Fatal and non-fatal cardiovascular events in a selected group of South Africans

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Acknowledgements

To my Lord and Saviour Jesus Christ, thank you for dying on the cross for me. I can do all things through you because you give me strength. In you I live and move and have my being.

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- My **parents** and **siblings**, you have always believed in me and that has given me the boldness to pursue my dreams, thank you.


*Most of the important things in the world have been accomplished by people who have kept on trying when there seemed to be no hope at all. - Dale Carnegie*
Preface
The article-format has been chosen for this dissertation. This is the format approved and recommended by the North-West University (NWU). The dissertation consists of a motivation, literature study, a manuscript to be submitted to a peer reviewed journal, namely Atherosclerosis and a concluding chapter which summarises the main findings and recommendations.

The layout of the dissertation is as follows:
Chapter 1: Overview of the study; background, motivation, aim and objectives, methodology, rigour and ethical considerations.

Chapter 2: Detailed literature study.

Chapter 3: Research manuscript consisting of the author's instructions for the journal Atherosclerosis, consisting of an abstract, introduction, materials and methods, results, discussion, conclusion and acknowledgements.

Chapter 4: Discussion of main findings, evaluation, limitations, conclusion and recommendations.

Each chapter’s references are included at the end of the chapter. Chapters 1, 2 and 4 follow the Harvard style of referencing. Chapter 3 is according to the guideline instructions of Atherosclerosis.
Author’s contributions

The following researchers contributed to the dissertation.

Mrs. JT Kganakga
Responsible for conducting the literature search. The candidate also performed all statistical analyses, designed, wrote and compiled the manuscript.

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Supervised all stages of compiling the manuscript, was responsible for collection of data. Provided recommendations on statistical analyses and interpretation of results.

Prof P Bester
Co-supervisor
Supervised all stages of compiling and writing of the manuscript and gave general professional input.

This is a statement from the authors confirming their individual contribution to the study and their permission that the manuscript may form part of this dissertation.

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Abstract
Cardiovascular disease (CVD) is a major health problem globally. The prevalence of CVDs in South Africa is increasing in both rural and urban areas. Despite the great void of current data, the few studies that have been conducted on CVDs indicate that there is a definite rise of CVDs, with an uneven distribution of CVDs mortality within the African continent even in South Africa. Although there are traditional risk factors for CVDs, every population has risk factors that are more prevalent than other populations based on factors such as lifestyle, environment and socio-economic status of the population. Due to this, it is imperative to determine risk factors that are dominating the population in study, in order to plan and implement relevant intervention programs.

The main aim of this research is to identify the most significant cardiovascular risk factors associated with fatal and non-fatal cardiovascular events over a period of five years within a selected group of black South Africans residing in the Dr Kenneth Kaunda District. The study included 746 males and 1,263 females, aged 35-70 years and who reported to have suffered from CVDs after baseline data collection or who passed away throughout the course of five years. For the purpose of the study, data was collected by means of questionnaires and individual health screening. Participants completed the adult questionnaire, as well as the International Physical Activity Questionnaire (IPAQ). Individual health screening included anthropometric measurements (height, weight, waist circumference and body mass index), blood pressure (BP), rapid testing of blood glucose and cholesterol. Point-biserial correlations were used to determine associations between risk factors and cardiovascular event outcomes. Binomial logistic regression was used to determine associations between cardiovascular event outcomes and categorical risk factors. Receiver Operating Characteristic (ROC) curves were assessed for the analysis of the prognostic value of independent predictors on cardiovascular event outcomes.

Fatal cardiovascular events with a prevalence of 56% were reported in rural areas compared to 44% in the urban areas (p-trend= 0.010). The non-fatal cardiovascular events group was more prevalent in the urban areas (65.2%) and also had the highest blood pressure (p-trend<0.001) and the lowest weighted physical activity index (p-trend=0.001). A positive correlation was found between suffering a non-fatal cardiovascular events and age (rpb=0.14, p<0.01), as well as all blood pressure parameters where SBP revealed the strongest correlation (rpb=0.14, p<0.01). Binary regression analysis reported age (β= 0.044), education (β=0.645), weighted physical activity index (β=-0.893) and FRS (β=0.038) to be important predictors of non-fatal cardiovascular events, while age (β=0.074) and glycated haemoglobin (β=-1.163) were important predictors of fatal cardiovascular events. ROC curve analysis showed that all blood
pressures (SBP, DBP and MAP) and FRS were found to be risk factors likely to be associated with both fatal and non-fatal cardiovascular outcomes.

All blood pressure (but more so, SBP) and FRS were the most significant risk factors in this population. Rural areas need urgent intervention to reduce and control the high prevalence of fatal cardiovascular events reported in the study. Although urban areas reported a lower prevalence of fatal cardiovascular diseases, high blood pressure was reported to higher and also needs attention. Interventions such as promoting physical activity and low salt diets are recommended. These findings need confirmation in larger prospective and experimental studies.

Words: 538

**Key words:** Systolic blood pressure, diastolic blood pressure, Framingham risk score, mean arterial pressure, rural, urban, black adults, fatal and non-fatal cardiovascular events.
List of abbreviations

AIDS          Acquired immune deficiency syndrome
ANOVA         Analysis of variance
ART           Antiretroviral treatment
AUTHeR        Africa Unit for Transdisciplinary Health Research
BMI           Body mass index
BP            Blood pressure
BRICS         Brazil, Russia, India, China and Africa
CAD           Coronary artery disease
CHD           Coronary heart disease
CI            Confidence intervals
cm            Centimetre
CV            Cardiovascular
CVA           Cerebrovascular accident
CVDs          Cardiovascular diseases
DALY          Disability adjusted life years
DBP           Diastolic blood pressure
DoH           Department of Health
DW            Disability weight
EAR           East Asia region
FRS           Framingham risk score
GBD           Global burden of disease
GDP           Gross domestic product
HDL           High density lipoprotein
HICs          High income countries
HIV           Human immunodeficiency virus
HREC          Health research ethics committee
I             Number of incident disability cases
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>SA</td>
<td>South Africa</td>
</tr>
<tr>
<td>SANHANES</td>
<td>South African National Health and Nutritional Examination Survey</td>
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<tr>
<td>SAR</td>
<td>South Asian Region</td>
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<tr>
<td>SBP</td>
<td>Systolic blood pressure</td>
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<td>SD</td>
<td>Standard deviation</td>
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<tr>
<td>SES</td>
<td>Socio-economic status</td>
</tr>
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<td>SPSS</td>
<td>Statistical package for social sciences</td>
</tr>
<tr>
<td>SSA</td>
<td>Sub-Saharan Africa</td>
</tr>
<tr>
<td>TB</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>TC</td>
<td>Total cholesterol</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>WEF</td>
<td>World economic forum</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organisation</td>
</tr>
<tr>
<td>YLD</td>
<td>Years lived with disability</td>
</tr>
<tr>
<td>YLL</td>
<td>Years of life lost</td>
</tr>
</tbody>
</table>
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CHAPTER 1
Background and motivation

1.1 General introduction
Non-communicable diseases (NCDs) are rapidly becoming the most common cause of mortality and morbidity globally (Celermajer et al., 2012). Before 1990, infectious diseases (communicable diseases) and malnutrition, followed by high infant and child mortality rates, constituted the most common cause of death in almost every part of the world (Bonow et al., 2012; Marais et al., 2013). High-income countries (HICs) could overcome this by significantly reducing and managing morbidities and mortalities from infectious diseases (Bonow et al., 2012), whereas low-to-middle-income countries (LMICs) are still amid an ongoing war against the effects (mortality and morbidity) of communicable diseases (Bhutta & Black, 2013), such as human immunodeficiency virus (HIV). During the early 2000's, the world has been experiencing a rise in NCDs (World Health Organisation [WHO], 2010 & WHO, 2014). Ample research report and confirm that NCDs are rapidly becoming the leading cause of death globally, surpassing the mortality and morbidity rates of communicable diseases (Beaglehole et al., 2011(a; b); Bonow et al., 2012; Huang et al., 2013; Kroll et al., 2015). This incoming tsunami of NCDs is of great concern, especially in LMIC countries, as it places an additional burden on the already overburdened health system of these countries (Mayosi et al., 2012).

