed that the prevalence of diabetes in firefighters was age-related. Based on age-group, diabetes was absent in the youngest group 20-29 years, while the 30-39 years had 1.81%. The age-group 40-49 years had a prevalence of 26.67%, and the 50-65 years had 33.33%, the highest. The prevalence of diabetes among the various ethnic groups was 10.00% in Coloured firefighters, 9.52% in White firefighters and 6.25% in Black firefighters.

4.2.2. Physical Inactivity

Physical inactivity was prevalent in 13.70% of firefighters (Figure 4.1). Both male and female firefighters had a similar prevalence for physical inactivity, 13.27% and 15.38%, respectively (Table 4.1). The youngest age-group of 20-29 years had physical inactivity in 20.83%, the age-group of 30-39 years had 9.09%, the age-group of 40-49 years had 6.67%, and the age-group of 50-65 years had the highest with 33.33%. According to ethnic groups, Coloured firefighters had the highest prevalence of physical inactivity with 15.71%, followed by Black firefighters with 12.50%, and White firefighters with 9.52%.

4.2.3. Family History

A total of 20.96% of firefighters reported a positive family history of CAD (Figure 4.1). Males and females reported a similar prevalence of family history, 21.42% and 19.23%, respectively (Table 4.1). When reported according to age-group, family history was prevalent in 12.50% of firefighters aged 20-29 years, in 10.90% aged 30-39 years, in 46.67% aged 40-49 years, and in 20.00% aged 50-65 years. White firefighters had the highest prevalence of family history with 38.08%, followed by Coloured firefighters with 22.86%, and Black firefighters with 6.25%.

4.2.4. Age

A total of 23.39% of firefighters had age as a CAD risk factor (Figure 4.1), and they were all male (29.59%) (Table 4.1). Age, as a CAD risk factor, was absent in the age groups 20-29 years and 30-39 years, while the age-group 40-49 years had 56.66% with age as a risk factor, and the age-group 50-65 years had all firefighters with age as a risk factor. Coloured firefighters had the highest prevalence of age as a risk factor with 25.71%, followed by White firefighters with 19.00%, and Black firefighters with 9.38%.

4.2.5. Hypertension

A total of 33.06% of firefighters had hypertension as a CAD risk factor (Figure 4.1). Among male firefighters, 34.69% had hypertension, and among female firefighters, 26.92% had hypertension (Table 4.1). In the age groups, hypertension was also age-related. In the age-group 20-29 years 8.33% had hypertension, the 30-39 years had 29.09%, the 40-49 years had 50.00%, and the 50-65 years had 53.33%, the highest. Coloured firefighters had the highest prevalence of hypertension in 37.14%, and White and Black firefighters had a similar prevalence with 28.57% and 28.14%, respectively. Among all firefighters, 18.55% were pre-hypertensive and 48.39% were normotensive (Table 4.1).

4.2.6. Obesity

A total of 37.10% of firefighters were obese (Figure 4.1). Male firefighters had 31.63% obese and female firefighters had 53.85% obese (Table 4.1). The prevalence of obesity was age-related. The age-group 20-29 years had 12.50% obese, followed by the 30-39 years with 32.72%. The older two groups, 40-49 years and 50-65 years, had the same obesity prevalence of 53.33% each. Obesity was most prevalent in White firefighters with 42.86%, followed by Coloured firefighters with 37.14%, and least prevalent in Black firefighters with 31.25%.

Furthermore, central obesity was prevalent in 29.59% of male firefighters, and 65.00% of female firefighters (Table 4.1). Central obesity was least prevalent in the youngest age-group of 20-29 years with 20.83%, followed by the 30-39 years with 34.54%, and the oldest two groups i.e., 40-49 years and 50-65 years, with 53.33% each. The prevalence of central obesity was highest in White firefighters with 42.86%, followed by Coloured firefighters with 38.57%, and lowest in Black firefighters with 28.13%.

4.2.7. Cigarette Smoking

A total of 39.52% of firefighters were current cigarette smokers or had quit within the last 6 months (Figure 4.1). Among the male firefighters, 44.89% were smokers, compared to 19.23% of female firefighters (Table 4.1). Among the smokers, 36.73% smoked less than 5 cigarettes per day and were classified as light smokers, 51.02% smoked 6 to 19 cigarettes a day and were classified as moderate smokers, and 14.29% smoked 20 or more cigarettes a day and were classified as heavy smokers (Kaleta, Makowiec-Dąbrowska, Dziankowska-Zaborszczyk, & Fronczak, 2012; Schane, Ling, & Glantz, 2010). Furthermore, 4.00% of firefighters recently quit smoking, with half (2.00%) of the recently quit smokers having asthma.

The youngest age-group 20-29 years had the highest prevalence of smokers (45.83%), followed by the 30-39 years with 43.63%. The age-group 40-49 years had the lowest prevalence of smokers with 30.00%, and the 50-65 years had 33.33%. Cigarette smoking was most prevalent in White firefighters with 47.62%, followed by Coloured firefighters with 41.43%, and lowest in Black firefighters with 28.13%.

4.2.8. Dyslipidemia

Dyslipidemia was the most prevalent CAD risk factor, and present in 40.32% of firefighters (Figure 4.1). Dyslipidemia among male and female firefighters was 41.84% and 34.62%, respectively (Table 4.1). Dyslipidemia was least prevalent in the youngest age-group 20-29 years with 12.50%, and increased in the 30-39 years to 40.00%, in the 40-49 years it was 56.67%, and in the 50-65 years it was 53.33%. Coloured firefighters with dyslipidemia was 44.29%, followed by White firefighters with 42.86%, and lowest in Black firefighters with 31.25%.

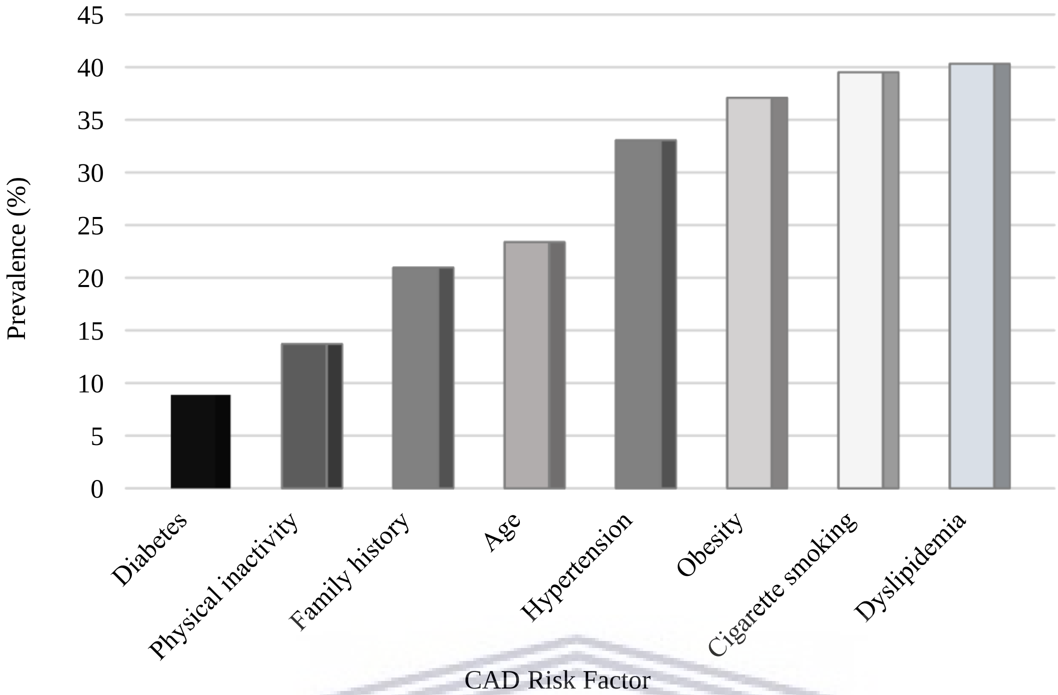

Figure 4.1: Prevalence of CAD risk factors in firefighters.

Table 4.1: Prevalence of CAD risk factors among firefighters according to gender, age-group and ethnicity.

	Gender		Age Group				Ethnicity[#]		
CAD Risk Factor	Male (n = 98)	Female (n = 26)	20-29 (n = 24)	30-39 (n = 55)	40-49 (n = 30)	50-65 (n = 15)	Coloured (n = 70)	Black (n = 32)	White (n = 21)
	%	%	%	%	%	%	%	%	%
Age (♂ ≥45y; ♀ ≥55y)	29.59	0.00	0.00	0.00	56.66	100.00	25.71	9.38	19.00
Family history ( ) (♂ ≤55y; ♀ ≤65y)	21.42	19.23	12.50	10.90	46.67	20.00	22.86	6.25	38.09
Cigarette smoking ( )	44.89	19.23	45.83	43.63	30.00	33.33	41.43	28.13	47.62
Physical inactivity ( )	13.27	15.38	20.83	9.09	6.67	33.33	15.71	12.50	9.52
Obesity (BMI ≥30 kg•m^{-2})	31.63	53.85	12.50	32.72	53.33	53.33	37.14	31.25	42.86
Overweight[PC] (I)	45.91	30.77	41.66	43.63	40.00	46.67	41.43	43.75	47.62
WC (II)	29.59	65.00	20.83	34.54	53.33	53.33	38.57	6.25	42.86
WHR (III)	33.67	42.30	12.5	29.09	46.67	73.33	37.14	28.13	42.86
Hypertension (≥140/90 mm Hg)	34.69	26.92	8.33	29.09	50.00	53.33	37.14	28.13	28.57
Systolic (≥140 mm Hg)	18.37	7.69	8.33	10.91	30.00	20.00	14.29	21.88	14.29
Diastolic (≥90 mm Hg)	17.34	15.38	0.00	18.18	33.33	6.67	22.86	9.38	9.52
Pre-hypertension[PC]	18.37	19.23	8.33	21.82	20.00	20.00	17.14	21.88	19.05
Diabetes (V)	11.22	0.00	0.00	1.81	26.67	33.33	10.00	6.25	9.52
Pre-diabetes[PC] (VI)	6.12	3.85	8.33	0.00	13.33	13.33	7.14	3.13	4.76
Dyslipidemia (VII)	41.84	34.62	12.50	40.00	56.66	53.33	44.29	31.25	42.86

Note: Italics indicates supporting measurements; [PC] indicates pre-clinical measurement; ♂ – indicates male, ♀ – indicates female; – indicates family history myocardial infarction, coronary revascularization or sudden death; BMI – body mass index; WC – waist circumference; WHR – waist-to-hip ratio; – indicates current smoker or quit within the last 6 months; – indicates not meeting the minimum ACSM exercise requirements of moderate-intensity exercise for 30 minutes, thrice weekly; I – indicates BMI <30 kg•m^{-2}; II – indicates WC ♂ ≥102 cm; ♀ ≥88 cm; III – indicates ♂ ≥0.95; ♀ ≥ 86; IV – indicates BP ≤139/89 mm Hg; V – indicates non-fasting blood glucose ≥11.05 mmol•L^{-1}; VI – indicates non-fasting blood glucose ≤11.04 mmol•L^{-1}; VII – indicates total cholesterol ≥5.18 mmol•L^{-1}. Ethnicity[#]: n = 123 due to one firefighter not fitting in the three ethnic groups.

The mean BMI for all firefighters was 29.31±5.65 kg•m^{-2} (Table 4.2), and for male firefighters 28.66±5.30 kg•m^{-2}, and for female firefighters 31.72±6.34 kg•m^{-2}. There was a significant difference in BMI between male and female firefighters [U = 889.00, p = 0.018]. The mean BMIs for the age groups 20-29 years, 30-39 years, 40-49 years, and 50-65 years were 25.65±3.56, 28.99±5.38, 31.38±5.38, and 32.18±6.36 kg•m^{-2}, respectively. There was a significant difference in BMI between age groups [H(3) = 20.41, p < 0.001]. The mean BMIs for White, Coloured and Black firefighters were 30.79±5.88, 29.11±5.75, and 28.94±5.44 kg•m^{-2}, respectively. There was no significant difference in BMI based on ethnicity [H(2) = 1.87, p = 0.392].

The mean WC for all firefighters was 96.41±14.2 cm (Table 4.2), and for male firefighters 96.09±14.21 cm, and for female firefighters 97.59±14.37 cm. There was no significant difference in WC between male and female firefighters [U = 1229.50, p = 0.785]. The mean WC of firefighters increased with age, with the age-group 20-29 years having 86.32±9.80 cm, the 30-39 years with 94.62±13.10 cm, the 40-49 years with 102.49±13.17 cm, and the 50-65 years with 106.90±14.39 cm. There was a significant difference in WC by age group [H(3) = 28.55, p < 0.001]. The mean WCs for White, Coloured and Black firefighters were 100.63±13.48, 97.14±14.25, and 92.36±14.04 cm, respectively. There was no significant difference in WC based on ethnicity [H(2) = 5.92, p = 0.052].

The mean WHR for all firefighters was 0.90±0.09, and for male and female firefighters, 0.91±0.08 and 0.85±0.66, respectively. There was a significant difference in WHR between male and female firefighters [U = 679.00, p < 0.001]. The mean WHRs were age-related, and for age groups 20-29 years, 30-39 years, 40-49 years and 50-65 years they were 0.85±0.06, 0.88±0.65, 0.93±0.11 and 0.97±0.05, respectively. There was a significant difference in WHR between age groups [H(3) = 30.41, p < 0.001]. The mean WHR for Coloured, White and Black firefighters were 0.92±0.09, 0.92±0.07 and 0.85±0.07, respectively. There was a significant difference in WHR between ethnic groups [H(2) = 15.99, p < 0.001].

The mean SBP for all firefighters was 121.69±15.15 mm Hg, and the mean DBP was 77.10±11.69 mm Hg (Table 4.2). The mean SBPs for male and female firefighters were 123.06±15.29 mm Hg and 116.54±13.70 mm Hg, respectively, and the mean DBPs for male and female firefighters were 78.10±11.46 mm Hg and 73.31±11.95 mm Hg, respectively. There was no significant difference in SBP [U = 978.00, p = 0.069] or DBP [U = 97.00, p = 0.056]. The mean SBP and DBP for the age-group 20-29 years were 117.50±11.62 and 71.92±10.26 mm Hg, respectively. In the age-group 30-39 years the mean SBP and DBP were 119.16±13.73 and 75.75±11.47 mm Hg, respectively. In the age-group 40-49 years the mean SBP and DBP were 127.93±16.73 and 83.33±12.04 mm Hg, respectively. And, in the age-group 50-65 years the mean SBP and DBP were 125.20±18.34 and 77.87±8.99 mmHg, respectively. There was a significant difference in both SBP [H(3) = 7.82, p = 0.050] and DBP [H(3) = 12.44, p = 0.006] based on age-group. The mean SBP and DBP for White firefighters were 123.24±13.78 and 77.62±8.73 mm Hg, Coloured firefighters were 121.63±14.89 and 78.89±11.86 mm Hg, and for Black firefighters were 121.19±16.99 and 72.81±12.36 mm Hg, respectively. There was no significant difference in SBP [H(2) = 0.51, p = 0.774] or DBP [H(2) = 3.64, p = 0.162] based on ethnic groups.

The mean NFBG concentration was 5.93±2.24 mmol•L^{-1} for all firefighters, with male firefighters having 6.01±2.48 mmol•L^{-1}, and female firefighters having 5.65±0.95 mmol•L^{-1} (Table 4.2). No significant difference in NFBG was found between male and female firefighters [U = 126.00, p = 0.961]. The mean NFBG was 5.81±0.93 mmol•L^{-1} in the age-group 20-29 years, 5.34±0.87 mmol•L^{-1} in the 30-39 years, 6.87±3.91 mmol•L^{-1} in the 40-49 years, and 10.63±2.16 mmol•L^{-1} in the 50-65 years. There was no significant difference in NFBG between age groups [H(3) = 5.56, p = 0.135]. The mean NFBG concentration was highest in White firefighters with 6.47±4.08 mmol•L^{-1}, followed by Black firefighters with 5.88±2.13 mmol•L^{-1}, and lowest in Coloured firefighters with 5.78±1.41 mmol•L^{-1}. There was no significant difference in NFBG between ethnic groups [H(2) = 0.28, p = 0.871].

The mean TC was 4.92±0.96 mmol•L^{-1} for all firefighters (Table 4.2), and for male and female firefighters, 4.93±0.99 and 4.84±0.79 mmol•L^{-1}, respectively. There was no significant difference in TC between male and female firefighters [U = 1255.50, p = 0.909]. The mean TC concentration was 4.46±0.92 mmol•L^{-1} for the age-group 20-29 years, 5.03±0.92 mmol•L^{-1} for the 30-39 years, 5.13±0.96 mmol•L^{-1} for the 40-49 years, and 4.79±1.12 mmol•L^{-1} for the 50-65 years. There was a significant difference in TC between age groups [H(3) = 12.44, p = 0.006]. Coloured firefighters had the highest mean TC with 5.02±0.94 mmol•L^{-1}, followed by white firefighters with 4.96±1.13 mmol•L^{-1}, and black firefighters with 4.68±0.87 mmol•L^{-1}. There was no significant difference in TC between ethnic groups [H(2) = 3.23, p = 0.199].

Table 4.2: CAD risk factor measurements according to demographic characteristics.