1.2 Background, motivation and problem statement
Despite NCDs rates still being elevated in HICs (WHO, 2014), research reports that there is a much sharper increase seen in LMICs compared to HICs (Di Cesare et al., 2013). Yusuf et al. (2004) refers to this as the NCD paradox, whereby HICs present most of the NCD risk factors, yet suffers from the least NCD-related morbidities and mortalities. On the other hand, LMICs with the least NCD risk factors, are suffering the most morbidities and mortalities. This might be due to a number of reasons such as i) less attention paid to NCDs due to immediate and pressing issues such as the high mortality rates from HIV (Marais et al., 2013) and child and maternal deaths in LMICs (Bhutta & Black, 2013); and ii) limited access to health care services for early detection and control (Hunter & Reddy, 2013). The on-going phenomenon of urbanisation seen in LMICs also contributes greatly to the risk and burden of NCDs (Ngo et al., 2013). This is because more people are now adopting a westernised lifestyle that is predominantly led in urban areas globally (Pisa et al., 2012). The World Health Organization (WHO) indicated cardiovascular diseases (CVDs), cancer, injuries, chronic respiratory disease and diabetes as the most predominant types of NCDs, responsible for the death of approximately 36 million people globally (Hosseinpoor et al., 2012; WHO, 2014). Although there
is evidently a rise in all types of NCDs in LMICs, CVDs have been reported to be the leading cause of mortalities within the NCDs group (Bowry et al., 2015). In 2015, CVDs were responsible for 31% of all deaths globally (WHO, 2017:2).

The 2013 Global Burden of Disease Study estimated that almost 30% of all deaths worldwide were caused by CVDs (Bhatnagar et al., 2015; Finegold et al., 2013). It is estimated that, by 2020, more than 80% of global CVDs will be in LMICs (Nugent et al., 2011; Teo et al., 2009). Eighty-five per cent (85%) of the world’s population currently lives in LMICs, therefore high disease rates and a significant global disease burden will be inevitable (WHO, 2005). There is scarcity of data on the epidemiology and burden of CVDs in Africa using national records due to poor journaling of data (Dalal et al., 2011). Despite the great void of current data, from the few studies that has been conducted on CVDs in Africa (Cook et al., 2012; Lopez & Mathers, 2013; Mensah et al., 2015), it is clear that there is definite rise of CVDs with an uneven distribution of CVDs mortality within the African continent (Dalal et al., 2011; Mensah, 2013; Moran et al., 2013). The rise of CVDs in this African continent will pose a challenge to an economy that is already heavily burdened by the significant amount of funds that are allocated to controlling and treating infectious diseases (Marais et al., 2013).

This study focused on the prevalence of fatal and non-fatal cardiovascular (CV) events and its associated risk factors within a selected group of black South Africans residing in both rural and urban communities. Several studies (Levitt et al., 2011; Stewart et al., 2011a; Stewart et al., 2011b; Tibazarwa et al., 2009) reported there are more cases of CVDs in the black population residing and/or have migrated to urban areas compared to those who have spent most of their lives in the rural areas. Despite the positive effects that accompany urbanisation (employment, educational prospects and potential better access to healthcare) it does not come without serious health effects (Mensah, 2013). CVDs risk factors are concentrated in urban environments (Mayosi et al., 2012). The majority of CVD-related deaths are precipitated by risk factors such as hypertension (Hall, 2014), hyperlipidaemia (Dalby, 2015; Klug et al., 2012), obesity (Ware et al., 2014), as well as diabetes; which can be prevented by an active lifestyle, healthy diet (low sugar and fat) (Opie, 2011) as well as avoiding/cessation use of alcohol and tobacco products (Schutte et al., 2012). However, urban living can also take away the autonomy of people to make or live out healthy choices (Pisa et al., 2012).

Research (Held et al., 2012; Wagner & Brath, 2012) indicates that the rate of urbanisation and urban migration is rapid, particularly in South Africa with nearly 62% of people living in urban areas (Ruhiiga, 2014). Therefore, it is essential to address CVDs and their associated risk
factors within South Africa. The increasing prevalence of CVDs in urbanisation does not however translate that people in rural areas are safe from developing CVDs (Hayter et al., 2015; Peer, 2015). Kahn (2011) reported that in South Africa, risk factors for CVDs are also high in rural areas. Unemployed and less educated people in rural areas do not have the educational and financial capacity to make informed decisions when it comes to nutrition and other lifestyle choices; putting them at risk for obesity, dyslipidaemia and hypertension (Mi et al., 2016; Mendis et al., 2011). For example, the prevalence of smoking tobacco is high amongst men in rural areas although the quantity smoked is lower compared to men in urban areas (Corsi et al., 2014; Griffin et al., 2015; Teo et al., 2013). Women who smoke in rural areas consume predominantly smokeless tobacco, also known as snuff (Ayo-Yusuf et al., 2013a; Ayo-Yusuf et al., 2013b; Kahar et al., 2016; Padrão et al., 2013). The prevalence of CVDs in rural areas is also increased by migrant workers who were previously residing in cities because of various employments, but now have returned home because they can no longer work due to ill-health (Fuster & Kelly, 2010; Gong et al., 2012; Mou et al., 2013).