CAD Risk Factor	$\bar{x}$ / SD	Total (n = 124)	Gender: Male (n = 98)	Gender: Female (n = 24)	Gender: p value	Age Group: 20-29 (n = 24)	Age Group: 30-39 (n = 55)	Age Group: 40-49 (n = 30)	Age Group: 50-65 (n = 15)	Age Group: p value	Ethnicity#: Coloured (n = 70)	Ethnicity#: Black (n = 32)	Ethnicity#: White (n = 21)	Ethnicity#: p value
Body mass index ($kg \cdot m^{-2}$)	$\bar{x}$	29.31	28.66	31.72	0.018*	25.65	28.99	31.38	32.18	<0.001**	29.11	28.94	30.79	0.392
	SD	5.65	5.30	6.34		3.56	5.53	5.38	6.36		5.75	5.33	5.88	
Waist circumference (cm)	$\bar{x}$	96.41	96.09	97.59	0.785	86.32	94.62	102.49	106.90	<0.001**	97.14	92.36	100.63	0.052
	SD	14.19	14.21	14.37		9.80	13.10	13.17	14.39		14.25	14.04	13.48	
Waist-to-hip ratio	$\bar{x}$	0.90	0.91	0.85	<0.001**	0.85	0.88	0.93	0.97	<0.001**	0.92	0.85	0.92	<0.001**
	SD	0.09	0.08	0.66		0.06	0.65	0.11	0.05		0.09	0.07	0.07	
Systolic blood pressure (mm Hg)	$\bar{x}$	121.69	123.06	116.54	0.069	117.50	119.16	127.93	125.20	0.050*	121.63	121.19	123.24	0 .774
	SD	15.15	15.28	13.70		11.62	13.73	16.73	18.34		14.89	16.99	13.78	
Diastolic blood pressure (mm Hg)	$\bar{x}$	77.10	78.10	73.31	0.125	71.92	75.75	83.33	77.87	0.006**	78.89	72.81	77.62	0.162
	SD	11.69	11.46	11.95		10.26	11.47	12.04	8.99		11.86	12.36	8.73	
Non-fasting blood glucose ($mmol \cdot L^{-1}$)	$\bar{x}$	5.93	6.01	5.65	0.961	5.81	5.34	6.87	10.63	0.135	5.78	5.88	6.47	0.871
	SD	2.24	2.48	0.95		0.93	0.87	3.91	2.16		1.41	2.13	4.08	
Total cholesterol ($mmol \cdot L^{-1}$)	$\bar{x}$	4.92	4.93	4.84	0.909	4.46	5.03	5.13	4.79	0.006**	5.02	4.68	4.96	0.199
	SD	0.96	0.99	0.79		0.92	0.92	0.96	1.12		0.94	0.87	1.13	

Note: *indicates statistically significant differences <0.05; **indicates statistically significant differences <0.01.
Ethnicity#: n = 123 due to one firefighter not falling into the three ethnic groups.

Among all firefighters, 13.71% presented with no CAD risk factors, 29.84% had one CAD risk factor, 19.35% had two, 23.39% had three, 5.65% had four, 6.45% had five, and 1.61% had six risk factors (Figure 4.2). Among female firefighters, 11.54% had zero CAD risk factors, 38.46% had one, 25.92% had two, and 23.08% had three risk factors. In male firefighters, 14.29% had zero CAD risk factors, 27.55% had one, 17.35% had two, 23.47% had three, 7.14% had four, 8.16% had five, and 2.04% had six risk factors.

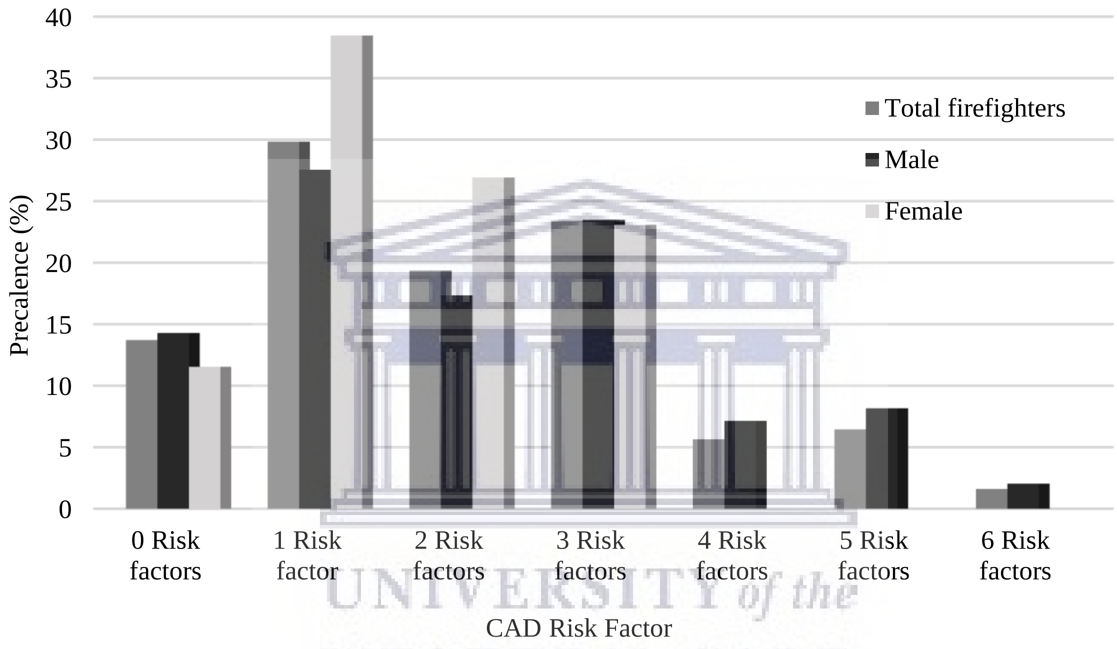

Figure 4.2: Prevalence of CAD risk factors in male and female firefighters.

Figure 4.3 illustrates the prevalence of CAD risk factors according to age-group. The number of CAD risk factors generally increased with age. In the age-group 20-29 years, 29.17% had zero risk factors, in 30-39 years, 14.55% had zero risk factors, in 40-49 years, 3.33% had zero risk factors, and in the age-group 50-65 years, there were no firefighters with zero risk factors. The age-group 20-29 years had one risk factor in 41.67%, the 30-39 years had one risk factor in 38.18%, the 40-49 years had one risk factor in 20.00%, and the 50-65 had one risk factor in 6.67%. The age-group 20-29 years had two risk factors in 29.17%, the age-group 30-39 years had two risk factors in 21.82%, the age-group 40-49 years had two risk factors in 10.00%, and the 50-65 years age-group had two risk factors in 13.33%. In the age-group 20-29 years, none had three CAD risk factors. The age-group 30-39 had three risk factors in 18.18%, the 40-49 years had three risk factors in 36.67%, and the 50-65 years had three risk factors in 53.33%. Four CAD risk factors were absent in the age groups 20-29 and 50-65 years. The age-group 30-39 years had four CAD risk factors present in 7.27%, and the 40-49 years had four risk factors in 10.00%. Five CAD risk factors were absent in age groups 20-29 years and 30-39 years. Five CAD risk factors were present in 16.67% in the age-group 40-49 years, and in 20.00% in the age-group 50-65 years. The two older groups were the only groups with six CAD risk factors, with the age-group 40-49 years and the 50-65 years with 3.33% and 6.67%, respectively.

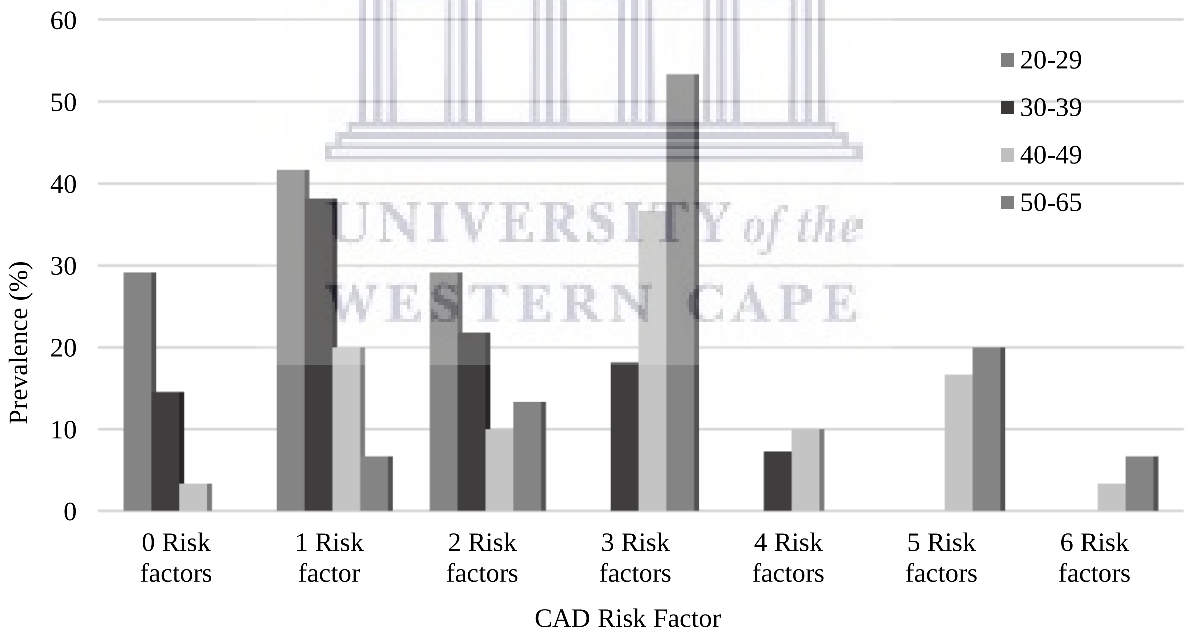

Figure 4.3: Prevalence of CAD risk factors in firefighters based on age-group.

Figure 4.4 illustrates the prevalence of CAD risk factors according to ethnic-group. Coloured firefighters had zero CAD risk factors in 12.86%, followed by Black firefighters with zero risk factors in 15.63%, and White firefighters with zero risk factors in 14.29%. Coloured firefighters had one risk factor in 25.71%, Black firefighters had one risk factor in 46.00%, and White firefighters had one risk factor in 14.29%. Coloured firefighters had two CAD risk factors in 20.00%, Black firefighters had two risk factors in 15.63%, and White firefighters had two risk factors in 23.81%. Coloured firefighters had three CAD risk factors in 24.29%, Black firefighters had three risk factors in 15.63%, and White firefighters had three risk factors in 33.33%. Coloured firefighters had four CAD risk factors in 5.71%, followed by Black firefighters with 6.25%, and White firefighters with 4.76%. White and Coloured firefighters were the only ethnic groups to have five CAD risk factors prevalent in 9.52% and 8.57%, respectively. Coloured firefighters were the only ethnic group to have six CAD risk factors in 2.86%.

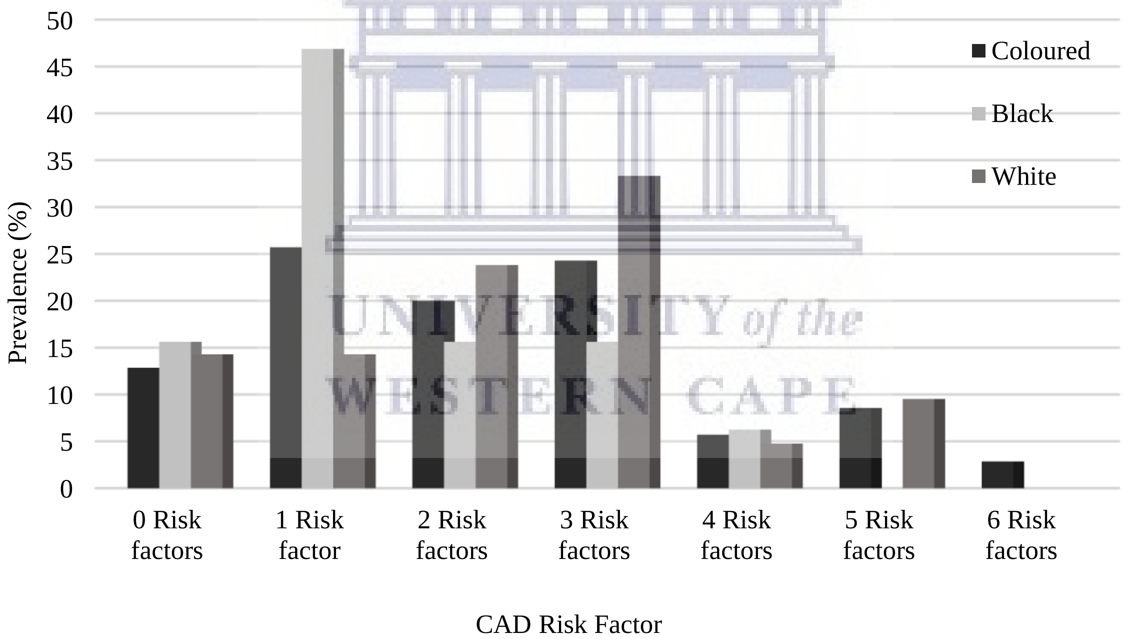

Figure 4.4: Prevalence of CAD risk factors firefighters based on ethnicity.

A post-hoc Bonferroni correction was applied to the findings in Table 4.2 to minimize type I error. Therefore, all effects are reported at a significance level of 0.0083 for age-group, and 0.0166 for ethnic-group. There was a significant difference in BMI between age groups 20-29 and 40-49 years ($U = 134.00$, $p < 0.001$), and between 20-29 and 50-65 years ($U = 54.00$, $p <$

0.001) (Table 4.3). Similarly, WC was significantly different between age groups 20-29 and 40-49 years (U = 103.00, p < 0.001), between 20-29 and 50-65 years (U = 38.50, p < 0.001), between 30-39 and 40-49 years (U = 532.00, p = 0.007), and between 30-39 and 50-65 years (U = 206.00, p = 0.003). Significant differences were found in WHR between age groups 20-29 and 40-49 years (U = 168.00, p = 0.001), between 20-29 and 50-65 years (U = 22.50, p < 0.001) and between 30-39 and 50-65 years (U = 108.00, p < 0.001). A significant difference was found in DBP between age groups 20-29 and 40-49 years (U = 169.00, p = 0.001). A significant difference was found in TC between age groups 20-29 and 30-39 years (U = 369.500, p = 0.002), and between 20-29 and 40-49 years (U = 186.00, p = 0.002). There was a significant difference in WHR between Coloured and Black firefighters (U = 608.50, p < 0.001), and between Black and White firefighters (U = 160.50, p = 0.006).

Table 4.3: Statistically significant differences in CAD risk factors based on demographic characteristics.

Age-group #		BMI	WC	HC	WHR	SBP	DBP	NFBG	TC
20-29 vs 30-39	U Sig.	425.50 0.012	424.50 0.012	458.50 0.032	480.00 0.055	580.00 0.392	543.00 0.210	487.50 0.065	369.50 0.002#
20-29 vs 40-49	U Sig.	134.00 <0.001#	103.00 <0.001#	197.50 0.005#	168.00 0.001#	214.00 0.011	169.00 0.001#	355.50 0.937	186.00 0.002#
20-29 vs 50-65	U Sig.	54.00 <0.001#	38.50 <0.001#	97.00 0.016	22.50 <0.001#	132.00 0.172	124.50 0.110	174.00 0.875	155.00 0.484
30-39 vs 40-49	U Sig.	592.50 0.033	532.00 0.007#	703.50 0.264	546.00 0.010	590.00 0.030	549.00 0.011	622.00 0.062	772.00 0.626
30-39 vs 50-65	U Sig.	275.00 0.049	206.00 0.003#	356.50 0.423	108.00 <0.001#	342.00 0.312	372.00 0.558	321.50 0.192	313.00 0.154
40-49 vs 50-65	U Sig.	214.00 0.791	177.00 0.248	224.50 0.990	147.50 0.062	206.00 0.646	159.50 0.109	219.50 0.894	164.50 0.145
Ethic Group¶									

Coloured vs White	U	592.00	618.00	557.00	677.50	706.00	687.00	673.00	671.00
	Sig.	0.178	0.270	0.094	0.588	0.784	0.648	0.558	0.549
Coloured vs Black	U	1113.50	873.00	968.00	608.50	1053.50	865.50	1092.00	877.50
	Sig.	0.963	0.075	0.273	<0.001[¶]	0.631	0.064	0.840	0.080
Black vs White	U	275.50	207.50	317.00	160.50	292.50	270.50	330.50	282.00
	Sig.	0.271	0.019	0.730	0.006[¶]	0.427	0.227	0.920	0.326

Note: [#] indicates $p < 0.0083$ for age-group; [¶] indicates $p < 0.016$ for ethnic group; U – indicates Man-Whitney U test statistic; sig. – indicates significance level.
BMI – body mass index; WC – waist circumference; HC – hip circumference; WHR – waist-to-hip ratio; SBP – systolic blood pressure; DBP – diastolic blood pressure; NFBG – non-fasting blood glucose; TC – total cholesterol.

In Table 4.4, there was a significant moderate correlation between age and BMI ($r = 0.42$, $p < 0.001$), between age and WC ($r = 0.52$, $p < 0.001$), and between age and WHR ($r = 0.52$, $p < 0.001$). There was a significant weak correlation between age and SBP ($r = 0.28$, $p = 0.002$) and between age and DBP ($r = 0.31$, $p < 0.001$). There was a significant strong correlation between BMI and WC ($r = 0.88$, $p < 0.001$), a significant moderate correlation between BMI and WHR ($r = 0.54$, $p < 0.001$), between BMI and DBP ($r = 0.48$, $p < 0.001$), a significant weak correlation between BMI and SBP ($r = 0.33$, $p < 0.001$), and between BMI and TC ($r = 0.18$, $p = 0.046$). There was a significant moderate correlation between WC and DBP ($r = 0.48$, $p < 0.001$), a significant weak correlation between WC and SBP ($r = 0.34$, $p < 0.001$), and between WC and TC ($r = 0.21$, $p = 0.017$). There was a significant weak correlation between HC and WHR ($r = 0.24$, $p = 0.009$), between HC and DBP ($r = 0.25$, $p = 0.008$), and between DBP and TC ($r = 0.25$, $p = 0.006$).