1.3 Cardiovascular disease best understood from the social health framework
This background further argued that CVDs are best understood as interactive and multidimensional and by presenting CVDs from a holistic perspective, it can enable the researcher to formulate recommendations towards health promotion and policy development. The determinants of health framework (WHO, 2010:1-79) are presented as a functional typology to understand CVDs within the intricate realities of human life. The determinants of health refer to the range of personal, social, economic and environmental factors determining the health status of individuals, families, communities and societies (WHO, 1998:6). The circumstances in which people are born, live, work, age and the systems in place to deal with CVDs are considered. These listed circumstances are again influenced by a broader set of forces, namely politics, economics and social politics. It argues that people’s living conditions and lifestyles influence health and longevity in general (Wilkinson & Marmot, 1998:1). A graphic depiction of the social determinants of health as originated by Dahlgren and Whitehead (1991) is presented as follows:
Figure 1-1: Graphic depiction of social determinants of health (Dahlgren & Whitehead, 1991)

The application of the social determinants of health framework to this study is as follows:

Table 1-1: Social determinants of health applied to this study

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Application to this study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biological determinants</strong></td>
<td>• Access to good food is essential to good health whilst healthy food has become a political issue. Malnutrition in the form of excess calorie intake contributes to cardiovascular diseases.</td>
</tr>
<tr>
<td></td>
<td>• Addiction of any form, whether tobacco, alcohol or drugs are detrimental to the individual and a wider social sphere. The social pathway of addiction links on the one hand to disintegrated social structures and on the other hand to detrimental health conditions.</td>
</tr>
<tr>
<td>such as genetics and hereditary factors, body structure and functioning, age and sex. Behavioural determinants such as risk and/or protective behaviours and <strong>individual lifestyle factors</strong> such as tobacco smoking prevalence, alcohol consumption, overweight and obesity, physical inactivity, victim of violence, etc. (Shaw, 2008:3) and individuals’ response to health challenges.</td>
<td></td>
</tr>
<tr>
<td><strong>Social and community influences</strong></td>
<td>• Parental poverty activates a lifetime of detrimental health risks in children.</td>
</tr>
<tr>
<td></td>
<td>• Insufficient or absent social support implies less social cohesion whereas social cohesion is a powerful protector of health. The lack of emotional social support increases the risk to complications and disability from chronic diseases.</td>
</tr>
</tbody>
</table>
Living and working conditions

- Social and psychological conditions such as insecurity, lack of control over work life and low self-esteem cause long-term stress. The outcomes of stress are an array of cascaded bio-psycho-physical processes impacting on the cardiovascular and immune systems.
- Social exclusion such as unemployment, poverty, migration and marginalisation impact negative on health.
- Workplace-related stress contributes to negative health outcomes. Toxic work conditions are associated with cardiovascular risk.
- Whilst job security increases health, well-being and job satisfaction; unemployment places health directly at risk. Job insecurity as a chronic stressor increase sickness directly.

General socio-economic, cultural and environmental conditions such as ethnicity, language, religious beliefs, social class and networks, education and literacy.

- Poor socio-economic conditions impact on health throughout the lifespan of man. Cultural trends are complex yet essential to consider in the prevention of cardiovascular diseases.

1.4 Aim and objectives

1.4.1 Aim

The main aim of this research was to identify the most significant cardiovascular risk factors associated with fatal and non-fatal cardiovascular events over a period of five years within a selected group of black South Africans residing in the Dr Kenneth Kaunda District, North West Province, South Africa.

1.4.2 Objectives

1. To determine the frequency of non-fatal cardiovascular events (angina pectoris, myocardial infarction, stroke and heart failure) in terms of prevalence and incidence over a period of five years within a selected group of black South Africans residing within the Dr Kenneth Kaunda District.

2. To determine the frequency of fatal cardiovascular events (angina pectoris, myocardial infarction, stroke and heart failure) in terms of prevalence and incidence over a period of five years within a selected group of black South Africans residing within the Dr Kenneth Kaunda District.
3. To determine the most significant cardiovascular risk factors (age, gender, locality, smoking, alcohol consumption, blood pressure, body composition, glycaemic status, lipids and physical activity) associated with non-fatal cardiovascular events over a five-year period.

4. To determine the most significant cardiovascular risk factors (age, gender, locality, smoking, alcohol consumption, blood pressure, body composition, glycaemic status, lipids and physical activity) associated with fatal cardiovascular events over a five-year period.

1.5 Concept clarification

1.5.1 Atherosclerosis

Atherosclerosis is a condition in which plaque builds up inside the walls of arteries, resulting in hardened arteries of the heart (GBD, 2015a) and increases the risk of heart attacks and strokes. The plaque is made of cholesterol, fatty substances (atheroma), cellular waste products, calcium and fibrin (a clotting material in the blood) (Katz & Ness, 2015).

1.5.2 Burden of disease

The metric used to measure the burden of diseases is Disability Adjusted Life Year (DALY). This composite burden of disease index combines fatal and non-fatal burden in a single measure. The DALY is calculated from the sum of Years of Life Lost (YLL) (mortality component) and Years Lived with Disability (YLD) (morbidity component) (DALY = YLL + YLD) (Audibert, 2011; Bertram et al., 2013). YLL corresponds to the number of deaths (N) multiplied by the standard of life expectancy at the age at which death occurs (LE) (YLL = N x LE). YLD is explained as the number of disability (incident) cases (I) multiplied by the average duration of the diseases (L, in years), multiplied by weight factor that reflects the severity of the diseases (DW, disability weight) on a scale from 0 (perfect health) to 1 (death) (Audibert, 2011). One DALY represents an individual being deprived of one year of a normal life, free of disease or disability (Audibert, 2011).

1.5.3 Cardiovascular disease

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels and include, but is not limited to, angina pectoris, cerebrovascular accident (stroke), coronary heart disease, heart failure and myocardial infarction (Loock et al., 2006; De Schutter et al., 2014). The Heart and Stroke Foundation South Africa in their ‘Heart disease in South Africa’ publication defined CVDs as “any disease of the heart and blood vessels. The most common ones are diseases of the heart muscle, strokes, heart attacks, heart failure and heart disease caused by high blood pressure” (Heart and Stroke Foundation South Africa, 2007:2). CVDs
along with other NCDs are increasingly becoming a global concern; particularly in LMICs where a more rapid increase has been documented compared to HICs (Bonow et al., 2012). Cardiovascular (CV) events can be classified into two groups based on their outcomes; namely fatal and non-fatal events (Perk et al., 2012). Fatal CV events result in an individual losing their life due to an event (Grover et al., 2014). Fatal CV events can result in premature deaths and in LMICs documented to occur mostly in the ‘working group’ (Rapsomaniki et al., 2014). Non-fatal CV events can result in mild outcomes whereby an individual can be rehabilitated back to health and continue their life as before the encountered event (Grover et al., 2014). The most severe form of a non-fatal CV event usually results in an individual being permanently disabled in certain part(s) of the body, leaving the individual unable to perform tasks that previously did not require assistance to achieve, i.e. walking, eating, bathing and dressing (Perk et al., 2012). This non-fatal form of CV event usually affects the quality of life of affected individuals adding to the burden of the disease (Li & Siegrist, 2012).

1.5.4 Cerebrovascular accident
Cerebrovascular accident (CVA) is the medical term for stroke (Han et al., 2010). A stroke occurs when the flow of oxygen-rich blood to a portion of the brain is blocked (Ballas et al., 2010). The brain cells rely on a constant oxygenated-blood supply to function optimally (Balti et al., 2013). When the blood supply stops or become reduced, the brain cells start to die after a few minutes (Han et al., 2010). Sudden bleeding in the brain can also cause a stroke if it damages brain cells (Feigin et al., 2016). If brain cells die or are damaged because of a stroke, symptoms occur in the parts of the body that these brain cells control (Balti et al., 2013; Feigin et al., 2016). Symptoms of stroke may include sudden weakness; paralysis (inability to move) or numbness of the face, arms, or legs, trouble speaking or understanding speech (Ballas et al., 2010); and trouble seeing. A stroke can cause permanent brain damage, long-term disability or even death (Feigin et al., 2016). The two most common types of stroke are ischaemic and haemorrhagic stroke (Laurence et al., 2014). Ischaemic strokes happen when the artery that supplies blood to the brain is blocked, for example by a blood clot (Han et al., 2010). Haemorrhagic strokes happen when a blood vessel bursts and bleeds into the brain, damaging brain tissue and starving some of the brain cells of blood and oxygen (Laurence et al., 2014).