Table 4.4: Relationship between the various CAD risk factors in firefighters.

Variables	Age	BMI	WC	HC	WHR	SBP	DBP	NFBG
BMI	0.42**							
WC	0.52**	0.87**						
HC	0.27**	0.81**	0.74**					
WHR	0.52**	0.54**	0.79**	0.24**				
SBP	0.28**	0.33**	0.34**	0.17	0.28**			
DBP	0.31**	0.39**	0.48**	0.25**	0.43**	0.73**		
NFBG	0.09	0.05	0.08	-0.01	0.11	0.17	-0.04	
TC	0.17	0.18*	0.21*	0.14	0.15	0.08	0.25**	-0.06

Note: *indicates statistically significant correlation <0.05; **indicates statistically significant correlation <0.01. BMI – body mass index; WC – waist circumference; HC – hip circumference; WHR – waist-to-hip ratio; SBP – systolic blood pressure; DBP – diastolic blood pressure; NFBG – non-fasting blood glucose; TC – total cholesterol.

In Table 4.5, male firefighters had a significant moderate correlation between age and BMI (r = 0.42, p < 0.001), between age and WC (r = 0.53, p < 0.001), between age and WHR (r = 0.58, p < 0.001), a significant weak correlation between age and SBP (r = 0.26, p = 0.010) and between age and DBP (r = 0.28, p = 0.005). Female firefighters had a significant moderate correlation between age and BMI (r = 0.51, p = 0.008), between age and WC (r = 0.41, p = 0.036), and between age and HC (r = 0.44, p = 0.027). Male firefighters had a significant weak correlation between BMI and SBP (r = 0.26, p < 0.001), and between BMI and DBP (r = 0.38, p < 0.001). Female firefighters had a significant moderate correlation between BMI and SBP (r = 0.48, p = 0.013), and between BMI and DBP (r = 0.68, p < 0.001). In male firefighters, WC had a significant moderate correlation with DBP (r = 0.41, p < 0.001), a significant weak correlation with SBP (r = 0.33, p = 0.001), and with TC (r = 0.25, p = 0.015). In female firefighters, WC had a significant strong correlation with DBP (r = 0.71, p < 0.001). In male firefighters, DBP had a significant weak correlation with TC (r = 0.29, p = 0.003).

Table 4.5: Relationship between the various CAD risk factors according to gender.

Variables	Gender	Age	BMI	WC	HC	WHR	SBP	DBP	NFBG
BMI	Male	0.42**							
	Female	0.51**							
WC	Male	0.53**	0.91**						
	Female	0.41**	0.87**						
HC	Male	0.28**	0.79**	0.79**					
	Female	0.44**	0.93**	0.84**					
WHR	Male	0.58**	0.73**	0.86**	0.44**				
	Female	0.24	0.48*	0.76**	0.32				
SBP	Male	0.26**	0.35**	0.33**	0.23*	0.32**			
	Female	0.38	0.48*	0.38	0.47**	0.22			
DBP	Male	0.28**	0.38**	0.41**	0.27*	0.27**	0.36**		
	Female	0.38	0.68**	0.71**	0.69**	0.53**	0.83**		
NFBG	Male	0.10	0.04	0.08	-0.03	-0.03	0.14	-0.05	
	Female	-0.26	0.12	0.04	0.04	0.00	-0.00	-0.04	
TC	Male	0.19	0.05	0.25*	0.19	0.19	0.17	0.29**	-0.06
	Female	0.01	0.07	0.10	0.05	0.03	-0.05	-0.0	-0.72

Note: *indicates statistically significant correlation <0.05; **indicates statistically significant correlation <0.01. BMI – body mass index; WC – waist circumference; HC – hip circumference; WHR – waist-to-hip ratio; SBP – systolic blood pressure; DBP – diastolic blood pressure; NFBG – non-fasting blood glucose; TC – total cholesterol.

In the age-group 20-29 years, there was a significant moderate correlation between BMI and WC ($r = 0.69$, $p < 0.001$), between DBP and NFBG ($r = -0.55$, $p = 0.006$), and between TC and DBP ($r = 0.41$, $p = 0.044$) (Table 4.6). In the age-group 30-39 years, there was a significant strong correlation between BMI and WC ($r = 0.91$, $p < 0.001$), a significant moderate correlation between BMI and WHR ($r = 0.49$, $p < 0.001$), between BMI and DBP ($r = 0.42$, $p = 0.001$), between WC and DBP ($r = 0.43$, $p = 0.001$), a significant weak correlation between WC and TC ($r = 0.39$, $p = 0.011$), between BMI and SBP ($r = 0.29$, $p = 0.035$), and between BMI and TC ($r = 0.27$, $p = 0.043$). In the age-group 40-49 years, there was a significant strong correlation between BMI and WC ($r = 0.83$, $p < 0.001$), and a significant weak correlation between BMI and WHR (r = 0.37, p = 0.045). In the age-group 50-65 years, there was a significant strong correlation between BMI and WC (r = 0.90, p < 0.001), and a significant moderate correlation between BMI and WHR (r = 0.62, p = 0.014).

Table 4.6: Relationship between the various CAD risk factors according to age-group.

Variables	Age-group	Age	BMI	WC	HC	WHR	SBP	DBP	NFBG
BMI	20-29	-0.16							
	30-39	0.21							
	40-49	0.03							
	50-65	0.24							
WC	20-29	0.03	0.67**						
	30-39	0.18	0.91**						
	40-49	0.29	0.83**						
	50-65	0.24	0.90**						
HC	20-29	-0.02	0.81**	0.71**					
	30-39	0.23	0.84**	0.82**					
	40-49	-0.38*	0.72**	0.47**					
	50-65	0.19	0.85**	0.96**					
WHR	20-29	0.44*	0.38	0.86**	0.33				
	30-39	0.08	0.49**	0.68**	0.18				
	40-49	0.51**	0.37*	0.73**	-0.14				
	50-65	0.48	0.62**	0.70**	0.55*				
SBP	20-29	-0.02	0.14	0.09	0.05	0.00			
	30-39	0.18	0.29*	0.24	0.21	0.13			
	40-49	0.57**	0.08	0.19	-0.30	0.29			
	50-65	0.35	-0.25	0.39	0.34	0.46			
DBP	20-29	0.09	0.15	0.36	0.19	0.31	0.52**		
	30-39	0.22	0.42**	0.43**	0.29*	0.39**	0.76**		
	40-49	0.52**	0.17	0.34	-0.49	0.04	0.80**		
	50-65	0.18	-0.34	0.39	0.28	0.32	0.69**		
NFBG	20-29	0.10	-0.21	-0.30	-0.24	-0.19	-0.29	-0.55**	
	30-39	0.18	0.08	0.08	0.09	0.04	0.24	0.02	
	40-49	0.06	0.07	0.13	-0.13	0.26	0.09	-0.08	

	50-65	-0.16	0.11	0.13	0.08	0.11	0.15	0.02	
TC	20-29	0.17	-0.13	-0.01	0.03	-0.38	0.19	0.41*	-0.12
	30-39	0.13	0.27*	0.39*	0.16	0.29*	0.14	-0.03	-0.03
	40-49	-0.15	0.02	0.02	0.06	0.04	-0.21	-0.01	-0.00
	50-65	-0.05	0.06	-0.13	-0.11	-0.14	-0.05	0.12	-0.12

Note: *indicates statistically significant correlation <0.05; **indicates statistically significant correlation <0.01. BMI – body mass index; WC – waist circumference; HC – hip circumference; WHR – waist-to-hip ratio; SBP – systolic blood pressure; DBP – diastolic blood pressure; NFBG – non-fasting blood glucose; TC – total cholesterol.

In Coloured firefighters, there was a significant weak correlation between age and BMI ($r = 0.36$, $p = 0.002$) (Table 4.7), between age and WC ($r = 0.42$, $p < 0.001$), between age and SBP ($r = 0.39$, $p = 0.001$), and between age and DBP ($r = 0.32$, $p = 0.007$). In Black firefighters, there was a significant moderate correlation between age and BMI ($r = 0.52$, $p = 0.002$), between age and WC ($r = 0.65$, $p < 0.001$), between age and DBP ($r = 0.51$, $p = 0.003$), and a significant weak correlation between age and SBP ($r = 0.35$, $p = 0.048$). In White firefighters, there was a significant moderate correlation between age and BMI ($r = 0.45$, $p = 0.042$).

In Coloured firefighters, there was a significant strong correlation between BMI and WC ($r = 0.88$, $p < 0.001$), a significant moderate correlation between BMI and DBP ($r = 0.44$, $p < 0.001$), and a significant weak correlation between BMI and SBP ($r = 0.27$, $p = 0.023$). In Black firefighters, there was a significant strong correlation between BMI and WC ($r = 0.89$, $p < 0.001$), a significant moderate correlation between BMI and SBP ($r = 0.43$, $p = 0.013$), and between BMI and DBP ($r = 0.41$, $p = 0.013$). In White firefighters, there was a significant strong correlation between BMI and WC ($r = 0.88$, $p < 0.001$), a significant moderate correlation between BMI and SBP ($r = 0.45$, $p = 0.043$), and between BMI and NFBG ($r = 0.47$, $p = 0.031$). In Coloured firefighters, there was a significant moderate correlation between WC and DBP ($r = 0.49$, $p < 0.001$), and a significant weak correlation between WC and SBP ($r = 0.27$, $p = 0.026$). In Black firefighters, there was a significant moderate correlation with between WC and SBP (r = 0.52, p = 0.002), and between WC and DBP (r = 0.49, p = 0.004). In White firefighters, there was a significant moderate correlation between WC and NFBG (r = 0.52, p = 0.015). In Coloured firefighters, SBP had a significant weak correlation to NFBG (r = 0.31, p = 0.009). In Black firefighters, there was a significant moderate negative correlation between DBP and NFBG (r = -0.43, p = 0.014).

Table 4.7: Relationship between the various CAD risk factors according to ethnicity.

Variables	Ethnicity	Age	BMI	WC	HC	WHR	SBP	DBP	NFBG
BMI	Coloured	0.36**							
	Black	0.52**							
	White	0.45*							
WC	Coloured	0.42**	0.88**						
	Black	0.65**	0.89**						
	White	0.66**	0.88**						
HC	Coloured	0.16	0.79**	0.78**					
	Black	0.46**	0.89**	0.82**					
	White	0.31	0.69**	0.69**					
WHR	Coloured	0.44**	0.59**	0.78**	0.30*				
	Black	0.56**	0.44*	0.69**	0.22				
	White	0.64**	0.77**	0.90**	0.37				
SBP	Coloured	0.39**	0.27*	0.27*	0.12	0.18			
	Black	0.35*	0.43*	0.52**	0.30	0.49**			
	White	-0.15	0.45*	0.24	0.21	0.27			
DBP	Coloured	0.32**	0.44*	0.49**	0.29*	0.39**	0.76**		
	Black	0.51**	0.41*	0.49**	0.31	0.54**	0.76**		
	White	-0.08	0.22	0.16	0.06	0.18	0.56**		
NFBG	Coloured	0.21	0.06	0.06	0.01	0.05	0.31**	0.12	
	Black	-0.28	-0.12	-0.06	-0.17	-0.02*	-0.07	-0.43*	
	White	0.39	0.47*	0.52*	0.28	0.56**	0.15	-0.00	
TC	Coloured	0.21	0.17	0.23	0.16	0.19	0.00	0.17	-0.14
	Black	0.10	0.28	0.16	0.23	-0.09	0.08	0.29	-0.03
	White	0.08	0.09	0.09	0.15	-0.00	0.20	0.13	0.03

Note: *indicates statistically significant correlation <0.05; **indicates statistically significant correlation <0.01. BMI – body mass index; WC – waist circumference; HC – hip circumference; WHR – waist-to-hip ratio; SBP - systolic blood pressure; DBP – diastolic blood pressure; NFBG – non-fasting blood glucose; TC – total cholesterol.

In Table 4.8, there was a significant association between gender and cigarette smoking [$\chi^2(1) = 5.66$, $p = 0.017$, OR = 3.42 (95% CI: 1.19, 9.81)]. The results indicate that cigarette smoking was dependent on gender, and that male firefighters were 3.42 times more likely to be smokers than female firefighters.

For family history, there was a significant association between firefighters in the age groups 20-29 and 40-49 years [$\chi^2(1) = 7.22$, $p = 0.007$, OR = 6.13 (95% CI: 1.50, 24.99)]. The results indicate that family history was dependent on age, with firefighters in the age-group 40-49 years 6.13 times more likely to have a family history than the age-group 20-29 years. For family history, there was a significant association between firefighters in the age groups 30-39 and 40-49 years [$\chi^2(1) = 13.79$, $p < 0.001$, OR = 7.15 (95% CI: 2.34, 21.69)]. The age-group 40-49 years was 7.15 times more likely to have a family history than the age-group 30-39 years.

For physical inactivity, there was a significant association between the age groups 30-39 and 50-65 years [$\chi^2(1) = 5.66$, $p = 0.017$, OR = 5.00 (95% CI: 1.22, 20.55)]. The age-group 40-49 years was 5.00 times more likely to be physically inactive than the age-group 30-39 years. Similarly, for physical inactivity, there was a significant association between the age groups 40-49 and 50-65 years [$\chi^2(1) = 5.41$, $p = 0.020$, OR = 7.00 (95% CI: 1.17, 42.00)]. The age-group 40-49 years was 7.00 times more likely to be physically inactive compared to the age-group 50-65 years. The results also show that firefighters between 40-49 years were the most physically inactive age-group.

For family history, there was a significant association between Black and White ethnic groups [$\chi^2(1) = 8.40$, $p = 0.004$, OR = 9.23 (95% CI: 1.7, 50.00)]. White firefighters were 9.23 times more likely to have a positive family history than Black firefighters. Similarly, for family history, there was a significant association between Coloured and Black ethnic groups [$\chi^2(1) = 4.17$, $p = 0.041$, OR = 4.44 (95% CI: 0.96, 20.65)]. Coloured firefighters were 4.44 times more likely to have family history than Black firefighters. No statistically significant associations were found between ethnic groups for cigarette smoking or physical inactivity.

Table 4.8: Relationship between the various CAD risk factors according to gender, age-group, and ethnicity.

	Family History				Cigarette Smoking				Physical Inactivity			
Category	Yes	No	P value	OR (95% CI)	Yes	No	P value	OR (95% CI)	Yes	No	P value	OR (95% CI)
Male (98) Female (26)	21 5	77 21	0.807	1.14 (0.38 – 3.40)	44 5	54 21	0.017*	3.42 (1.19 – 9.81)	13 4	85 22	0.780	0.81 (0.25 – 2.83)
20-29 (n = 24) 30-39 (n = 55)	3 6	21 49	0.838	1.17 (0.3 – 5.1)	11 24	13 31	0.857	1.09 (0.40 – 2.9)	5 5	19 50	0.149	2.63 (0.68 – 10.13)
20-29 (n = 24) 40-49 (n = 30)	3 14	21 16	0.007**	6.13 (1.50 – 24.99)	11 9	13 21	0.231	1.97 (0.64 – 6.05)	5 2	19 28	0.124	3.68 (0.65 – 20.99)
20-29 (n = 24) 50-65 (n = 15)	3 3	21 12	0.528	0.57 (0.09 – 3.29)	11 5	13 10	0.440	1.69 (0.44 – 6.46)	5 5	19 10	0.384	0.53 (0.12 – 2.26)
30-39 (n = 55) 40-49 (n = 30)	6 14	49 16	<0.001**	7.15 (2.34 – 21.69)	24 9	31 21	0.218	1.81 (0.70 – 4.65)	5 2	50 28	0.698	1.40 (0.25 – 7.69)
30-39 (n = 55) 50-65 (n = 15)	6 3	49 12	0.351	0.49 (0.11 – 2.25)	24 5	31 10	0.473	1.55 (0.47 – 5.13)	5 5	50 10	0.017*	5.00 (1.22 – 20.55)
40-49 (n = 30) 50-65 (n = 15)	14 3	16 12	0.082	3.50 (0.82 – 14.99)	9 5	21 10	0.820	0.86 (0.23 – 3.23)	2 5	28 10	0.020*	7.00 (1.17 – 42.00)
Coloured (n = 70) White (n = 21)	16 8	54 13	0.165	0.48 (0.17 – 1.37)	29 10	41 11	0.615	0.79 (0.29 – 2.07)	11 2	59 19	0.577	1.77 (0.36 – 8.71)
Coloured (n = 70) Black (n = 32)	16 2	54 30	0.041*	4.44 (0.96 – 20.65)	29 9	41 23	0.197	1.81 (0.73 – 4.57)	11 4	59 28	0.671	1.31 (0.38 – 4.46)
Black (n = 32) White (n = 21)	2 8	30 13	0.004**	9.23 (1.70 – 50.00)	9 10	23 11	0.148	2.32 (0.73 – 7.35)	4 2	28 19	0.738	0.74 (0.12 – 4.43)

Note: *indicates statistically significant association p < 0.05; **indicates statistically significant association p < 0.01; OR (95% CI) = odds ratio (95% confidence interval).