1.5.5 Coronary heart disease
Coronary heart disease (CHD) (also known as ischaemic heart diseases) is a disease that occurs when the coronary arteries (the arteries that supply the heart muscle with oxygen-rich blood) become narrowed due to the process of atherosclerosis (De Schutter et al., 2014; Moran
et al., 2012) and the heart gets deprived of oxygen (Laurence et al., 2014). CHD includes or can lead to other CVDs (Bonow et al., 2012; Dawber et al., 2015). If the flow of oxygen-rich blood to the heart muscle continues to be reduced or blocked, an angina or a heart attack may occur (Stone et al., 2013). Prolonged CHD can result in weakened heart muscle which may lead to heart failure and arrhythmias (problems with the rate/rhythm of the heartbeat) (Donegani et al., 2014). There are several factors that can increase the risk of developing CHD (Feig et al., 2016; Jespersen et al., 2012). The main ones are smoking, hypertension (Hall, 2014), high blood cholesterol (Dalby, 2015), diabetes, physical inactivity, obesity/overweight (Ware et al., 2014), family history of heart disease (genetics), ethnic background and age (Opie, 2011). These risk factors are discussed in detail in Chapter 2.

1.5.5.1 Angina pectoris
Angina pectoris is a symptom resulting from CHD (Arokiasamy et al., 2015). It is described as chest pain or discomfort that occurs when the heart muscle does not get enough blood (Moran et al., 2012). This may feel like pressure or a crushing pain in the chest, which may also occur in the shoulders, arms, neck, jaw or back (Jespersen et al., 2012) as shown in Figure 1-2 below. Angina pectoris can be triggered by excessive physical activities (Miszurka et al., 2012), causing insufficient oxygenated-blood to reach the heart muscle, smoking, consuming heavy meals, emotional stress and exposure to very hot or cold temperatures (Zaman et al., 2010). There are two types of angina pectoris; stable and unstable angina pectoris (Zaman et al., 2010). Reversible (stable) angina occurs when the heart works harder and needs more oxygen and goes away when heart demand is decreased (Moran et al., 2012). Progressive (unstable) angina occurs when a plaque in one or more of your coronary arteries ruptures (bursts) (Miszurka et al., 2012). If the build-up happens rapidly, it may lead to the risk of a heart attack (Jespersen et al., 2012).
1.5.6 Demographic transition

The demographic transition refers to a change from a period of high fertility and mortality to one of low fertility and mortality which occurs as a result of an increase in income, education and employment (Abrahams et al., 2011). Over the course of this transition, declines in birth rates followed by declines in death rates brought about an era of rapid population growth (Lee & Reher, 2011). This transition usually accompanies the development process that transforms an agricultural society into an industrial one (Canning, 2011). Before the onset of demographic transition, population growth (which equals the difference between the birth and death rate in the absence of migration) was near zero, although there were high rates, the death rates were also high (Visaria, 2015). This was typical in a population mostly depended on agriculture for livelihood before the industrial revolution (Eastwood & Kipton, 2011). During the first phase of demographic transition the population growth rate rises as the death rate declines while the birth rate remains high (Galor, 2012). In the second phase, the growth rate declines (but remains positive) due to a decline in the birth rate (Harper & Armelagos, 2010). The industrial revolution contributes positively to the change in the economy and gross domestic product (GDP) of each country (Canning, 2011) and income per person (Cervellati & Sunde, 2011).
1.5.7 Disability
Disability refers to the departures from ideal health in important domains of health; mobility, self-care, participation in usual activities, pain and discomfort, anxiety and depression, cognitive impairment (Audibert, 2011; Mendis et al., 2011).

1.5.8 Epidemiology
Aschengrau and Seage III (2014:7) define epidemiology as the study of the distribution and determinants of disease frequency in human populations and the application of the study to control health problem. The central paradigm of epidemiology is that patterns of disease in populations may be analysed systematically to provide understanding of the causes and control of disease (Krieger, 2014). Epidemiology seeks out the differences and similarities ('compare and contrast') in the disease patterns of populations to gain new knowledge (Bhopal, 2012). Valid measurements of the frequency of disease and factors which may influence disease are used as potential explanations for the observed patterns and are crucial to the epidemiological goal (Bhopal, 2012).

1.5.9 Epidemiological transition
Epidemiological transition refers to a change from a period of high prevalence of infectious disease associated with poor sanitation, famine and malnutrition; to a period of high prevalence of chronic and degenerative diseases (Abrahams et al., 2011). The concept of an epidemiological transition model was first developed by Omran and focuses on the complex changes in patterns of health and disease, the interactions between these patterns and the demographic, economic and sociologic determinants and consequences (Omran, 1971; Weisz & Olszynko-Gryn, 2010). Originally, the model suggested three stages of epidemiological transition (Agyei-Mensah & de-Graft Aikins, 2010; Omran, 1971). The first stage, referred to as the “Age of Pestilence and Famine,” was characterized by a demographic regime of high and fluctuating birth and death rates that reflected Old World epidemics of infection and famine (Agyei-Mensah & de-Graft Aikins, 2010; Santosa et al., 2014). At this stage, high death rates continued to limit population growth. The second stage was that of the “Age of Receding Pandemics (Omran, 1971),” in which epidemics became less frequent and the impact death rates caused by infectious disease declined (Harper & Armelagos, 2010). The third stage of the transition constituted the “Age of Degenerative and Man-made Diseases” (Omran, 1971; Weisz & Olszynko-Gryn, 2010). This stage of transition was largely driven by social factors such as lifestyle, diet, occupation and income. Omran (1971) argued that as infectious and parasitic diseases decrease, they will be replaced by a series of chronic (Harper & Armelagos, 2010), degenerative diseases associated with ageing populations, such as heart diseases, stroke and
cancers: these diseases would become significant causes of mortality (Collinson et al., 2014). At a later stage, two additional stages were added to Omran’s model, (Smallman-Raynor & Phillips, 1999). The fourth stage was termed the “Age of Delayed Degenerative Diseases” (Gersh et al., 2010; Smallman-Raynor & Phillips, 1999). In this fourth stage, degenerative diseases such as CVDs and cancers still remain important as major causes of death (Collinson et al., 2014), but changes in medical technology might extend the life expectancy of elderly people suffering from cancer and CVDs (Gersh et al., 2010). The fifth stage referred to as the “Age of Emergent and Re-emergent Infections” is characterized by the rise of both old and new infectious and parasitic diseases (Agyei-Mensah & de-Graft Aikins, 2010). Epidemiological transition is a widely used concept suggesting that in each stage of transition there is a characteristic change that occurs in the contributing causes of death (Gersh et al., 2010). The epidemiological transition has been broadened to encompass the more general health transition, including both morbidity and mortality (Mayosi et al., 2012).

Omran’s model of epidemiological transition was opposed by Frenk et al. (1989) a decade later. The authors introduced another model termed the “epidemiological polarized” model (Defo, 2014). The latter model was developed after finding that the sequential stage process proposed by Omran’s model does not reflect epidemiological changes in some societies (Agyei-Mensah & de-Graft Aikins, 2010). For example, based on the outcomes of their epidemiological transition research in Latin America, Frenk et al. (1989) concluded that the Latin American experience does not fit the Omran’s model (Santosa et al., 2014). This was because of the reoccurrence of malaria and dengue fever in the region, as well as rising differences in the two broad disease categories (infectious vs. chronic degenerative) between regions and social classes (Clark et al., 2010; Masquelier et al., 2014).

1.5.10 Heart failure
Heart failure is a chronic, progressive condition in which the heart muscle is unable to pump enough blood through the heart to meet the body’s needs for blood and oxygen (Laurence et al., 2014). Heart failure usually results in an enlarged heart. The heart compensates by enlarging. When the heart chamber enlarges (Swedberg et al., 2010) it stretches more and can contract more strongly, to pumps more blood. With an enlarged heart, the body starts to retain fluid, the lungs are congested with fluid and the heart begins to beat irregularly (Damasceno et al., 2012). A second result of an enlarged heart is developing more muscle mass (hypertrophy). This increase in muscle mass occurs because the contracting cells of the heart get bigger (McMurray et al., 2012). This lets the heart pump more strongly, at least initially. Thirdly, the heart pumps faster to increase cardiac output (Damasceno et al., 2012).
The body also tries to adapt by narrowing blood vessels to keep the pressure of the blood up, in order to make up for the heart's loss of power (Aliti et al., 2013). 2) The body diverts blood away from less important tissues and organs (like the kidneys), the heart and brain (Kato & Pinsky, 2015). These temporary measures mask the problem of heart failure, but they do not solve it. Heart failure continues and worsens until these substitute processes no longer work (Kovács, 2015; Mori et al., 2015). Eventually the heart and body fail to keep up and an individual starts to experience fatigue, breathing problems and other symptoms that usually prompt a trip to the doctor (Anderson et al., 2010). The body's compensation mechanisms help explain why some people may not become aware of their condition until years after their heart begins its decline. Heart failure can involve the heart's left side, right side or both sides (Kato & Pinsky, 2015). However, it usually affects the left side first (Damasceno et al., 2012; Kovács, 2015).

1.5.10.1 Left-sided heart failure
The heart's pumping action moves oxygen-rich blood as it travels from the lungs to the left atrium, then on to the left ventricle, which pumps it to the rest of the body (Aliti et al., 2013). The left ventricle supplies most of the heart's pumping strength. Therefore, it is larger than the other chambers and essential for normal function (Kato & Pinsky, 2015). In the case of left-sided or left ventricular (LV) heart failure, the left side of the heart works harder to pump the same volume of blood (Swedberg et al., 2010; Tieu, 2016). There are two types of left-sided heart failure and the drug treatment differs for each type.

1.5.10.1.1 Systolic heart failure
The left ventricle loses its ability to contract normally. The heart cannot pump with enough force to push enough blood into circulation (Tieu, 2016).

1.5.10.1.2 Diastolic heart failure
Diastolic heart failure is also known as diastolic dysfunction. The left ventricle loses its ability to relax normally, because the muscle has become stiff (Janmey & Miller, 2011). The heart cannot properly fill with blood during the resting period between each beat (Kovács, 2015).

1.5.10.2 Right-sided heart failure
During the normal functioning of the heart, the heart's pumping action moves de-oxygenated blood that returns to the heart through the veins and the right atrium, into the right ventricle (Kovács, 2015; Sagiv, 2012). The right ventricle then pumps the blood back out of the heart into the lungs to be replenished with oxygen. Right-sided or right ventricular (RV) heart failure usually occurs as a result of left-sided failure (Masina et al., 2016). When the left ventricle fails,
increased fluid pressure is, in effect, transferred back through the lungs, ultimately damaging the heart's right side. When the right side loses pumping power, blood backs up in the body's veins (Kovács, 2015; McMurray et al., 2012). This usually causes swelling or congestion in the legs, ankles and swelling within the abdomen such as the gastrointestinal tract and liver causing ascites (Swedberg et al., 2010).

1.5.10.3 Congestive heart failure
When the process of blood flow out of the heart slows down, the blood returning to the heart through the veins, backs up, causing congestion in the body's tissues, then swelling (edema) occurs (Sagiv, 2012). Sometimes fluid collects in the lungs and interferes with breathing, causing shortness of breath, especially when a person is lying down (Masina et al., 2016). This is called pulmonary edema and if left untreated, can cause respiratory distress. Heart failure also affects the kidneys' ability to dispose of sodium and water (Swedberg et al., 2010).

1.5.11 Hypertensive heart disease
Hypertensive heart disease is a collection of abnormalities that includes left ventricular hypertrophy (LVH), systolic and diastolic dysfunction and their clinical manifestations including arrhythmias and symptomatic heart failure (Georgiopoulou et al., 2010). A common pattern of hypertensive heart disease is when the left ventricular (LV) wall thickens in response to elevated blood pressure as a compensatory mechanism to minimize wall stress (Drazner, 2011; Georgiopoulou et al., 2010).

1.5.12 Incidence
Incidence is defined at the occurrence of new cases of disease that that develop in a study population over a specified time period (Aschengrau & Seage III, 2014:42).

1.5.13 Myocardial infarction
Another word for myocardial infarction (MI) is heart attack. This condition is also caused by CHD (Moran et al., 2012). It occurs when the blood flow that brings oxygen to the heart muscle is severely reduced or stopped (Heartz et al., 2014). This happens because coronary arteries that supply the heart with blood can slowly become thicker and harder due atherosclerosis and form a build-up of fat, cholesterol and other substances, called plaque (Norton & Woodiwiss, 2011). If the plaque breaks open and a blood clot forms that blocks the blood flow, a heart attack occurs (Masina et al., 2016). The results could be fatal or non-fatal with minor or permanent damage on the heart muscle as shown in Figure 1-3 below.
1.5.14 Non-communicable disease
Non-communicable diseases (NCDs) are not infectious or transferrable from person to person through infections. Types of NCDs include diseases such as diabetes mellitus, CVDs, cancer, stroke and chronic pulmonary diseases and are also referred to as chronic diseases (Beaglehole et al., 2011; Mayosi et al., 2009).

1.5.15 Prevalence
Prevalence measures the frequency of existing disease; it is defined as the proportion of the total population that is diseased. There are two types of prevalence measures; the point and period prevalence (Aschengrau & Seage III, 2014:48). Point prevalence measures the proportion of the diseased population at a single point in time and it is thought of as a snapshot of the population. Period prevalence measures the proportion of the diseased population during a period of time (Aschengrau & Seage III, 2014:48).
1.6 Research methodology

1.6.1 Study setting

The study selected four communities (2 x rural and 2 x urban) in the North West Province, South Africa. Communities A and B were in the rural areas, whereby community B was located deep in the rural 35 km east from community A and only accessible by gravel road. Both communities were under tribal law. The urban communities (communities C and D) were chosen in close proximity to a major city within the North West Province. Community C was selected from the established part of the township, Ikageng, within the Tlokwe Municipality; whereas community D was selected from the informal settlements surrounding community C (Kruger & Kruger, 2015). The main selection criteria for the communities were migration stability. Meaning that, potential participants had to reside within the community for at least five years from baseline data collection.