In Table 4.9, there was a significant association between family history and age [$\chi^2(1) = 4.17$, $p = 0.041$, OR = 2.59 (95% CI: 1.02, 6.62)], indicating that family history was dependent on age, with aged firefighters 2.59 times more likely to have a positive family history of CAD. A family history was significantly associated with central obesity [$\chi^2(1) = 3.96$, $p = 0.047$, OR = 2.41 (95% CI: 0.99, 5.79)], where firefighters with central obesity were 2.41 times more likely to have a family history. There was a significant association between physical inactivity and obesity [$\chi^2(1) = 4.33$, $p = 0.038$, OR = 2.94 (95% CI: 1.03, 8.37)], indicating physical inactivity was dependent on obesity, with obese firefighters 2.94 times more likely to be physically inactive. There was a significant association between hypertension and age [$\chi^2(1) = 18.01$, $p < 0.001$, OR = 6.31 (95% CI: 2.56, 15.54)], hypertension and obesity [$\chi^2(1) = 7.99$, $p = 0.005$, OR = 3.02 (95% CI: 1.39, 6.59)], hypertension and central obesity [$\chi^2(1) = 7.20$, $p = 0.007$, OR = 2.85 (95% CI: 1.35, 6.18)], hypertension and WHR [$\chi^2(1) = 20.87$, $p < 0.001$, OR = 6.26 (95% CI: 2.78, 14.25)], hypertension and systolic hypertension [$\chi^2(1) = 41.33$, $p < 0.001$, OR = 70.82 (95% CI: 8.98, 558.54)], hypertension and diastolic hypertension [$\chi^2(1) = 51.18$, $p < 0.001$, OR = 5.15 (95% CI: 3.48, 7.63)], hypertension and diabetes [$\chi^2(1) = 5.09$, $p = 0.040$, OR = 4.01 (95% CI: 1.12, 14.81)], and hypertension and dyslipidemia [$\chi^2(1) = 8.45$, $p = 0.004$, OR = 3.09 (95% CI: 1.43, 6.72)]. The results also indicated that firefighters with hypertension were 6.31 times more likely to have age as a risk factor, 3.02 times more likely to be obese, 2.85 times more likely to have central obesity, 6.26 times more likely to have a high WHR, 70.82 times more likely to have systolic hypertension, 5.15 times more likely to have diastolic hypertension, 4.01 times more likely to have diabetes, and 3.09 times more likely to have dyslipidemia.

Table 4.9: Relationship between family history, cigarette smoking, physical inactivity, hypertension and other CAD risk factors.

	Family History			Cigarette Smoking			Physical Inactivity			Hypertension		
Risk Factor	χ^2	*p*	OR (95% CI)	χ^2	*p*	OR (95% CI)	χ^2	*p*	OR (95% CI)	χ^2	*p*	OR (95% CI)
CS	0.11	0.743	1.26 (0.48 – 2.79)									
PI	2.71	0.120	0.22 (0.03 – 1.62)	2.11	0.187	0.42 (0.13 – 1.39)						
HTN	0.04	0.850	1.09 (0.44 – 2.72)	0.74	0.439	0.71 (0.33 – 1.55)	0.04	0.833	1.12 (0.38 – 3.28)			
SH	0.02	1.000	1.09 (0.33 – 3.65)	0.34	0.562	0.73 (0.26 – 2.10)	0.16	0.693	1.31 (0.34 – 5.13)	41.33	<0.001**	70.82 (8.98 – 558.54)
DH	0.88	0.381	1.66 (0.57 – 4.82)	1.27	0.331	0.56 (0.20 – 1.56)	0.01	1.000	1.06 (0.28 – 4.07)	51.18	<0.001**	5.15 (3.48 – 7.63)
Age	4.17	0.041*	2.59 (1.02 – 6.62)	1.14	0.286	0.62 (0.26 – 1.50)	1.56	0.212	1.99 (0.67 – 5.96)	18.01	<0.001**	6.31 (2.56 – 15.54)
OB	2.67	0.102	2.06 (0.86 – 4.96)	0.46	0.496	0.77 (0.36 – 1.64)	4.33	0.038*	2.94 (1.03 – 8.37)	7.99	0.005**	3.02 (1.39 – 6.59)
CO	3.96	0.047*	2.41 (0.99 – 5.79)	0.20	0.654	0.84 (0.39 – 1.78)	0.84	0.360	1.64 (0.58 – 4.53)	7.20	0.007**	2.85 (1.31 – 6.18)
WHR	0.13	0.721	1.18 (0.48 – 2.87)	0.84	0.359	0.70 (0.33 – 1.50)	1.15	0.283	1.75 (0.62 – 4.93)	20.87	<0.001**	6.26 (2.78 – 14.25)
DM	0.29	0.590	1.47 (0.36 – 5.97)	0.76	0.384	0.55 (0.14 – 2.17)	0.20	0.651	1.45 (0.29 – 7.38)	5.09	0.040*	4.01 (1.12 – 14.81)
DLP	0.05	0.826	1.11 (0.46 – 2.67)	0.08	0.852	0.89 (0.43 – 1.88)	0.06	1.000	1.04 (0.37 – 2.95)	8.45	0.004**	3.09 (1.43 – 6.72)

Note: * indicates statistically significant association $p < 0.05$; ** indicates statistically significant association $p < 0.01$; OR (95% CI) = odds ratio (95% confidence interval); χ^2 = Chi square

PI – physical inactivity; CS – cigarette smoking; OB – obesity; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

In male firefighters, there was a significant association between hypertension and age [$\chi^2(1) = 17.27$, $p < 0.001$, OR = 6.84 (95% CI: 2.63, 17.79)], hypertension and obesity[$\chi^2(1) = 10.93$, $p < 0.001$, OR = 4.41 (95% CI: 1.78, 10.94)], hypertension and central obesity [$\chi^2(1) = 7.62$, $p = 0.006$, OR = 3.49 (95% CI: 1.41, 8.85)], hypertension and WHR [$\chi^2(1) = 4.58$, $p < 0.001$, OR = 3.89 (95% CI: 1.05, 14.41)], hypertension and diabetes [$\chi^2(1) = 4.58$, $p = 0.032$, OR = 3.55 (95% CI: 1.05, 14.41)] and hypertension and dyslipidemia [$\chi^2(1) = 8.49$, $p = 0.004$, OR = 3.55 (95% CI: 1.49, 8.49)] (Table 4.10). Male firefighters who were hypertensive were 6.84 times more likely to be aged, 4.41 times more likely to be obese, 3.49 times more likely to have central obesity, 5.60 times more likely to have a high WHR, 3.89 times more likely to have diabetes, and 3.55 times more likely to have dyslipidemia. In female firefighters, there was a significant association between hypertension and WHR [$\chi^2(1) = 7.39$, $p = 0.021$, OR = 16.80 (95% CI: 1.60, 176.23)], with females who had a high WHR also 16.80 times more likely to be hypertensive. Based age-group Hypertension had a significant association with WHR in the age groups 30-39 [$\chi^2(1) = 12.21$, $p < 0.001$, OR = 9.71 (95% CI: 2.41, 34.82)] and 40-49 years [$\chi^2(1) = 4.82$, $p = 0.028$, OR = 5.50 (95% CI: 1.15, 26.41)], with the age-group 30-39 years 9.71 times, and the age-group 40-49 years 5.50 times more likely to be hypertensive, if they had a high WHR. In the age-group 50-65 years, there was a significant association between hypertension and dyslipidemia [$\chi^2(1) = 5.53$, $p = 0.041$, OR = 18.00 (95% CI: 1.27, 255.74)], where firefighters who had dyslipidemia were 18.00 times more likely to be hypertensive.

Table 4.10: Relationship between hypertension and other CAD risk factors according to gender and age-group.

Risk Factor		Hypertension					
		Gender		Age Group			
		Male	Female	20-29	30-39	40-49	50-65
Age	Positive (%)	19.39	0	0	0	36.66	0
	χ^2	17.27	0	0	0	8.57	0
	p value	<0.001**	0	0	0	0.003**	0
	OR (95% CI)	6.84 (2.63 – 17.79)	0	0	0	11.00 (1.99 – 60.57)	0
OB	Positive (%)	18.37	15.38%	0	14.55	30.00	33.33
	χ^2	10.93	0.042	0.31	3.06	0.54	0.58
	p value	<0.001**	1.000	1.000	0.080	0.464	0.619
	OR (95% CI)	4.41 (1.78 – 10.94)	1.20 (0.21 – 6.88)	0	2.90 (0.86 – 9.78)	1.71 (0.40 – 7.29)	2.22 (0.28 – 17.63)
CO	Positive (%)	16.33	23.08	0	14.55	30.00	33.33
	χ^2	7.62	1.75	0.31	2.38	0.54	0.58
	p value	0.006**	0.357	1.000	0.211	0.464	0.619
	OR (95% CI)	3.49 (1.41 – 8.65)	4.36 (0.44 – 43.72)	0	2.55 (0.77 – 8.48)	1.71 (0.40 – 7.29)	2.22 (0.28 – 17.63)
WHR	Positive (%)	20.41	23.08	0	18.18	33.33	40.00
	χ^2	14.74	7.39	0.31	12.21	4.82	0.02
	p value	<0.001**	0.021*	1.000	<0.001**	0.028*	1.000
	OR (95% CI)	5.60 (2.25 – 13.99)	16.8 (1.6 – 176.23)	0	9.17 (2.41- 34.82)	5.50 (1.15 – 26.41)	1.20 (0.12 – 11.87)
DM	Positive (%)	7.14	0	0	0	16.66	13.33
	χ^2	4.58	0	0	0.42	3.33	0.02
	p value	0.032*	0	0	1.000	0.169	1.000
	OR (95% CI)	3.89 (1.05 – 14.41)	0	0	0	7.00 (0.72 – 69.49)	0.83 (0.08 – 8.24)
DLP	Positive (%)	21.43	11.54	0	14.55	33.33	40.00
	χ^2	8.49	0.29	0.31	0.62	1.22	5.53
	p value	0.004**	0.661	1.000	0.431	0.269	0.041*
	OR (95% CI)	3.55 (1.49 – 8.49)	1.63 (0.027 – 9.66)	0	1.60 (0.49 – 5.17)	2.29 (0.52 – 10.01)	18.00 (1.27 – 255.74)

Note: *indicates statistically significant association $p < 0.05$; **indicates statistically significant association $p < 0.01$; OR (95% CI) = odds ratio (95% confidence interval), χ^2 = Chi square; Positive (%) – both risk factors are positive.

PI – physical inactivity; CS – cigarette smoking; OB – obesity; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

In Coloured firefighters, there was a significant association between hypertension and age [$\chi^2(1) = 9.05$, $p = 0.003$, OR = 5.43 (95% CI: 1.71, 17.24)], between hypertension and obesity [$\chi^2(1) = 21.43$, $p = 0.006$, OR = 7.48 (95% CI: 2.56, 15.54)], between hypertension and central obesity [$\chi^2(1) = 21.43$, $p = 0.006$, OR = 4.09 (95% CI: 1.45, 11.52)], between hypertension and WHR [$\chi^2(1) = 14.13$, $p < 0.001$, OR = 7.35 (95% CI: 2.47, 21.86)], and between hypertension and dyslipidemia [$\chi^2(1) = 7.46$, $p = 0.006$, OR = 7.46 (95% CI: 1.45, 11.31)] (Table 4.11). Furthermore, Coloured firefighters who were older, obese, centrally obese, with a high WHR and dyslipidemic were 5.43, 7.48, 4.09, 7.35 and 7.46 times more likely to be hypertensive, respectively. In White firefighters, there was a significant association between hypertension and WHR [$\chi^2(1) = 23.80$, $p = 0.046$, OR = 13.75 (95% CI: 1.21, 156.65)], where White firefighters with a high WHR were 13.75 times more likely to be hypertensive.

Table 4.11: Relationship between hypertension and other CAD risk factors according to ethnicity.

	Hypertension			
Risk Factor		Ethnicity		
	Test Statistics	Coloured	Black	White
Age	Positive (%)	17.14	9.38	19.00
	χ^2	9.05	4.97	4.20
	p value	0.003**	0.057	0.120
	OR (95% CI)	5.43 (1.71 – 17.24)	11.00(0.96 – 125.77)	8.00 (0.96 – 66.45)
Obesity	Positive (%)	21.43	9.38	19.00
	χ^2	7.48	0.03	1.94
	p value	0.006**	1.000	0.331
	OR (95% CI)	4.09 (1.45 – 11.52)	1.14 (0.22 – 5.93)	4.00 (0.537 – 29.810
CO	Positive (%)	21.43	9.38	19.00
	χ^2	7.48	0.03	1.94
	p value	0.006**	1.000	0.331
	OR (95% CI)	4.09 (1.45 – 11.52)	1.14 (0.22 – 5.93)	4.00 (0.537 – 29.810
WHR	Positive	24.29	12.50	23.8
	χ^2	14.13	1.65	5.62
	p value	<0.001**	0.226	0.046*
	OR (95% CI)	7.35 (2.47 – 21.86)	2.88 (0.56 – 14.94)	13.75 (1.21 – 156.65)
DM	Positive	7.14	6.25	0
	χ^2	3.92	5.45	0.88
	p value	0.093	0.073	1.000

	OR (95% CI)	5.00 (0.89 – 27.96)	0	0
DLP	Positive	24.28	12.50	14.29
	χ^2	7.46	0.56	0.51
	p value	0.006**	0.681	0.63
	OR (95% CI)	4.05 (1.45 – 11.31)	1.83 (0.37 – 8.94)	2.00 (0.29 – 13.74)

Note: *indicates statistically significant association p < 0.05; **indicates statistically significant association p < 0.01; OR (95% CI) = odds ratio (95% confidence interval), χ^2 = Chi square; Positive (%) – both risk factors are positive.
PI – physical inactivity; CS – cigarette smoking; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

In Table 4.12, family history had a significant association with age [χ^2 (1) = 4.17, p = 0.041, OR = 2.8 (95% CI: 1.09, 7.55)] in male firefighters. This indicated family history was dependent on age in male firefighters, with aged male firefighters 2.78 times more likely to have a family history of CAD. A family history also had a significant association with obesity [χ^2(1) = 5.42, p = 0.021, OR = 3.14 (95% CI: 1.26, 8.49)] and central obesity [χ^2(1) = 6.66, p = 0.010, OR = 3.61 (95% CI: 1.32, 9.99)] in male firefighters. This indicated that family history was dependent on obesity and central obesity in male firefighters, with obese male firefighters 3.14 times more likely to have family history, and males with central obesity 3.61 times more likely to have family history. There were no significant associations found between gender and the other CAD risk factors.

Table 4.12: Relationship between family history, cigarette smoking, physical inactivity and other CAD risk factors according to gender.

Risk Factor		Family History			Cigarette Smoking			Physical Inactivity		
	Gender	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)
CS	Male	0.61	0.437	1.47 (0.56 – 3.86)						
	Female	1.47	0.545	1.31 (1.03 – 1.67)						
PI	Male	4.09	0.043*	1.20 (1.09 – 1.33)	1.21	0.271	0.50 (0.14 – 1.75)			
	Female	0.10	1.000	1.50 (0.12 – 18.44)	1.13	0.289	1.29 (1.03 – 1.62)			
obesity	Male	5.32	0.021*	3.14 (1.26 – 8.49)	0.00	0.972	1.02 (0.43 – 2.39)	3.42	0.064	2.97 (0.90 – 9.73)
	Female	0.48	0.635	0.50 (0.07 – 3.65)	0.48	0.635	0.50 (0.07 – 3.65)	0.85	0.598	3.00 (0.27 – 33.49)
CO	Male	6.66	0.010*	3.61 (1.32 – 9.89)	0.19	0.663	1.21 (0.51 – 2.89)	0.57	0.452	1.59 (0.47 – 5.34)
	Female	0.08	1.000	0.75 (0.10 – 5.58)	0.08	1.000	0.75 (0.10 – 5.58)	0.19	1.000	1.71 (0.15 – 19.36)
WHR	Male	1.01	0.315	1.66 (0.62 – 4.46)	1.47	0.226	0.59 (0.25 – 1.39)	1.05	0.307	1.84 (0.57 – 6.01)
	Female	1.26	0.261	0.28 (0.03 – 2.89)	0.79	0.620	2.44 (0.33 – 17.91)	0.12	1.000	1.44 (0.17 – 12.23)
HTN	Male	0.14	0.797	1.21 (0.44 – 3.28)	3.31	0.069	0.45 (0.19 – 1.07)	0.10	1.000	0.82 (0.23 – 2.87)
	female	0.15	1.000	0.63 (0.06 – 6.80)	3.44	0.106	6.38 (0.79 – 51.78)	1.28	0.287	3.4 (0.38 – 30.66)
SH	Male	0.08	1.000	0.82 (0.21 – 3.19)	0.42	0.515	0.69 (0.23 – 2.09)	0.01	1.000	0.92 (0.18 – 4.62)
	Female	1.32	0.354	5.00 (0.26 – 97.69)	0.52	1.000	1.11 (0.96 – 1.27)	1.99	0.289	7.00 (0.34 – 144.06)
DH	Male	2.35	0.125	2.40 (0.77 – 7.25)	1.99	0.158	0.45 (0.15 – 1.39)	0.97	0.455	0.36 (0.04 – 2.97)
	Female	1.13	0.289	1.24 (1.00 – 1.52)	0.10	1.000	1.50 (0.12 – 18.44)	4.35	0.099	10.00 (0.87 – 114.75)
DM	Male	0.25	0.698	1.44 (0.35 – 5.98)	1.56	0.336	0.42 (0.11 – 1.69)	0.26	0.610	1.54 (0.29 – 8.06)
	Female	4.37	0.192	0.80 (0.52 – 1.24)	0.25	1.000	1.05 (0.95 – 1.16)	0.19	1.000	1.05 (0.96 – 1.15)
DLP	Male	0.37	0.545	1.35 (0.51 – 3.56)	0.34	0.56	0.79 (0.35 – 1.77)	0.12	0.735	1.22 (0.38 – 3.96)
	Female	0.58	0.628	0.41 (0.04 – 4.31)	0.08	1.000	1.33 (0.18 – 9.91)	0.19	1.000	0.58 (0.05 – 6.59)

Note: *indicates significant association p < 0.05; **indicates significant association p < 0.01; OR (95% CI) = odds ratio (95% confidence interval); χ^2 = Chi square
PI – physical inactivity; CS – cigarette smoking; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

A significant association was found between cigarette smoking and physical inactivity [χ^2 (1) = 5.34, p = 0.041, OR = 1.63 (95% CI: 1.06, 2.49)] in the age-group 20-29 years (Table 4.13). This indicated that cigarette smoking was dependent on physical inactivity, where smokers in the age-group 20-29 years were 1.63 times more likely to be physically inactive compared to non-smokers. Furthermore, in the age-group 20-29 years, there was a significant association between family history and central obesity [χ^2 (1) = 9.19, p = 0.032, OR = 40.00 (95% CI: 1.75, 914.79)]. A family history was dependent on WC, where firefighters in the age-group 20-29 years who had central obesity were 40.00 times more likely to have a family history of CAD. There were no significant associations between the other age groups and the other CAD risk factors.