1.6.2 Study design

This study formed part of the larger multi-country Prospective Urban and Rural Epidemiology (PURE) study (Teo et al., 2009). The PURE study was designed as a prospective longitudinal study. Baseline data was collected in 2005 and follow-up data collected in 2010 following a cross-sectional design. This study was reliant on data already obtained within the larger PURE study (Teo et al., 2009). This study followed a quantitative research approach and pursued a non-experimental research design (descriptive and correlational) (Botma et al., 2010). This study only investigated relevant data retrospectively by identifying associations between exposure (CVD risk factors) and the outcomes (fatal and non-fatal cardiovascular events) over the period of five years.

1.6.3 Target population

Since the aim of this study was to investigate the modifiable CV risk factors associated with cardiovascular events (fatal and non-fatal CV events), only participants who reported a CVD event after baseline data was collected, were included into the sub-study.

Hence the inclusion criteria for the participant and participant data were as follows:

- Males and females aged between 35 and 70 years.
- Participants who reported to have suffered any of the following non-fatal cardiovascular events: angina pectoris, coronary heart disease (CHD), stroke, myocardial infarction and heart failure.
- Participants who passed away due to fatal cardiovascular events: angina pectoris, coronary heart disease (CHD), stroke, myocardial infarction and heart failure.
Participants were excluded if:

- They had suffered a cardiovascular event before the time of baseline data collection.

1.6.4 Sampling

Purposive sampling was used to select participants and they had to meet certain inclusion criteria (Botma et al., 2010). The reason for the main selection criteria of at least five years migration stability as explained above was due to the fact that this was a ten-year longitudinal study. The study was aiming to investigate the health transition on chronic diseases of lifestyle in urban and rural participants. Communities had to be large enough to allow random selection of participants.

A household census regarding the number of people, their ages and health profile was done in 6 000 households (1 500 households from each community) starting from a randomly selected point. Every head of household signed written informed consent to fill out the questionnaire. If a person refused or was not at home, the next house was taken and a non-complier questionnaire completed. From the data obtained from the census, a paper-based selection of possible subjects was done based on the following criteria (Kruger & Kruger, 2015).

Inclusion criteria:

- Males and females aged between 35 and 70 years.
- No reported chronic diseases, including pulmonary tuberculosis (TB) and HIV.
- Not taking any chronic medication.

A total of 2 010 (urban = 1 004 and rural =1 006) apparently healthy African volunteers were selected to participate in the study.

1.6.5 Development of data collection tool

As this was a sub-study of the PURE-SA study (which is part of the larger PURE study), the quality of the data was standardised by using a comprehensive operations manual, periodic training workshops, training DVDs and regular communication with the coordinating office in Canada. The structured questionnaires were developed by the coordinating office in Canada. All data was entered in a customised database programmed with range and consistency checks and transmitted electronically to the Project Office at the Population Health Research Institute in Hamilton to implement further quality control measures. Data collection occurred at three levels: community, household and individual, using standardized and common questionnaires. This current study utilised data collected at the individual level using the Adult questionnaire and the International Physical Activity Questionnaire (IPAQ).
1.6.6 Validity and reliability of data collection tool

All of the researchers and assistants (nurses, anthropometrists, counsellors, students) that were part of this study were experienced in their fields. All staff members were trained intensively and standardised in terms of data collection and completion of questionnaires prior to data collection. Physical and anthropometric measures were gathered by staff using standardized protocols. Key staff (principal investigator, coordinator and nutritionists) attended initial training. After training, they trained local staff. Then staff were trained and tested on “mock” participants as a trial run, to ensure that measured values between interviewer and a local certified “expert” (supervisor) were within an acceptable range. Retraining was done there if the variation between interviewers compared to the supervisor was unacceptable. The fieldworkers were re-trained intensively every time prior to any form of data collection, inter alia all the procedures of the study, in order to give the participants a comprehensive overview of what was expected of them on the day of data collection.

1.6.7 Data collection method

Questionnaires

Data was obtained using structured questionnaires was collected through a face-to-face interview by extensively trained research assistants and fieldworkers. In the case where a participant was not clear of the question, the assistant/fieldworker could translate the question into the participants’ preferred language, whereby the participants could also respond in their preferred language. Information regarding the participant’s smoking and drinking habits were collected, as well as the level of activity (IPAQ). All participants were asked whether they had a medically diagnosed CVD (angina pectoris, CHD, stroke, myocardial infarction and heart failure); whether they received medication (treatment); and a list of all their medications were recorded. CVDs were ascribed on the basis of self-reported information and verified with medical records (clinic cards) brought by participants during the first annual follow-up. All of the reported events along with the supporting documents were sent to a medical doctor who adjudicated and verified each individual case and assigned ICD-10 codes.

Anthropometric measurements

Each participant was measured for weight (body mass (kg), height (cm), hip circumference (cm) and waist circumference (cm) at baseline as well as at their follow-up visit. The measurements were taken by trained anthropometrists using calibrated instruments and following standardised methods (Precision Health Scale, A & D Company, Tokyo, Japan; Leicester Height Measure, Seca, Birmingham, United Kingdom). Each measurement was taken three times and to the
nearest decimal. Body mass index (BMI) was calculated as weight divided by height squared (kg /m$^2$).

**Cardiovascular measurements**

Blood pressure (BP) was taken while the participant was in a seated position. Arriving at the point where blood pressure was taken, the participant was required to rest for five minutes before a measurement was taken on the right arm. A second measurement was taken again, five minutes after the first was completed. Systolic BP (SBP) and diastolic BP (DBP) were measured with the validated OMRON HEM-757 device (Omron Healthcare, Kyoto, Japan) and appropriate-sized cuffs were used for obese participants. According to the South African Hypertension Guidelines, hypertension is classified as blood pressure of $\geq 140/90$ mmHg and or/usage of antihypertensive medication (Seedat & Bayner, 2012) and this guideline was followed during tests.

1.6.8 **Data collection process**

The main study (PURE study) received permission from different bodies of authority prior to data collection, including the Mayor of Potchefstroom, the household leader and the individual. The baseline data was collected between October and November 2005 and a five-year period interval data collection was done during the period of June and July of 2010. This study used data that had already been collected during the main study; therefore the process explained here is similar to that of the main study. The PURE-SA study conformed to the Declaration of Helsinki (revised in 2004). Information sessions were held with participants, various researchers and an independent person to explain the nature of the study in detail, including benefits and risk involved. This was done in the participant’s preferred language with a trained translator present at all times. After the participant had given voluntary and informed consent, they were given an extensive questionnaire regarding physical and psychological health, socio-economic background, lifestyle practices and support systems available to fill out. For participants who were illiterate a witness was used to sign informed consent. Remuneration was given to participants to ensure that they would be able to pay transport to visit a primary health care clinic if referred. Arrangements with primary health care clinics in the area were made to accept any referrals from the research site should there be any matters of concern evidenced by the findings.
1.6.9 Data analyses

Data analyses were performed according to the specific objectives as stipulated previously. All analyses were performed using the Statistical Package for Social Sciences (SPSS) version 23 (IBM SPSS, Chicago, United States of America).