Table 4.13: Relationship between family history, cigarette smoking, physical inactivity and other CAD risk factors according to age-group.

Risk Factor	Family History				Cigarette Smoking			Physical Inactivity		
	Age	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)
CS	20-29	0.22	1.000	0.55 (0.04 – 7.03)						
	30-39	1.45	0.387	2.90 (0.48 – 17.38)						
	40-49	2.07	0.236	3.25 (0.63 – 16.79)						
	50-65	1.88	0.505	1.71 (1.06 – 2.77)						
PI	20-29	0.33	0.521	2.13 (0.15 – 29.66)	5.34	0.041*	1.63 (1.06 – 2.49)			
	30-39	0.67	1.000	1.11 (1.01 – 1.22)	0.59	0.643	2.07 (0.32 – 13.51)			
	40-49	1.88	0.485	2.00 (1.38 – 2.89)	0.92	1.000	1.11 (0.96 – 1.27)			
	50-65	1.88	0.505	1.43 (0.95 – 2.14)	0.60	0.600	0.38 (0.03 – 4.71)			
obesity	20-29	1.36	0.343	4.75 (0.29 – 78.74)	0.22	0.642	0.55 (0.04 – 7.03)	4.37	0.099	12.00 (0.81 – 177.44)
	30-39	0.00	1.000	1.03 (0.17 – 6.24)	0.44	0.570	1.47 (0.47 – 4.56)	0.13	1.000	1.42 (0.22 – 9.33)
	40-49	1.27	0.299	2.31 (0.53 – 10.09)	0.41	0.694	0.60 (0.12 – 2.89)	1.88	0.485	2.00 (1.38 – 2.89)
	50-65	0.60	0.569	0.36 (0.03 – 5.11)	0.54	0.427	0.44 (0.05 – 3.98)	2.14	0.282	6.00 (0.48 – 75.34)
CO	20-29	9.19	0.032*	40.00 (1.75 – 914.79)	0.59	0.576	2.67 (0.21 – 34.19)	0.33	0.521	2.13 (0.15 – 29.66)
	30-39	0.00	1.000	0.94 (0.16 – 5.67)	0.03	1.000	0.91 (0.29 – 2.79)	0.07	1.000	1.29 (0.19 – 8.50)
	40-49	1.27	0.299	2.31 (0.53 – 10.09)	0.41	0.694	0.60 (0.12 – 2.89)	1.88	0.485	2.00 (1.38 – 2.89)
	50-65	0.60	0.569	0.36 (0.03 – 5.11)	0.13	1.000	1.50 (0.17 – 13.23)	0.13	1.000	1.50 (0.17 – 13.23)
WHR	20-29	1.36	0.343	4.75 (0.29 – 78.74)	0.59	0.576	2.67 (0.21 – 34.19)	0.33	0.569	2.13 (0.15 – 29.66)
	30-39	0.50	0.660	0.45 (0.05 – 4.22)	0.00	1.000	1.01 (0.31 – 3.25)	0.32	0.622	1.71 (0.26 – 11.38)
	40-49	0.15	0.730	0.75 (0.18 – 3.17)	3.09	0.118	0.21 (0.04 – 1.29)	2.45	0.209	2.33 (1.52 – 3.58)
	50-65	0.09	1.000	0.67 (0.04 – 10.25)	0.17	1.000	1.71 (0.13 – 22.51)	0.68	0.560	0.38 (0.04 – 3.99)
HTN	20-29	0.31	1.000	1.11(0.96 – 1.27)	0.00	1.000	1.20 (1.01 – 3.25)	1.13	0.380	4.5 (0.23 – 88.24)
	30-39	0.50	0.660	0.45 (0.05 – 4.22)	0.11	0.771	0.82 (0.24 – 2.72)	0.22	1.000	0.58 (0.06 – 5.67)
	40-49	0.54	0.715	0.58 (0.14 – 2.48)	0.16	1.000	0.73 (0.15 – 3.49)	2.14	1.000	2.15 (1.45 – 3.21)
	50-65	0.27	1.000	2.00 (0.14 – 28.42)	0.54	0.608	0.44 (0.05 – 3.98)	0.54	0.608	0.44 (0.05 – 3.98)
SH	20-29	0.31	1.000	1.11 (0.96 – 1.27)	0.02	1.000	1.20 (0.07 – 21.72)	1.13	0.380	4.50 (0.23 – 88.24)
	30-39	0.67	1.000	1.11 (1.01 – 1.22)	0.03	1.000	0.85 (0.13 – 5.53)	0.79	0.391	2.88 (0.26 – 32.26)

	40-49	3.68	0.544	0.60 (0.12 – 2.89)	0.13	0.719	0.71 (0.11 – 4.47)	0.59	0.469	3.00 (0.17 – 54.57)
	50-65	0.42	0.516	2.50 (0.15 – 42.80)	0.00	1.000	1.00 (0.07 – 14.64)	1.88	0.505	1.43 (0.95 – 2.14)
DH	20-29	0	0	0	0	0	0	0	0	0
	30-39	0.01	1.000	0.89 (0.09 – 8.57)	0.92	0.486	0.49 (0.11 – 2.14)	0.01	1.000	1.14 (0.11 – 11.44)
	40-49	0.27	0.709	0.67 (0.14 – 3.11)	0.00	1.000	1.00 (0.19 – 5.24)	4.29	0.103	3.50 (1.95 – 6.29)
	50-65	4.29	0.200	0.67 (0.30 – 1.48)	0.54	1.000	1.11 (0.90 – 1.37)	0.54	1.000	1.11 (0.90 – 1.37)
DM	20-29	0	0	0	0	0	0	0	0	0
	30-39	0.13	1.000	1.02 (0.98 – 1.06)	1.32	0.436	0.96 (0.88 – 1.04)	0.10	1.000	1.02 (0.98 – 1.062)
	40-49	0.54	0.657	0.50 (0.77 – 3.27)	0.64	0.637	0.40 (0.04 - 4.02)	0.54	1.000	1.27 (1.05 – 1.54)
	50-65	0.09	1.000	1.50 (0.09 – 23.07)	0.17	1.000	0.58 (0.04 – 7.66)	0.68	0.560	2.67 (0.25 – 28.44)
DLP	20-29	1.36	0.343	4.75 (0.29 – 78.74)	0.59	0.439	2.67 (0.21 – 34.19)	0.90	1.000	1.19 (0.98 – 1.44)
	30-39	1.75	0.383	0.25 (0.03 – 2.26)	0.00	0.984	0.99 (0.34 – 2.91)	0.07	1.000	0.92 (0.14 – 6.01)
	40-49	0.48	0.491	0.60 (0.14 – 2.58)	0.01	1.000	0.94 (0.19 – 4.52)	1.64	0.492	1.87 (1.32 – 2.64)
	50-65	0.60	0.438	2.80 (0.19 – 40.06)	0.13	1.000	0.67 (0.08 – 5.88)	0.54	0.608	2.25 (0.25 – 20.13)

Note: *indicates statistically significant association $p < 0.05$; **indicates statistically significant association $p < 0.01$; OR (95% CI) = odds ratio (95% confidence interval), χ^2 = Chi square

PI – physical inactivity; CS – cigarette smoking; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

In Coloured firefighters, there was a significant association between family history and age [$\chi^2(1) = 6.40$, $p = 0.020$, OR = 4.40 (95% CI: 1.33, 14.56)] (Table 4.14). Aged Coloured firefighters were 4.40 times more likely to have family history. In Coloured firefighters, there was also a significant association between physical inactivity and obesity [$\chi^2(1) = 3.92$, $p = 0.048$, OR = 3.68 (95% CI: 0.96, 14.13)], where physical inactivity was dependent on being obese, and obese coloured firefighters were 3.68 times more likely to be physically inactive. In White firefighters, there was a significant association between family history and obesity [$\chi^2(1) = 5.45$, $p = 0.032$, OR = 10.00 (95% CI: 1.28, 78.12)] and also between family history and central obesity [$\chi^2(1) = 5.45$, $p = 0.032$, OR = 10.00 (95% CI: 1.28, 78.12)]. The results showed family history was dependent on both obesity and central obesity, with White firefighters 10.00 times more likely to have family history, if they were obese or had central obesity. There were no significant associations between ethnicity and the other CAD risk factors.

Table 4.14: Relationship between family history, cigarette smoking, physical inactivity and other CAD risk factors according to ethnicity.

Risk Factor	Family History				Cigarette Smoking			Physical Inactivity		
	Ethnicity	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)	χ^2	p value	OR (95% CI)
CS	Coloured	0.13	0.716	0.81 (0.26 – 2.55)						
	Black	0.84	1.000	1.43 (1.13 – 1.81)						
	White	1.15	0.387	2.67 (0.43 – 16.39)						
PI	Coloured	1.40	0.436	0.29 (0.04 – 2.49)	1.08	0.299	0.48 (0.12 – 1.98)			
	Black	0.31	1.000	1.15 (1.00 – 1.33)	1.79	0.303	1.21 (1.00 – 1.46)			
	White	1.36	0.505	1.18 (0.94 – 1.49)	0.00	1.000	1.11 (0.06 – 20.49)			
Age	Coloured	6.40	0.020*	4.40 (1.33 – 14.56)	1.86	0.173	0.45 (0.14- 1.44)	0.78	0.379	1.84 (0.47 – 7.21)
	Black	0.99	0.395	1.15 (1.00 – 1.33)	1.08	0.557	3.00 (0.35 – 25.46)	0.65	1.000	1.17 (1.00 – 1.36)
	White	0.40	0.656	0.53 (0.08 – 3.76)	1.53	0.361	0.30 (0.04 – 2.11)	4.42	0.100	3.80 (1.79 – 8.06)
Obesity	Coloured	0.00	0.973	1.02 (0.32 – 3.23)	0.01	0.909	1.06 (0.39 – 2.83)	3.92	0.048*	3.68 (0.96 – 14.13)
	Black	0.35	0.534	2.33 (0.13 – 41.55)	0.48	0.681	0.54 (0.09 – 3.21)	0.75	0.572	2.50 (0.29 – 20.92)
	White	5.45	0.032*	10.00 (1.28 – 78.12)	1.29	0.387	0.36 (0.06 – 2.16)	0.05	1.000	1.38 (0.07 – 25.43)
CO	Coloured	0.24	0.628	1.32 (0.43 – 4.10)	0.17	0.685	1.22 (0.46 – 3.24)	1.41	0.236	2.17 (0.59 – 7.98)
	Black	0.35	0.534	2.33 (0.13 – 41.55)	0.48	0.681	0.54 (0.09 – 3.21)	0.08	1.000	0.70 (0.06 – 7.74)
	White	5.45	0.032*	10.00 (1.28 – 78.12)	1.29	0.387	0.36 (0.06 – 2.16)	0.05	1.000	1.38 (0.07 – 25.43)
WHR	Coloured	0.31	0.579	0.71 (0.22 – 2.35)	0.15	0.698	0.82 (0.31 – 2.21)	1.69	0.193	2.34 (0.64 – 8.62)
	Black	0.51	0.490	2.75 (0.15 – 49.36)	0.22	1.000	0.65 (0.11- 3.97)	0.02	1.000	0.83 (0.08 – 9.25)
	White	0.27	0.673	1.60 (0.27 – 9.49)	1.29	0.387	0.36 (0.06 – 2.16)	0.05	1.000	1.38 (0.07 – 25.43)
HTN	Coloured	0.00	0.973	1.02 (0.32 – 3.23)	0.79	0.374	0.64 (0.23 – 1.73)	0.00	1.000	0.96 (0.25 – 3.66)
	Black	0.51	0.477	2.75 (0.15 – 49.36)	0.17	0.682	1.42 (0.27 – 7.52)	1.08	1.000	3.00 (0.35 – 25.46)
	White	0.08	1.000	0.75 (0.10 – 5.47)	0.69	0.635	0.44 (0.06 – 3.16)	0.88	1.000	1.46 (1.08 – 1.98)
SH	Coloured	0.02	0.878	1.14 (0.21 – 6.30)	3.12	0.078	0.17 (0.20 – 1.49)	0.59	0.443	1.96 (0.34 – 11.29)
	Black	0.99	0.395	4.00 (0.22 – 73.62)	0.96	0.370	2.38 (0.41 – 13.75)	0.03	0.872	1.22 (0.11 – 13.97)

	White	0.03	1.000	0.79 (0.06 – 10.38)	0.51	0.586	2.50 (0.19 - 32.80)	0.37	1.000	1.18 (0.98 – 1.44)
DH	Coloured	0.05	0.816	1.17 (0.32 – 4.28)	0.89	0.347	0.57 (0.17 – 1.86)	0.16	0.688	0.71 (0.14 – 3.70)
	Black	0.22	1.000	1.11 (0.99 – 1.25)	0.04	1.000	1.31 (0.10 – 16.56)	1.31	0.340	4.33 (0.29 – 63.29)
	White	3.59	0.133	0.75 (0.50 – 1.12)	2.01	0.476	1.22 (0.93 – 1.62)	0.23	1.000	1.12 (0.96 – 1.30)
DM	Coloured	0.14	0.704	1.40 (0.25 – 8.01)	2.36	0.124	0.21 (0.02 – 1.83)	0.97	0.324	2.40 (0.40 – 14.31)
	Black	0.14	1.000	1.07 (0.97 – 1.18)	0.84	1.000	1.09 (0.97 – 1.24)	0.31	1.000	1.07 (0.97 – 1.19)
	White	0.13	1.000	1.71 (0.09 – 31.92)	2.43	0.214	0.80 (0.59 – 1.09)	0.23	1.000	1.12 (0.96 – 1.30)
DLP	Coloured	0.27	0.600	1.35 (0.44 – 4.13)	0.06	0.939	1.04 (0.39 – 2.70)	0.01	0.932	1.01 (0.29 – 3.55)
	Black	0.97	1.000	1.50 (1.17 – 1.93)	0.06	0.938	0.94 (0.18 – 4.79)	0.18	1.000	0.60 (0.06 – 6.57)
	White	0.00	1.000	0.96 (0.16 – 5.90)	0.53	0.659	0.51 (0.09 – 3.12)	0.13	1.000	1.71 (0.09 – 31.92)

Note: *indicates significant association $p < 0.05$; **indicates significant association $p < 0.01$; OR (95% CI) = odds ratio (95% confidence interval); χ^2 = Chi square.
PI – physical inactivity; FH – family history; CS – cigarette smoking; CO – central obesity; WHR – waist-to-hip ratio; HTN – hypertension; SH – systolic hypertension; DH – diastolic hypertension; DM – diabetes mellitus; DLP – dyslipidemia.

CHAPTER FIVE: DISCUSSION

5.1. Introduction

This section discusses the prevalence of CAD risk factors among firefighters in the City of Cape Town Fire and Rescue Service, as well as the correlations and associations between the various CAD risk factors according to gender, age-group and ethnicity.

5.2. Prevalence of Coronary Artery Disease Risk factors in Firefighters

The study found that 86.29% of firefighters had one CAD risk factor, 56.45% had two risk factors and 36.29% had three risk factors occurring simultaneously. This prevalence of CAD risk factors is similar to the results reported by Gendron et al. (2018a), where 85% of firefighters had at least one or more risk factors present, other than age, and 59.1% reported two or more risk factors. Similarly, Martin et al. (2019) found 94.6% of volunteer firefighters reported at least one CAD risk factor, 68% had two or more risk factors, and 51.4% had three or more risk factors. Smith et al. (2012) reported 20.41% of firefighters had one or less risk factors, and that 45.92% of firefighters had two or more risk factors. The importance of determining the number of CAD risk factors is that the presence of two or more risk factors stratifies the individual as being at moderate risk for CAD that is contrary to optimal health and work performance, and increases the risk of sustaining a cardiovascular emergency (ACSM, 2014, p. 28).

Female firefighters reported higher percentages for one (38.46%) and two (25.92%) CAD risk factors compared to male firefighters, but had similar percentages for three risk factors. However, only male firefighters had four or more risk factors. Gendron et al. (2018b) reported 73% of female firefighters had at least one modifiable CAD risk factor, and 22% had at least two modifiable risk factors. Similarly, Wolkow, Netto, Langridge et al. (2012) reported 46.6%

and 26.6% of female and male firefighters had one or less risk factors, respectively, and that 50.8% of female firefighters had two or more risk factors compared to 68.2% of male firefighters.

The likelihood of two or more CAD risk factors increased with age, with the age-group 20-29 years reporting 29.17% with two or more risk factors, the age-group 30-39 years with 47.27%, the age-group 40-49 years with 76.67%, and the age-group 50-65 years with 80.00% having two or more risk factors. Byczek Walton, Conrad, Reichelt and Samo (2004) reported that CHD generally increased as firefighters aged, with 74% of firefighters at moderate CAD risk in the 30-34 age-group, with 40% at moderate risk in the 35-39 age-group, 51% at moderate risk in the 40-44 age-group, 79% at moderate risk in the 45-49 age-group, 67% at moderate risk in the 50-59 age-group, and 87% at moderate risk in the 60-64 age-group.

Even though Black firefighters reported the lowest prevalence of two or more CAD risk factors, the prevalence was still unacceptably high at 37.50%, followed by Coloured firefighters with 60.76% and White firefighters with 66.67%. Previous literature reports a similar prevalence of individual risk factors in the different ethnic groups of firefighters (Choi et al., 2016c; Lima et al., 2013; Poston et al., 2014).

5.3. Diabetes

Diabetes was the least prevalent CAD risk factor compared to the other risk factors, with 8.87% of firefighters being diabetic, and all male, especially above the age of forty years, and unrelated to ethnicity. Stokes, Berry, Mchiza et al. (2017) found that diabetes prevalence increased significantly with age in the general South African population, which is reflected in the statistics for firefighters as well. Savall et al. (2018) reported a similar low prevalence of diabetes in firefighters, where 3.2% of firefighters had diabetes. Similarly, Mehrdad et al. (2013) reported 3.4% of firefighters were diabetic. Plat et al. (2012), Budoff, Karwasky, Ahmadi et al. (2009) and Winter et al. (2017) also reported a low prevalence of diabetes in 1%, 1.8% and 3% of firefighters, respectively. Noh, Lee, Hyun et al. (2020) reported a slightly higher prevalence of diabetes in 10% of firefighters, but found no significant association between diabetes and other CAD risk factors.

In the present study, there was a significant association between diabetes and hypertension, particularly in male firefighters. Superko et al. (2011) reported a similarly low prevalence of diabetes in 3.72% of firefighters, and found significant associations between blood glucose, increased BMI and blood pressure. Smith et al. (2012) also reported a similar diabetes prevalence, where 2% of firefighters were diagnosed diabetics, but no significant relationships were found between diabetes and other CAD risk factors. Similarly, Soteriades et al. (2003) reported a low prevalence of diabetes in 4.11% of firefighters, but found no significant association between diabetes and other CAD risk factors in firefighters. Eastlake et al. (2015) reported that 4.5% of firefighters had high blood sugar, and that it was significantly associated with age. Damacena et al. (2020) reported 30.72% of firefighters had elevated blood glucose that was significantly associated with central obesity. Despite the low prevalence of diabetes among firefighters it, nevertheless, impacts significantly on morbidity and mortality, and is associated with a tenfold increase in deaths in firefighters while on duty (Smith et al., 2016; Soteriades et al., 2011).

The present study reported an absence of diabetes in female firefighters, while Wolkow et al. (2014) reported that female firefighters had a slightly lower prevalence of diabetes compared to male firefighters (3.6% vs 6.8, respectively). Studies by Gendron et al. (2018a; 2018b) reported similar low results for diabetes prevalence in both genders, but with female firefighters slightly higher than male firefighters (3% vs 1.7%, respectively). In both studies, diabetes was self-reported, and may account for the gender difference in results.

With regard to ethnicity, Poston et al. (2014) found no significant difference in diabetes prevalence. The present study reported a similar result, where diabetes was not significantly associated to ethnicity. Choi et al. (2016c) reported that in Asian firefighters, blood glucose had a high significant correlation to obesity, but no correlation was found between blood glucose and obesity in Hispanic firefighters.

The prevalence of diabetes can be attributed partially to the firefighters' variable work schedules which, in most cases, demands a maximal response when dealing with an emergency. This, invariably, leads to increased stress, both physiological and psychological, and adversely impacts blood sugar levels (Joseph & Golden, 2017; Wellen & Hotamisligil, 2005). In addition, indulging in fast-foods tends to be the unhealthy first choice of many firefighters that aggravates their diabetes risk (Choi et al., 2016c; Savall et al., 2018; Gendron et al., 2018a; Polsky, Moineddin, Glazier, Dunn, & booth, 2016; Yeo, Yoon, & Kim, 2017). Muegge, Zollinger, Song et al. (2020) found that a lack of knowledge was the most common barrier to weight management (19%) in firefighters, as well as a lack of access to low calorie foods (15.7%).

5.4. Physical Inactivity

Quite understandably, the minority (13.71%) of firefighters were classified as physically inactive and not meeting the minimum physical activity requirements for healthy adults (ACSM, 2018, p. 44), with the age-group 40-49 years the most likely to be physically inactive, for both genders and all ethnicities. Mehrdad et al. (2013) reported a slightly higher prevalence of physical inactivity in firefighters at 23.8%. In contrast, Durand et al. (2011) found that almost half (49%) of all firefighters were sedentary, and that physical inactivity was directly associated with the total amount of weekly exercise and HDL-C concentration, and inversely associated with TC/HDL-C and TC concentration. Cavalcante Neto et al. (2019) reported that 55% of firefighters were physically inactive. Similarly, Risavi and Staszko (2015) reported that 47.3% of firefighters were physically inactive. Eastlake et al. (2015) also reported a high prevalence of physical inactivity in 62% of firefighters. This is supported by Amodeo and Nickelson (2020) who reported that 46.7% of firefighters were physically inactive, and 14% did not participate in any moderate-intensity exercise. Porto, Schmidt, De Souza et al. (2019) reported that 34.2% of firefighters were not physically active while on-duty, and that 15.4% of off-duty firefighters were not physically active. Soteriades, Psalta, Leka and Spanoudis (2019) also reported a high prevalence of physical inactivity among firefighters, where 37.2% reported exercising 1-2 times per week, and 16.7% reported never exercising. The same study also reported physical inactivity was significantly associated with an increase in musculoskeletal injuries. Smith Horn, Woods, Ploutz-Snyder and Fernhall (2016b) reported that 78% of firefighters between the ages 40-60 years were physically inactive. Age was significantly associated with being physically active, and older firefighters were more likely to be physically inactive (Amodeo & Nickelson, 2020).

The current study reported a significant association between physical inactivity and BMI in firefighters, where physically inactive firefighters were more likely to be obese. Baur et al. (2012a) reported that 56.9% of firefighters exercised for less than 30 minutes per session, and 16.2% exercised once or less per week. The same study also found that obese firefighters exercised less than the recommended 150 minutes per week for healthy adults, and had significantly lower cardiorespiratory fitness. Choi et al. (2016a) reported that 27.5% of firefighters exercised once or less per week, and this was significantly associated with obesity. Gendron, Lajoie, Laurencelle and Trudeau (2020) reported that after adjustment for covariates (age, smoking, stress, alcohol, and diet related factors), physical activity was negatively correlated with BMI, WC, WHR and DBP. Damacena et al. (2020) reported a similar finding, where 62.44% of firefighters were physically inactive, and that physical inactivity was significantly associated with WC.

The present study reported a similar prevalence of physical inactivity for males and females, in 13.27% and 15.38%, respectively. Gendron et al. (2018a; 2018b) reported that 62% of female firefighters were physically inactive compared to 70% of male firefighters. In Coloured firefighters, there was a significant association between physical inactivity and obesity. In contrast, Poston et al. (2014) reported no significant association between physical inactivity and ethnicity in firefighters.

Even though the prevalence of physical inactivity was not high in firefighters in the current study, however, it is a cause of concern from both a public safety point of view, as well as from a personal health perspective. Therefore, encouraging physical activity among firefighters who are at risk will help to address physical inactivity as a modifiable CAD risk factor (Baur et al., 2012a; Durand et al., 2011; Seyedmehdi et al., 2016).

5.5. Family History of Coronary Artery Disease

In the present study, 20.97% of firefighters indicated a positive family history of CAD that was similar in both genders, and related to advancing age in male firefighters. The study also found a significant association between family history, older age, and WC, as well as between family history and BMI, but in male firefighters only, especially of White and Coloured ethnicity. Martin et al. (2019) reported a similar prevalence of family history in 25% of firefighters, but found no significant association between family history and other CAD risk factors. Smith et al. (2012) reported a much lower prevalence of family history in 5.17% of firefighters, but also no significant association between family history and other CAD risk factors. Smith et al. (2016b) reported a similar low prevalence of family history in 5% of firefighters aged 40 years or older. Mehrdad et al. (2013) reported that 6.1% of firefighters had family history. Savall et al. (2018) also reported a low prevalence of family history in 11.1% of firefighters.

Gendron et al. (2018a; 2018b) reported similar results as the present study on the prevalence of family history based on gender, but reported no significant association between family history and other CAD risk factors. Santora et al. (2013) reported a much higher prevalence of family history in 38% of males and in 56% of females. Ratchford et al. (2014) reported a slightly higher prevalence of family history in 32% of firefighters, but found no significant association between family history and other CAD risk factors. Pillutla, Ahmadi and Budoff (2012) and Budoff et al. (2009) also reported a relatively high prevalence of family history in 35% and 28.9% of firefighters, respectively. Korre et al. (2016) reported an even higher prevalence of family history in 40% of firefighters. In Coloured firefighters, there was a significant association between family history and age. In White firefighters, family history was also significantly associated with obesity and central obesity. No previous literature reported on the association between family history and ethnicity in firefighters (Choi et al., 2016c; Lima et al., 2013; Poston et al., 2014).

A positive family history of CAD in firefighters varied quite broadly among studies, ranging from 5% to 40% (Glueck et al., 1996; Korre et al., 2016; Martin et al., 2019; Savall et al., 2018), and was likely due to differences in study sample size, gender, and age.

5.6. Age

In the present study, 23.39% of firefighters had age as a CAD risk factor, especially in Coloured and White male firefighters older than 45 years. Age was significantly correlated with BMI and WC in both genders, and to SBP and DBP in male firefighters only. Martin et al. (2019) reported that 35.1% of firefighters had age as a risk factor. Similarly, Savall et al. (2018)

reported 31.9% of firefighters had age as a risk factor. In contrast, Mehrdad et al. (2013) reported only 11.6% of firefighters had age as a risk factor.

Noguiera et al. (2016) reported a similar result as the present study, and found that older age was significantly associated with BMI in firefighters. Munir, Clemes, Houdmont and Randall (2012) reported a significant difference between firefighter BMI categories and mean age, where older firefighters had higher mean BMIs than younger firefighters. Soteriades et al. (2003) reported that aged firefighters (45 years or older) had a significantly higher prevalence of hypertension than their younger counterparts. Similarly, Eastlake et al. (2015) reported that age in firefighters had a significant association with high blood cholesterol, high blood glucose and high blood pressure. In contrast, Smith et al. (2012) reported that 47.4% of firefighters were 45 years or older, but that there was no significant association with other risk factors.

Gendron et al. (2018a; 2018b) reported that 45.3% of male firefighters had age as a risk factor compared to only 10% of female firefighters. Jahnke et al. (2012) reported a similar result where male firefighters had a mean age higher than female firefighters. Smith et al. (2020) reported that as male and female firefighters aged, both genders had a significant increase in BMI, but only male firefighters had a significant increase in hypercholesterolemia, hypertension, and hyperglycaemia. Perroni et al. (2014) found significant differences between age and BMI in the age categories 25 years or younger, 26-30 years, 31-35 years, 36-40 years and 41-42 years, where older firefighters were more likely to be obese. Burgess et al. (2012) reported that 47.23% of firefighters were aged 45 years or older, and when split into age categories, the 45 years or older group was significantly associated with dyslipidemia. Similarly, Davis et al. (2002) reported that SBP, DBP, BMI and TC increased as firefighters aged, and also found that age was significantly associated with SBP, DBP, BMI and TC. Ide (2000) also reported that BMI, blood pressure and cholesterol significantly increased as firefighters aged. Damecena et al. (2020) reported that central obesity increased as firefighters aged, with 9.64% of firefighters being obese in the under 30 age-group, 11.75% in the 30-39 age-group, 34.40% in the 40-49 age-group, and 36.59% in the 50-59 age-group. Also, the two older age groups (40-49 years and 50-59 years) were significantly associated with central obesity.

Both Kim and Lee (2017) and Donovan, Nelson, Peel et al. (2009) reported that Korean and North American firefighters aged between 40-49 years and 50-59 years were significantly associated with metabolic syndrome. Baur, Christophi and Kales (2012b) also found a significant association between metabolic syndrome and increased age. In contrast, Kirlin et al. (2017) reported no significant difference between age groups for BMI in female firefighters.

The current study found significant correlations between age, BMI, WC, HC and WHR in all ethnicities and between age, SBP and DBP in Coloured and Black firefighters. Poston et al. (2014) reported that White firefighters had a higher mean age than firefighters of colour, and the former were more likely to have dyslipidemia, hypertension and obesity.

Age as a risk factor in firefighters ranged between 11% and 47.4% in the literature, and was significantly associated with obesity, hypertension and dyslipidemia (Davis et al., 2002; Eastlake et al., 2015; Martin et al., 2013; Mehrdad et al., 2013; Munir et al., 2012; Noguiera et al., 2016; Perroni et al., 2014; Smith et al., 2012; Soteriades et al., 2003). Aged firefighters were shown to have an eighteenfold increase in CAD-related fatalities while on-duty (Smith et al., 2016; Soteriades et al., 2011).

5.7. Hypertension

In most studies, the prevalence of hypertension in firefighter’s ranged between 10 and 30% (Choi et al., 2016c; Gendron et al., 2018a; Soteriades et al., 2003). In the present study, 33.06% of firefighters were hypertensive, especially male firefighters older than 40 years and in all ethnic groups. There were significant correlations between blood pressure and age, BMI, WC and WHR and significant associations between hypertension, obesity, central obesity, WHR, diabetes and dyslipidemia, especially in Coloured male firefighters. Furthermore, there was a significant correlation between DBP and TC. In previous studies, female firefighters were reported to have a lower prevalence of hypertension compared to male firefighters (Gendron et al., 2018a; Gendron 2018b; Li et al., 2017; Wolkow et al., 2014). Choi et al. (2016b) found that 10.9% of firefighters were hypertensive, with significant correlations between blood pressure, BMI and WC. Soteriades et al. (2008) reported a prevalence of hypertension in 18.24% of firefighters, and found that hypertension was significantly associated with obesity. Nor, Lee, Park et al. (2019) reported that 18.1% of firefighters had hypertension, and that hypertension was significantly associated with an increased risk of major adverse cardiovascular events (MACE). Plat et al. (2012) reported a prevalence of hypertension in 23% of Dutch firefighters. Espinoza, Delgado-Floody, Martínez-Salazar et al. (2019) also reported a relatively high prevalence of hypertension, in 25% of firefighters. Soteriades et al. (2003) reported that 20% of firefighters were hypertensive, and that hypertension was significantly associated with age (45 years and older), obesity, and elevated blood glucose levels. Choi et al. (2016b) reported both SBP and DBP were significantly higher in older firefighters, and that the prevalence of hypertension increased proportionately with age-group from 25-34 years (1.2%), 35-44 years (6.7%), 45-54 years (17.2%) and 55-61 years (35.0%). The study also reported that a high percentage of firefighters with hypertension were also obese. Therefore, aged male firefighters were more likely to be hypertensive and obese (Choi et al., 2016c; Choi et al., 2016b; Gendron et al., 2018a; Gendron et al., 2018b; Li et al., 2017; Soteriades et al., 2008; Soteriades et al., 2003; Wolkow et al., 2014). Additionally, the study reported that the prevalence of hypertension was higher in White firefighters compared to other ethnicities (Choi et al., 2016b). Douglas and Oraeksi (2015) reported that in Nigerian firefighters, 9.6% were hypertensive that was significantly associated with being overweight and cigarette smoking. Choi et al. (2016c) reported blood pressure were significantly correlated with all ethnicities, especially DBP in Hispanic firefighters and SBP in Asian firefighters. Choi et al. (2016b) reported that White firefighters had a higher prevalence of hypertension compared to other ethnic groups.

The prevalence of hypertension is associated with increased stress, which is aggravated by the irregular sleeping patterns of firefighters, and exposure to hazardous fumes and constant smoke inhalation in the routine performance of their duties (Kaikkonen, Lindholm, & Lusa, 2017; Lim, Baek, Chung, & Lee, 2014; Smith et al., 2016; Smith et al., 2013). Hypertension is also associated with significant plaque build-up in the arteries that increased SCD risk twelvefold in firefighters (Burgess et al., 2012; Yang et al., 2013).

Factors related to the alarm response and emergency duties, such as 24-hour shifts, night shift, sleep cycle disruption, sleep deprivation, emotional and physical stress, and altered eating patterns caused alterations in the circadian rhythm of blood pressure in firefighters (Reinberg, Smolensky, Riedel et al., 2017). Due to firefighter's irregular work schedules and stressful occupational tasks, insomnia was quite prevalent in firefighters (Jang, Jeong, Ahn, & Choi, 2019). Sleep deprivation, in combination with mental and physical stress, were significant causes of hypertension, especially in firefighters working 24-hour shifts, night shifts, and multiple shifts a month (Choi et al., 2016b; Jang et al., 2019; Reinberg et al., 2017).