1.6.9.1 Descriptive statistics

Frequencies (n) were interpreted as percentage (%) values, arithmetic means, medians, standard deviations (SD) and 95% confidence intervals (CI) were used to summarise the data.

1.6.9.2 Inferential statistics

Depending on the data, either parametric statistical analyses (continuous data) or non-parametric statistical analyses (categorical data) were used. Data was presented as mean and interquartile ranges (IQR) (Q1-Q4) in the case where it was not normally distributed. One-way analysis of variance (ANOVA) and a two-sample z-test were performed to compare means and proportions, respectively. Point-biserial correlations were used to determine associations between risk factors (continuous data) and cardiovascular event outcomes (categorical dichotomous data). Binomial logistic regression was used to determine associations between categorical dependent variables (cardiovascular event outcomes) and categorical risk factors. Receiver Operating Characteristic (ROC) curves were assessed for the analysis of the prognostic values of independent predictors on cardiovascular event outcomes. All probabilities were two-tailed and p<0.05 was regarded as significant and the exact p-value was mentioned. A 95% confidence interval (CI) was also reported.

1.7 Ethical considerations

1.7.1 Permission

The large South African arm of the PURE study received permission from the Health Sciences Research Ethics Committee (Ethics number: 04M10, renewed in 2010: NWU-00016-10-A1). Permission to conduct the study was also obtained from the North West Department of Health and the local government authorities of each selected site. This current sub-study obtained ethical clearance (NWU-00077-16-A1) from the Health Research Ethics Committee (HREC) of the Faculty of Health Sciences, of the North-West University.

1.7.2 Informed consent

Recruitment of participants: During individual household visits, done by fieldworkers, the participants were fully informed about the study (objectives, risks and expected outcomes). Potential participants were collected on a pre-arranged date and time and were brought to the
research facility (Metabolic Unit of the North-West University). On the day of data collection, the principle investigator informed the participants again about the study (objectives, risks and expected outcomes). Each potential participant was requested to sign a written informed consent form before they could participate in any research, as a legal requirement. Since this was a sub-study of a longitudinal study and research is on-going, out of respect for the participants, prior to this study, fieldworkers had to obtain a re-consent from all active participants. The fieldworkers (who also act as mediators) performed house visits to each individual at least three (3) months prior to the start of the study. Their role at that stage was to inform the participants about the upcoming follow-up data collection. All of the procedures / measurements performed on the day of data collection were then discussed and explained in full to each participant by the fieldworker. The participants were also given an opportunity to ask questions. This process was done in the participant’s preferred language (Setswana, English or Afrikaans). A follow-up visit was done one month prior to the start of data collection. During this visit, the fieldworkers informed the participant fully again about the study and provided them opportunity to ask questions. The participant was given one week to consider further participation within the study. After a week the fieldworker returned to the participant for feedback. If the participant agreed to partake, the fieldworker obtained re-consent from the participant. In the case where a participant was illiterate, the right thumb print was taken as substitute for a signature.

Participants were repetitively reminded that their decision to participate was completely voluntarily and they could withdraw at any point without any consequences or being penalised. The fieldworkers scheduled an appointment, that suited the participant and logistical arrangements were made for data collection. The day before the participant was scheduled to arrive at the research facility, the fieldworker did one last house visit, to make final arrangements with the participants regarding pick-up time and to remind and explain to them to bring along all necessary documentation.

1.7.3 Privacy
At the research facility (Metabolic Unit) of the North-West University, there were 10 dedicated private rooms. These rooms were assigned to priority measurements, including anthropometry and blood pressure measurement. During the time of a measurement, only the participant, the researcher and an assistant was present. The door of the room was closed and nobody was allowed inside until the measurements were completed. Due to the limited amount of rooms available within this research facility and the prioritising of sensitive measurements, a special area was set-up where the questionnaires were completed. Special partitions were used to
ensure that the fieldworker and the participants had privacy while completing the questionnaires. The area was set-up in such a way that no passers-by could intrude.

1.7.4 Confidentiality
Each participant was assigned a unique participant number during the initial baseline data collection in 2005. This unique number was used in all stages of data gathering. Upon arrival on the day of data collection, the participants produced their South African identity document (ID), in order to verify the ID number against their unique participant number. This was done only by the project coordinators. No other researcher and/or assistant had access to this information were involved in the process. Participants were not required to provide their personal information to any other researcher or assistant, except in some cases a date of birth was required for input into research apparatus. All of the data captured were done by using the unique participant number. The data that was electronically captured were handed to the PI who matched the new data with existing data in the master data set.

1.7.5 Justification of research study
Currently there is no sufficient data on cardiovascular risk profiles of affected communities. This study sought to identify the dominating cardiovascular risk factors in the communities under investigation and to address these risk factors for the purposes of health promotion. The findings will also add to the body of knowledge that is currently limited.

1.7.6 Respect for research participants
All participants were treated with respect starting with being allowed to decide if they wanted to participate in the study and were allowed that they could pull out of the study at any point before data analysis without any penalties. Participants’ information was also treated with respect by protecting it. Elderly participants who were illiterate were also treated with respect and patience and were allowed to use the language they were fluent in.

1.7.7 Benefit-risk ratio analysis
The risks of tests conducted in this study had minimal harm to the participant and the benefits outweighed the risk.

1.7.7.1 Anticipated benefits
Anticipated benefits in this study were that each participant got to know the status of their health and therefore were informed to make the necessary adjustment in their lives to improve it.
1.7.7.2 Direct benefits
Participants who were involved in the study directly benefited from the day’s measurements in the sense that feedback was given to them immediately regarding results that were available. These included blood pressure and anthropometry. In the case of any abnormalities identified by the measurements, the participant received a referral letter by a senior researcher to seek medical help at their nearest hospital or local clinic. The principle investigator visited the local hospital and clinics to inform them about the upcoming follow-up study and to plan for possible referrals.

1.7.7.3 Indirect benefits
As mentioned earlier, South Africa is a LMIC with extreme disparities on the income level of the population as some areas have limited resources whilst a large proportion of people suffer from poverty, HIV and malnutrition. It is therefore of utmost interest to limit the burden of chronic diseases in this population. Through participating within the PURE study, the participants assisted in providing SA with a direct estimate of the health/disease burden attributable to established and emerging risk factors for obesity and CVDs.

Ultimately, a large proportion of the South African population should benefit from this study because the long-term goal of PURE is to ensure transition of South Africa’s poor people from an inadequate diet directly to an optimal/prudent diet and lifestyle rather than the current trend from a more adequate but prudent diet and lifestyle. Findings from the PURE study will help to facilitate the development of effective public health policies in SA, which in turn should decrease the burden of disease in SA, hence indirectly benefiting the overall population.

1.7.8 Anticipated risks and precautions
Like other research studies involving human participants, there is always some form of risk involved. Although most of the techniques and procedures undertaken during the study were non-invasive, there were some discomforts that could be experienced during some of the measurements.