5.8. Obesity

In the literature, the prevalence of obesity in firefighters varied considerably from 14.7% to 51.7% (Choi et al., 2016c; Gendron et al., 2018; Nogueira et al., 2016; Smith et al., 2013). In the current study, 37.10% of firefighters were obese, and especially with central obesity in both female and male firefighters aged 40 years or older and in all ethnic groups. In addition, BMI correlated significantly with age, WC, HC, WHR, SBP, and DBP in both genders, and BMI with TC in male firefighters only. Other studies reported that more male firefighters were obese than female firefighters (Crespo-Ruiz, García, Fernández-Vega, Crespo-Ruiz, & Rivas-Galan, 2020; Gendron et al., 2018a, Gendron et al., 2018b; Jahnke et al., 2012; Li et al., 2017). Choi et al. (2016c) had a lower prevalence of 22.8% obesity in firefighters, however, BMI correlated significantly with WC, SBP, DBP, TC and fasting blood glucose. Similarly, Gendron et al. (2018a) found obesity prevalent in 23.6% of firefighters, and a significant association between obesity, age and family history. Clark, Rene, Theurer and Marshall (2002) reported an obesity prevalence of 29.8% in United States firefighters, with 2.3% being morbidly obese. The study also found that DBP and cholesterol were significantly higher in obese firefighters. Eastlake et al. (2015) reported that 33% of United States firefighters were obese, and that BMI was significantly associated with high cholesterol in firefighters. Similarly, Poston et al. (2011) reported 33.5% of Unites States firefighters were obese, and significantly associated with SBP, DBP, triglycerides and low HDL-C levels. Leary et al. (2020) and Espinoza et al. (2019) also reported a high prevalence of obesity in 46.8% and 34.2% of firefighters, respectively.

In the present study, central obesity, as indicated by WC, correlated significantly with BMI, WHR, SBP, DBP and TC. Choi et al. (2016c) found similar correlations between WC, BMI, SBP, DBP, fasting blood glucose and age. Choi et al. (2016c) also reported significant correlations between BMI, WC, and age in both male and female firefighters. Damacena et al. (2020) reported that obesity was prevalent in 10.99% of Brazilian firefighters and that 18.61% had central obesity. In addition, central obesity was significantly associated with age, TC and blood glucose concentration (Damacena et al., 2020).

Perroni et al. (2014) had similar results to the present study, where BMI was significantly higher in the age-group 40 years and older. Ide (2000) reported that 22.3% of firefighters were obese, and that obesity and age were significantly associated. Walker et al. (2014) also found a significant association between obesity and age in volunteer Australian firefighters, and reported significant differences in WC between the firefighter age groups, with WC being significantly lower in the 25-34 year age-group compared to the 45-54 year age-group. Similarly, Choi et al. (2016a) reported that central obesity increased significantly with age-group, i.e., 25-34 years (7.8%), 35-44 years (25.5%), 45-54 years (33.6%), and 55-64 years (38.1%). Rahimi, Sedek and Teh (2016) also reported that BMI was significantly associated with age and WC in firefighters. Wilkinson et al. (2014) reported that 46% of US firefighters were obese and over the age of 40 years. Similarly, Soteriades et al. (2005) reported that 50.5% of firefighters aged 45 years or older were obese, and Soteriades et al. (2008) reported 53% of firefighters aged 40 years or older were obese, but both studies reported no significant association between obesity and other risk factors.

Poston et al. (2014) reported that firefighters of colour in the US had significantly higher BMIs compared to White firefighters, but there was no significant association between WC and ethnicity. Choi et al. (2016a; 2016c) reported that a higher percentage of White firefighters were obese than other ethnic groups, and that all ethnic groups were associated with obesity.

Obesity was not only a major CAD risk factor, but also a catalyst for many other CAD risk factors, such as hypertension, diabetes and dyslipidemia (Smith et al., 2013; Choi et al., 2011). Central obesity was also a significant predictor of hypertension, diabetes, dyslipidemia and mortality (Pandey, Patel, & Lavie, 2018).

Older firefighters classified as obese were more susceptible to cardiovascular incidents or physical injury, while on duty (Baur et al., 2012a; Perroni et al., 2014; Walker et al., 2018; Yang et al., 2013; Zachmeier et al., 2018). Kaipust et al. (2019) also found that sleep-deprived obese firefighters were more likely to get injured. Obesity was associated with decreased cardiorespiratory fitness, lower cardiorespiratory performance, and reduced work capacity (Nogueira et al., 2016; Perroni et al., 2014). Furthermore, firefighters who were older and obese, with lower cardiorespiratory fitness were most at risk for sustaining a cardiovascular incident during fire suppression and related firefighting duties (Baur et al., 2012a; Kaipust et al., 2019; Perroni et al., 2014; Smith el at., 2013; Sternfeld et al., 2002; Walker et al., 2018; Yang et al., 2013; Zachmeier et al., 2018).

5.9. Cigarette Smoking

Cigarette smoking was the second most prevalent risk factor in 39.52% of firefighters, especially in White and Coloured male firefighters of all ages, and particularly in the youngest age-group. Cigarette smoking showed no significant association with other CAD risk factors. In contrast, Gendron et al. (2018a; 2018b) reported that the prevalence of cigarette smoking was higher in female firefighters. Similarly, Jahnke et al. (2012) reported more female firefighters were smokers compared to male firefighters (22.2% vs. 13.6%, respectively). Li et al. (2017) also showed a slightly higher prevalence of smoking in female firefighters. Jitnarin et al. (2019) reported that 5.1% of female firefighters were smokers, were also significantly younger, and had a significantly higher BMI compared to their non-smoker counterparts.

Planinc et al. (2016) reported that 38% of Slovenic volunteer firefighters were smokers, with no significant association between smoking and other risk factors. Haddock et al. (2011) found that 13.6% of career firefighters were smokers, and also reported significant associations between smoking and other health risk behaviours, such as anxiety disorders and binge drinking. Jitnarin et al. (2015) found that 20.8% of firefighters were smokers, 31.9% were obese, and 14.1% were hypertensive, but no significant associations were found between these variables compared to non-smokers. However, smokers were less likely to engage in vigorous physical activity, more likely to be drinkers, and present with symptoms of depression (Jitnarin et al., 2015). Seyedmehdi et al. (2016) reported that 21.7% of firefighters were smokers, and that cigarette smoking combined with physical inactivity were significantly related to lower aerobic fitness. Other studies also reported a higher prevalence of cigarette smoking in 38.3%, 41.9% and 43.7% of firefighters, respectively (Noh et al., 2020; Leary et al., 2020; Soteriades et al., 2019).

In the present study, a significant association was reported between cigarette smoking and physical inactivity in the 20-29 year age-group. Jitnarin et al. (2015) found smokers were significantly younger than non-smokers. Similarly, Yoo and Franke (2009) reported that tobacco use was most prevalent (40%) in the youngest age-group of 16-30 years compared to the older groups of 31-42 years (32%) and 43-69 years (19%). Ide (2000) also reported that the prevalence of smoking significantly decreased as firefighters aged.

Jitnarin et al. (2013) reported that fewer White firefighters smoked compared to other ethnic groups. Similarly, Lima et al. (2013) reported that 8.3% of White Brazilian firefighters were smokers, 6.8% of mixed ethnicity were smokers, and 9.3% of Black firefighters were smokers, but reported no significant association between smoking and ethnicity. Alkali, Mubi, Ballah, and Bandele (2015) reported that in Nigerian firefighters, 16% of smokers were obese, but found no significant association between smoking and obesity. Poston et al. (2014) reported a similar prevalence of smoking between ethnicities, and no significance association between smoking and ethnicity.

Mons et al. (2015) found that there was a dose-response relationship between cigarette smoking and cardiovascular disease. Cigarette smoking was reported to advance CVD mortality rates by 5.5 years (Mons et al., 2015). Similarly, Smith et al. (2013) reported that smoking increased the relative risk of on-duty deaths by 8.6 times, due to heart disease.

Firefighters exposed to regular wildland fires and other environmental fires were associated with a significant decline in lung function (forced vital capacity, forced expiratory volume, and forced expiratory flow), and an increase in CAD risk (Navarro, Kleinman, Mackay et al., 2019). Smoking was shown to cause a decrease in forced expiratory volume and forced vital capacity, leading to premature morbidity and mortality in firefighters (Jitnarin et al., 2014; Navarro et al., 2019; Seyedmehdi et al., 2016). A decrease in lung function increased the stress on the cardiorespiratory system, and compounded any underlying CAD risk factors in firefighters (Anthonisen et al., 2002; Nikolakaros et al., 2017; Wilson, Hoeg, D'Agostino et al., 1997). The detrimental effects of environmental and wildlife fire smoke, when compounded by cigarette smoke inhalation, significantly increased the risk of sustaining an abrupt cardiovascular incident or SCD (Anthonisen et al., 2002; Jitnarin et al., 2015; Navarro et al., 2019; Nikolakaros et al., 2017; Seyedmehdi et al., 2016; Wilson et al., 1997).

5.10. Dyslipidemia

In the current literature, the prevalence of dyslipidemia in firefighters ranged between 20 and 56.5% (Byczek et al., 2004; Choi et al., 2016c; Cohen et al., 2019; Martin et al., 2019; Smith et al., 2012). Dyslipidemia was the most prevalent CAD risk factor in 40.32% of firefighters in both genders and in all ethnic groups, and was related to advancing age. There was a significant correlation between dyslipidemia, BMI and WC in male firefighters only. In addition, there was a significant association between dyslipidemia and hypertension in male firefighters aged 50-65 years. Savall et al. (2018) found that 19.5% of firefighters had elevated cholesterol levels. Similarly, Byczek et al. (2004) reported a prevalence of hypercholesterolemia in 24% of US firefighters, and Martin et al. (2019) reported that 29.7% of volunteer firefighters had dyslipidemia. Lee and Kim (2017) reported a high prevalence of elevated triglycerides in 36.2% of firefighters. Similarly, Baur et al. (2012b) reported that 28.5% of firefighters had elevated triglycerides, and 40.8% had low HDL-C levels. Leary et al. (2020) reported a similar prevalence, where 46.7% of firefighters had high triglycerides, and 31.1% had low HDL-C levels. Cohen et al. (2019) reported an even higher prevalence of dyslipidemia in 56.5% of firefighters and that is was significantly associated with age.

Gendron et al. (2018a; 2018b) found that male firefighters had a higher prevalence of dyslipidemia in 17.4% compared to 5% in female firefighters. Similarly, Santora et al. (2013) reported that hypercholesterolemia was present in 46% of male firefighters and 11% of female firefighters. Wolkow et al. (2014) reported elevated triglycerides in female and male firefighters, at 26.9% and 32.3%, respectively.

The present study found significant correlations between TC, WC and DBP in male firefighters, but not female firefighters. Choi et al. (2016c) found significant associations between TC, BMI and WC. Smith et al. (2012) reported that 13.79% of firefighters had high cholesterol, with no significant association between high cholesterol and BMI. Yu, Au, Lee et al. (2015) also found no significant association between TC, physical activity, BMI and smoking in Hong Kong firefighters. Damacena et al. (2020) reported that 22.9% of firefighters had high cholesterol, and reported a significant association between cholesterol and central obesity.

Burgess et al. (2012) reported that 26.97% of firefighters had high LDL-C levels, and in the 45-year and older age-group, increased LDL-C was significantly associated with hypertension. Davis et al. (2002) also reported that the mean TC concentration increased with firefighter age. The study also found a significant association between TC and age in firefighters. Soteriades et al. (2002) reported 33.3% of firefighters had high TC levels, and that there was a significant association between TC, triglyceride levels, age (45 years or older), and obesity. Similarly, Eastlake et al. (2015) reported that 35% of firefighters had high cholesterol, and that it was significantly associated with BMI and age. Smith et al. (2016b) also reported a high prevalence of dyslipidemia (50%) in older (40 years or older) firefighters. Soteriades et al. (2008) reported 73% of firefighters aged 40 years or older had dyslipidemia, but found no significant association with obesity. Glueck et al. (1997) reported that White and Black firefighters had a similar prevalence of high cholesterol levels. Choi et al. (2016c) reported that LDL-C and obesity was significantly correlated in Hispanic firefighters compared to other ethnic groups. Poston et al. (2014) reported minority firefighters had a higher prevalence of high cholesterol compared to white firefighters (32.7% vs. 28.1%, respectively), but no significance was found.

Fast foods, high in saturated and trans-fatty acids, are directly related to increased TC (Gu & Yin, 2020; Liska, Cook, Wang, Gaine, & Baer, 2016). Environmental and wildland fire smoke has been reported to cause an increase in oxidative stress and to change certain serum haematological parameters, specifically TC, LDL-C, lactate dehydrogenase, creatine kinase and urea nitrogen (Al-Malki, Rezq, & Al-Saedy, 2008; Coker, Murphy, Johannsen, Galvin & Ruby, 2019; Gaughan, Siegel, Hughes et al., 20014).

5.11. Strengths and Limitations

This was the first study in South Africa to look at CAD risk factors in firefighters according to gender, age and ethnicity. This study provides valuable research in a scarcely studied area, especially in South Africa and the Western Cape.

A limitation was that the study used convenient sampling that negatively impacted the external validity. Also, the relatively small sample size of 124 firefighters negatively impacted the power of the study. However, this was unavoidable, as the CoCT limited the number of firefighters allowed to participate in the study, due to concerns of firefighter work disruption. Blood glucose was measured in the non-fasted state, therefore, diabetes had to be medically diagnosed. The study was also under-represented by female participants, and only one firefighter was of Indian ethnicity.

5.12. Conclusion

Obesity, cigarette smoking and dyslipidemia, were the most prevalent CAD risk factors among firefighters, with older males having the highest prevalence of multiple CAD risk factors, especially in the Coloured and White ethnic groups, placing this population demographic at highest risk for CAD related morbidity and mortality while on-duty. Age and obesity were significantly correlated with other CAD risk factors. Male firefighters were more likely to be smokers, who also presented with hypertension and diabetes. Female firefighters had a higher prevalence of obesity, especially central obesity.

There is a need to educate firefighters on CAD risk factors, and to implement behavioural and lifestyle modification strategies to mitigate the prevalence of risk factors. Firefighters should also have regular health screenings to monitor CAD risk factors, and the implementation of regular exercise programmes should be prioritised in order to reduce CAD morbidity and mortality among firefighters.

5.12.1. Recommendations

It is recommended that future studies use random sampling that would be sufficiently powered in order to ensure external validity. In addition, a more representative sample of female firefighters in the CoCT is recommended.

5.12.2. Summary

On-duty fatalities amongst firefighters are often due to SCD, and are frequently attributed to the prevalence of modifiable CAD risk factors. The study aimed to determine the prevalence of the major CAD risk factors in firefighters in the City of Cape Town Fire and Rescue Service. The study also determined the relationship between the various CAD risk factors in firefighters, and the relationship between CAD risk and demographic characteristics.

The prevalence of CAD risk factors was diabetes in 8.87%, physical inactivity in 13.70%, family history in 20.96%, age in 23.39%, hypertension in 33.06%, obesity in 37.10%, cigarette smoking in 39.52% and dyslipidemia in 40.32% of firefighters. The study found that 86.29% of firefighters had at least one risk factor, 56.45% had at least two, and 36.29% had three or more risk factors. Male firefighters had a higher prevalence of CAD risk factors, and the prevalence of risk factors increased with age. Significant associations were found between age, obesity, hypertension and dyslipidemia, particularly in older male firefighters of mixed ethnic descent. There is a need to educate firefighters on CAD risk factors, and to implement behavioural and lifestyle modification strategies to mitigate the prevalence of risk factors in firefighters. Furthermore, regular health screening to monitor CAD risk factors, and the implementation of regular exercise programmes are needed in order to reduce CAD-related morbidity and mortality among firefighters.

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APPENDIX A: INFORMATION LETTER

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INFORMATION SHEET

Project Title: **Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town Fire and Rescue Service**

Dear Participant,

Introduction

This is an invitation for you to participate in a scientific study. This information sheet will help you to decide whether or not you would like to participate in this study. Before you decide to participate it is required for you to fully understand what is involved in this study. If there are any questions regarding this study that this sheet cannot explain to you, please feel free to ask the interviewer the questions.

What is this study about?

This is a research project being conducted by Jaron Ras from the University of the Western Cape. We are inviting you to participate in this research project in order to establish your current possible coronary artery disease (CAD) risk factors. This will give an indication of the areas you need to focus on in order to improve your future results, as well as contribute to research which could benefit other firefighters in future, when looking at common trends regarding CAD risk factors amongst firefighters.

What will I be asked to do if I agree to participate?

You will be asked to complete a consent form before any information or data is recorded. Participation may range from filling in a questionnaire to participating in a CAD risk assessment in order to gather the relevant information. This will be done in a private area within the relevant fire stations for the convenience of those on duty. The duration of each assessment may be varied, however, this will be established and communicated to you. Questions you will complete will include information about cigarette smoking, family history of heart disease, age, ethnicity and gender. CAD risk assessments will include measuring resting blood pressure (BP), fasting glucose, total cholesterol, waist, hip, height and weight.

Would my participation in this study be kept confidential?

All your personal information will be kept strictly confidential. To help protect your confidentiality, we will have all assessments done in a secure, private location within the comfort of the fire station. All recorded data will be kept confidential by replacing your name with numeric codes, and saving the information within a private folder which will be reviewed only by the researcher and supervisor of this research project. If we write a report or article about this research project, your identity will be protected.

What are the risks of this research?

There may be some risks from participating in this research study. Much like any activity or assessment, there are risks which can be described as both expected and unexpected. Possible expected risks of an emotional and psychological nature may include feeling self-conscious, embarrassed or anxious, due to having fears of possible negative outcomes. Unexpected risks include physical aspects, such as increased heart rate and blood pressure and discomfort during assessments. Risks associated with finger prick blood sampling, such as transferring viruses from one person to another will be prevented by using gloves when administrating blood samples and using an experienced researcher who will adhere to the universal precautions of safety.

What are the benefits of this research?

The benefits to you include personal enrichment and awareness of your current risk stratification. As a firefighter you will be able to establish which areas of your lifestyle need-to be altered in order to maintain your health and well-being, as well as improve your results in future health assessments.

Do I have to be in this research and may I stop participating at any time?

Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify.

Is any assistance available if I am negatively affected by participating in this study?

If any negative effects of a severe nature occur, medical support will be contacted. Emergency care will be taken by the researcher who is a qualified first aider (Level 3) to support you until medical support arrives.

What if I have questions?

This research is being conducted by Jaron Ras from the University of the Western Cape. If you have any questions about the research study itself, please contact Jaron Ras on 3405618@myuwc.ac.za

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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Dean CHS: Prof Anthea Rhoda
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This research has been approved by the University of the Western Cape's Senate Research Committee and Ethics Committee.

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APPENDIX B: CONSENT FORM

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CONSENT FORM

Title of the Research Project: **Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town Fire and Rescue Service**

The study has been described to me in language that I understand and I freely and voluntarily agree to participate. My questions about the study have been answered. I understand that my identity will not be disclosed and that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.

Participant's name: ……………......................................…………..

Participant's signature: ....…………………………….

Date: ....……………………….

APPENDIX C: DATA RECORDING SHEET

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Project Title: **Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town fire and Rescue Service**

Data Recording Sheet

Participant Information	Alpha-numeric code	
	Ethnicity (B, C, I, W)	
	Sex (Male=1, female=2). Indicate with a number	
	Date of Birth	

	Do you have any past or present medical conditions?	
Medical Information	1. Are you currently taking any medication?	Yes □ No □ Please state if any: ______________________________
	2. Do you have a family history of heart disease? [i.e., myocardial infarction, coronary revascularization or sudden death before 55 years in father or other male first-degree relative (i.e., brother or son) or before 65 years in	Yes □ No □ Please state if any: ______________________________

	mother or other female first-degree relative (i.e., sister or daughter)]	
	3. Do you presently have any physical (orthopaedic) injuries?	Yes □ No □ Please state if any: ________________________________
	4. If you answered positively in question 3 above, are you currently receiving treatment for the physical injuries?	Yes □ No □ Please state if any State: ________________________________
	5. Do you currently smoke cigarettes, or any other recreational substance?	Yes □ No □ Please state if any State: ________________________________ If yes, please state the average number of cigarettes or packets you smoke per day: Number of cigarettes:_____ per day or Number of packets: ______ per day.
Lifestyle Information	6. For previous cigarette smokers, if you currently do not smoke, have you quit in the last 6 months?	Yes □ No □ Not applicable □ State: ________________________________
	7. Do you currently drink alcohol?	Yes □ No □ If yes, please state the common type(s) and average number of drinks you consume: Type(s) of Alcohol:_____________________

	Number of Drinks: ______ per day or (e.g., 1 can of beer) ______ per week or ______ per month
8. Do you currently take any other drugs?	Yes □ No □ If yes, please state the type(s) and average number of drugs you consume: Type(s) of Drug(s):____________________ Number of Drugs: ______ per day or ______ per week or ______ per month
9. Do you presently exercise in your leisure time? Example, go to the gym, play sport, go running, etc.	Yes □ No □ If yes, state what you do: _______________ If more than one, state all of them. ____________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ (You don't sweat) moderate intensity □ (You sweat lightly) heavy intensity: □ (You sweat heavily) If more than one, state the others below: ____________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ moderate intensity □ heavy intensity: □

10. Do you presently participate in yard or gardening activities	Yes □ No □ If yes, state what you do: ________________ If more than one, state all of them. _______________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ (You don't sweat) moderate intensity □ (You sweat lightly) heavy intensity: □ (You sweat heavily) If more than one, state the others below: _____________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ moderate intensity □ heavy intensity: □
11. Does your occupation require high amounts of physical activity? E.g. standing for long periods, walking continuously, heavy lifting etc.	Yes □ No □ If yes, state what you do: ________________ If more than one, state all of them. _______________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ (You don't sweat) moderate intensity □ (You sweat lightly) heavy intensity: □ (You sweat heavily)

	If more than one, state the others below: ______________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ moderate intensity □ heavy intensity: □
12. How many minutes (If any) transportation related physical activity do you do?	Yes □ No □ If yes, state what you do: ________________ If more than one, state all of them. _______________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ (You don't sweat) moderate intensity □ (You sweat lightly) heavy intensity: □ (You sweat heavily) If more than one, state the others below: ______________________________________ How often: _______ days per week How long: _______ minutes per day How hard: low intensity □ moderate intensity □ heavy intensity: □

	13. Total minutes of physical activity per week?	Low intensity:______________ Moderate intensity:_____________ High Intensity:_______________ Average minutes of exercise per week: ________________
TEST DATA	**Date of Measurement:** **Time of Measurement: _____h_____**	_________________________________

Measurements	**Measure**	**Measure**	**Measure**	**Final**
	1	2	3	**Measure**
Body mass (kg)				
Stretch stature (cm)				
Waist girth (min.) (cm)				
Hip girth (max.) (cm)				
Systolic Blood Pressure (mm Hg)				
Diastolic Blood Pressure (mm Hg)				

Non-Fasting Glucose (mmol•L^{-1})				
Total Cholesterol (mmol•L^{-1})				

APPENDIX D: LETTER OF PERMISSION TO THE CITY OF CAPE TOWN

13 June 2019

Ms Jameyah Armien

Organisational Research Branch

City of Cape Town

Dear Ms Armien

Re: UWC Research with the CCT Fire and Rescue Service

This letter pertains to the request for permission to conduct research in the City of Cape Town (CCT) Fire and Rescue Service.

The following information or documents are submitted as requested by the City of Cape Town, namely:

1. An approved research proposal that includes:
    a. The research title and topic, a concise description of the research project, and the research purpose and focus.

    b. The research partners or organisations involved in the research:

       The research partners are the CCT Fire and Rescue Service and the Department of Sport, Recreation and Exercise Science, UWC.

    c. A short summary of the literature and research framework.

       A brief review of the literature related to the research on firefighters is contained in the research proposal (refer to pages 5 – 9), as well as the research framework (refer to page 5).

    d. Details of the research methodology (including sampling, research questionnaire, intended analysis and management of the data post the research).

    e. A high-level research plan with timeframes and expected final research completion date.

       This information in also contained in the research proposal (refer to page 32).

2. A letter or document related to the research ethics pertaining to the research.

This is contained in the Ethical Considerations stated in the proposal (refer to pages 12-13), and attached is an ethics clearance letter from the Biomedical Research Ethics Committee at the University of the Western Cape.

3. Full details of how the research and information is planned to be used:

The research will be used primarily for degree purposes of Mr Ras and other students who will be conducting research on firefighters. Mr J Ras

(student number: 3405618) is currently registered for an MSc degree in Biokinetics in our department at UWC. The intention is to use the information to positively impact the health and wellness of firefighters in the City of Cape Town. Hopefully, the outcome of this research will help influence the overall firefighters' fitness-for-duty, and be protective on both the firefighters on duty, as well as the broader public who will be provided with quality service by the fire department that can ensure the safety of public lives and minimise the damage to property, as a result of the fire emergency. The research is also intended to help reduce the risk of injuries in firefighters, as well as minimise the likelihood of them sustaining life-threatening cardiovascular events both on and off duty. In addition, the intention is to have the research presented at national and international conferences, as well as published in peer-reviewed an accredited journals in order to disseminate the information to others who can benefit from the information both locally and internationally.

Our department and I, specifically, have a long history with the City of Cape Town Fire and Rescue Service that goes as far back as 1992, when we assisted in the health and wellness programme of the Bellville Fire Department under the Fire Station Commander Mr Cyprian Cairncross.

Since then, I have worked with the Fire Station Commander, Mr Mark Smith, in establishing health-related physical fitness testing protocols for firefighters in order to ensure that they are fit-for-duty, and remain so throughout their career. Currently, I serve on an Advisory Task Team to the

Fire and Rescue Service together with other health practitioners, such as Dr Brynt Cloete, who advise the Chief Fire Officer on the medical and physical fitness testing of firefighters that is intended to become a standardised annual programme and policy.

Our department has also been involved in the Toughest Firefighter Alive South Africa (TFASA) competition in advising competing firefighters on their preparation and training for the competition. This relationship is still in operation for the competition this year in September. The intention is for Cape

Town to produce the toughest firefighters at the competition, who will then represent us at the international competition.

Our department is also involved in other research with the City of Cape Town, such as the Western Cape on Wellness (WoW) Project that is intended to positively impact the health and wellness of all municipal departments and staff. The project has been operating for the past five years, and includes a substantial amount of research that is conducted by the various universities in the Cape Peninsula.

Our primary intention with this project is to establish quality support and research with the City of Cape Town Fire and Rescue Service that will extend well into the future. We would like our university to be the institution of choice for all research related to the Fire Service that will hopefully establish them as the best unit in the country, and Cape Town as the healthiest city.

4. Full details of what is specifically requested from the City of Cape Town for the research, including data, information, documents and the identification of potential CCT participants and how these are anticipated to be accessed.

We would like the City of Cape Town to grant permission in writing for the research to be conducted amongst the firefighters in the City of Cape Town. Once permission has been granted by the City of Cape Town for the research to be conducted, this information will then be communicated to all the Fire Station Commanders and firefighters through the Office of the Divisional Commander, Mr Ian Bell. All the necessary research information and documents, such as the study information letter, consent form, and questionnaires, will be issued in hardcopy format by the researchers to the relevant Station Commanders and firefighters in person. Arrangements will be made with the Station Commanders to communicate the information and details of the study to the firefighters both verbally and in writing. All firefighters will be informed that their participation in the study is voluntary, and should they choose to participate, they can stop participating or withdraw at any stage without any negative consequences. All measurements will be taken at the individual fire stations in Cape Town. Access to the firefighters will depend on the instructions of the Station Commanders and the availability of the firefighters when on or off duty. Understandably, if the firefighters are tested when on duty, all testing will stop immediately in the presence of an emergency call to the fire station. The testing will then resume on another occasion that is convenient for the firefighters.

5. Full details of the expected impact on time for potential participants:

Measurement of the CAD risk factors will take a maximum of 30 minutes per firefighter in order to complete all the information required. The written information will comprise the firefighters' age, gender, race, family history of heart disease, history of cigarette smoking, and physical activity habits. The physical measurements will comprise measuring blood pressure, blood cholesterol, fasting blood glucose, height, weight and waist and hips circumferences.

6. The time period during which the research is planned to be conducted in the City of Cape Town:

   This research study by Mr Jaron Ras in planned to take place from July to December 2019.

7. Details on any planned publishing of the research (name of publication and timeframes):

   The research is planned to be published in peer-reviewed and the Department of Higher education and Training (DHET) accredited journals, such as Health SA and Occupational Health Southern Africa. The papers are planned for submission for January – March 2020 and final publications in July – December 2020 (refer to the research proposal, page 32).

Because the research is used for academic purposes, the following documents were also requested by CCT, and are attached:

- Proof of current registration of the student at a Tertiary Institution. A letter from the main supervisor confirming the candidate's requirement to undertake the research and details of the relevant course or study.
- A letter from the Tertiary Institution's Ethics Committee or similar equivalent, indicating approval of the research subject, topic and proposal.

This research study by Mr Jaron Ras is intended to be the first of many projects which we intended conducting with the CCT Fire and Rescue Service. Additional studies that are currently being submitted to the Biomedical Research Ethics Committee, UWC, that are intended for implementation from July – December 2019 are the following, namely:

Mr Mathew Brooks (SN: 3043555): Relationship between health-related physical fitness and functional occupational fitness of firefighters in the City of Cape Town Fire and Rescue Service. MSc Degree in Biokinetics.

Ms Gabriella Santos (SN: 3451042): The prevalence and risk factors of work-related musculoskeletal disorders in firefighters in the City of Cape Town Fire and Rescue Service. MSc Degree in Biokinetics.

Mr Ghaleelullah Achmat (SN: 2542036): The impact of a multiple health intervention strategy on the coronary heart disease risk factors, health-risk behaviours, health-related physical fitness levels, functional occupational fitness, and musculoskeletal disorders in municipal firefighters. PhD degree.

This is an intervention study that is likely to extend from July 2019 to December 2020.

The relevant information for each of the above three studies, i.e., research proposals, ethics clearance letters, and proofs of registration, will be made available to CCT, once these studies have been approved by the Biomedical Research Ethics Committee, UWC.

I hope that the information supplied is sufficiently informative and appropriate. Nevertheless, I am willing to provide any additional information, as may be requested by the City of Cape Town in order to support our request.

Thank you for your consideration in this matter, and we look forward to your reply at your earliest convenience.

Yours sincerely

Prof L Leach

Research Supervisor

OPP23

URGENT

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Date	: 26 August 2019
To	: DIRECTOR: POLICY & STRATEGY
Reference	: PSRR-0148

Research Approval Request

In terms of the City of Cape Town System of Delegations (March 2019) - Part 29, No 1 Subsection 4, 5 and 6 "*Research:*

(4) To consider any request for the commissioning of an organizational wide research report in the City and to approve or refuse such a request.

(5) To grant authority to external parties that wish to conduct research within the City of Cape Town and/or publish the results thereof.

(6) To after consultation with the relevant Executive Director, grant permission to employees of the City of Cape Town to conduct research, surveys etc. related to their studies, within the relevant directorate

The Director: Policy & Strategy is hereby requested to consider, in terms of sub-section 5, the request received from

Name	: Jaron Ras
Designation	: Masters candidate
Affiliation	: University of the Western Cape (UWC)
Research Title	: Prevalence of Coronary Artery Disease Risk Factors in Firefighters in the City of Cape Town

Taking into account the recommendations below (see Annexure for detailed review):

Recommendations

That the CCT Director: Policy & Strategy grants permission to Jaron Ras in his capacity as a MSc Biokinetics Master's candidate at the University of the Western Cape, to conduct research in the City of Cape Town, subject to the following conditions:

- Engagement for CCT staff participation selection should only be via The Chief Fire Officer – Ian Schnetler;
- Pre-arranged dates and times of station or personnel visits to be advised regularly to the Office of the Chief Fire Officer;
- There is to be no disruption of service at any stage of the research and the researcher is not to impact or interfere with the CCT Fire Services or the Fire personnel during the course of all aspects of the research;
- CCT officials to sign an undertaking stating that they are participating in a voluntary capacity and agreeing to the use of the study tools and tests before participation takes place;
- The willingness and/or availability of individual CCT firefighter staff to participate in the research, in a voluntary capacity;
- Adherence to the scope and scale of the study as proposed – a maximum of 120 CCT fire fighters;
- Clear acknowledgement in the report that respondents' views and inputs are not regarded as official policy of their respective institutions;
- Data collection only to be done by the researcher (Jaron Ras) or his academic supervisor (Prof Lloyd Leach);
- All research and related information is to be treated with the strictest confidentiality;
- The researcher to provide one debriefing session with each participant;
- Anonymising of the City name and its officials and their responses;
- Use of the City's logo or brand is not permitted;
- Submission of the pre final results and report to The Chief Fire Officer, for verification;
- Submission of the completed research report to the Chief Fire Officer, the Director: Policy & Strategy, and the Manager: Research Branch – Policy & Strategy, within 3 months of completion of the report and research.

VC Wright 28/8/19

CIVIC CENTRE   IZIKO LEENKONZO ZOLUNTU   BURGERSENTRUM
12 HERTZOG BOULEVARD CAPE TOWN 8001 PRIVATE BAG X9181 CAPE TOWN 8000
www.capetown.gov.za

Making progress possible. Together.

Delegated authority:	Acceptance by Applicant:
Approved ☑ Comment:	I, JARON RAS confirm that I agree to abide by the conditions as stipulated above.
Not Approved ☐ Comment:	
Hugh Cole: Director: Policy & Strategy:	**Applicant**:
Date: 28/8/2019	**Date**: 29/08/2019
CCT departments: No interviews or data to be provided without proof of acceptance of the conditions under which the research permission is granted.	***Kindly return signed copy to*** Jameyah.armien@capetown.gov.za

http://teamsites.capetown.gov.za/sites/OPP-OPSRT/Shared Documents/DRAFT REVIEWS/UNDER REVIEW/JARON RAS & LLOYD LEACH/V5 RECOMMENDATIONS JARON RAS.docx

UNIVERSITY *of the* WESTERN CAPE

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APPENDIX E: ETHICS CLEARANCE LETTER

23 June 2020

Mr J Ras
SRES
Faculty of Community and Health Sciences

Ethics Reference Number: BM19/4/3

Project Title: Prevalence of Coronary Artery Disease risk factors in firefighters in the City of Cape Town and Rescue Services.

Approval Period: 29 November 2019 – 29 November 2020

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

Permission to conduct the study must be submitted to BMREC for record-keeping.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: BMREC-130416-050

APPENDIX F: TURN-IT-IN REPORT

Jaron Ras Masters Thesis

ORIGINALITY REPORT

21%	12%	12%	17%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of the Western Cape Student Paper	3%
2	hdl.handle.net Internet Source	2%
3	PanVascular Medicine, 2015. Publication	1%
4	Elke A Westerkamp, Siobhan C Strike, Michael Patterson. "Dietary intakes and prevalence of overweight/obesity in male non-dysvascular lower limb amputees", Prosthetics and Orthotics International, 2019 Publication	1%
5	m.scirp.org Internet Source	<1%
6	Submitted to London Metropolitan University Student Paper	<1%
7	Submitted to University of Stellenbosch, South Africa Student Paper	<1%