1.7.8.1 Anticipated risks to the participants and precautions taken
Some of the measurements (anthropometry) required that the participants removed the top layer of their clothes and remained only in their underwear or light clothing in order for the researcher to conduct the necessary measurements. This could make the participant feel uncomfortable. In order to minimize any discomfort, the dedicated measurements areas were closed off and private and only the researchers and / or assistant were present.
Participants had to arrive at the research facility in a fasting state for blood samples to be collected. Being in a fasting state could make the participant feel uncomfortable or perhaps light headed. A light breakfast was provided to them as soon as the blood sample was collected to relieve their fasting state.

Concluding all of the measurements usually took approximately the whole day, which could have been very exhaustive for some participants. In order to minimize their discomfort participants were provided with a lunch as well as tea / coffee / juice / water throughout the duration of the day at the seating / waiting area.

To avoid confusion and wasting of participant’s time and energy, when each participant finished at every measurement station, research assistants assisted the participants along to the next station. Providing personal information (smoking and alcohol use as well as CVD events) could make the participant feel uncomfortable. To avoid this, all of the questionnaires were completed individually with a fieldworker in a private area.

1.7.8.2 Anticipated risks to the researcher and precautions taken
Working long hours with people can lead to exhaustion and inaccurate recording of results. To avoid this each station had more than one person to relieve each other.

1.7.9 Reimbursement of study participants
The participants were required to arrive in a fasting state, therefore they were provided with a light breakfast and later with lunch because they spend the whole day at the research centre. An amount of fifty Rands (R50) was also given to each participant per day for any expenses or loss of income incurred due to their attendance.

1.7.10 Data management
1.7.10.1 Hard copy data
All hard copies are stored in a locked office within the Africa Unit of Transdisciplinary Health Research (AUTHeR) at the North-West University (Potchefstroom Campus). Since the hard copies contain identifiable data (personal information) of each individual participant, strict controls over the hard copies are applied. Hence, only the supervisors have access to the hard copies. The hard copies will be securely stored for five years after the study finished. After five years, it will be destroyed according to the North-West University’s rules and regulation for data / record management.
1.7.10.2 Electronic data
Data that was captured electronically was stored on a central computer and is password protected. The data set is only accessible to the principle investigator. For research and dissemination purposes, data will be made available to other team members (researchers) via the primary investigator and only upon request. It will be handed to them in a format that contains no personal information regarding the participants (de-identified data set) and thus researchers will not be able to identify any participants based upon the data received. All electronic data is backed-up on an external hard drive which is locked up in a cupboard within a secured office at AUTHeR.

1.7.10.3 Access to data
Firstly, it is important to note that this is an international study which included 25 countries. PURE is supervised by the PHRI, Hamilton, Canada, under the administration and supervision of Prof Salim Yusuf. The North-West University and principal study leaders are under contractual agreement to send some of the data to PHRI on an annual basis. As a research institute, PHRI complies and accords to all research ethics to ensure that data is handled privately, securely and confidential. Furthermore, no data will be accessed by any person unless permission is granted by the principle investigator and even then, only the necessary data will be provided. The researcher of this study obtained data through the principle investigator, on an USB/flash drive. Data was also stored on the researcher’s working laptop. The researcher was bound by the rules and regulations of the North-West University and the PHRI to use data only for the purposes of the said research. Upon completion of this study, the USB/flash drive containing data and the researcher’s laptop shall be formatted.

1.7.11 Dissemination of research results
Measurements that were immediately available on the day of the study were reported back verbally and individually in a private place. A referral letter was given to all participants with results that needed further medical attention. These included blood pressure and anthropometry.

After all data has been analysed, a report regarding the disease burden within the focus of this study will be given to the North West Provincial Department of Health. Gatekeepers and participants will be informed about the results of the study in their respective communities. Results of the study will also be published in peer-reviewed academic journals, conference proceedings and health reports.
1.7.12 Role of the members in the research team

1.7.12.1 Role of the mediators
The fieldworkers acted as mediators between the research team and participants. The fieldworkers live within the communities involved within the study. They fulfil an important role; not only do they track the participants enrolled in the study, but they act as advisors and offer support to the participants regarding basic health issues and basic health education.

1.7.12.2 Role of gatekeepers
The gatekeepers were the councillors and chiefs of the communities, their role was to protect the communities from being “over-researched” and also to make sure that the study benefits the communities where participants are recruited from.

1.7.12.3 Conflict of interest
There were no conflicts of interest identified.

1.8 Summary
The prevalence of CVDs has been on an increase globally, significantly in developing countries. South Africa is one of the developing countries where rate of urbanisation is very fast and the change from a traditional to westernized lifestyle especially amongst black South Africans is clearly visible. The aim of this research was to identify the most significant modifiable risk factors for cardiovascular events within a selected urban group of black South Africans residing in the Dr Kenneth Kaunda District. Furthermore, the study sought to determine possible changes in the order of significance of these risk factors over a period of five years. This study is a sub-study of the Prospective Urban Rural Epidemiological (PURE) study that employed standardised questionnaires to collect data on medical history, lifestyle behaviours (physical activity and dietary profile) by means of face-to-face interviews. Physical measurements such as blood pressure and anthropometric measurements were also conducted. Descriptive and correlational analysis was performed using SPSS.
1.9 References


CHAPTER 2
Literature study

2.1 Introduction
Cardiovascular diseases (CVDs) have been previously considered to be diseases of the affluent and also common among Caucasians (Saab et al., 2014). This picture has been constantly changing with increasing numbers of black Africans manifesting CVDs due to many factors such as demographic, epidemiological and nutrition transitions (Grover et al., 2014; Saab et al., 2014). Earlier studies reported that low to middle income countries (LMICs) had the least CVD risk factors but the mortality and morbidity was higher compared to HICs where the CVD risk factors are high but the mortality and morbidity due to CVD is lower (Bowry et al., 2015; Roth et al., 2015b; Yusuf et al., 2013). The tide has changed and more people in LMICs, particularly black Africans have CVD risk factors which were previously not associated with them (Bowry et al., 2015; Saab et al., 2014). Black Africans have previously been reported to possess high-density lipoproteins (HDL) which are considered “good fat” because they protect against CHD and other types of CVDs (Sliwa et al., 2012; Zeba et al., 2012). More recent reports have however reported that more black Africans are now found to have increased levels of total cholesterol, triglycerides and low-density lipoproteins (LDL) which are considered the “bad fats”, which increases the risk of atherosclerotic form of CVD (Gorski et al., 2016; Steyn & Mchiza, 2014; Sliwa et al., 2012). Diabetes was also not associated with the black population however that is no longer the case (Matsha et al., 2012). It is evident that more research and understanding on CVDs in black populations is crucial.

2.2 Epidemiology and Burden of Cardiovascular Diseases
2.2.1 Global
The 2013 Global Burden of Disease Study estimated that almost 30% of all deaths worldwide were caused by CVDs (Bhatnagar et al., 2015). About 85% of the world’s population lives in LMICs, therefore, the burden of CVDs is felt more in most of these parts of the world (Bonow et al., 2012). In LMICs the increase of the CVD burden is largely a result of an increase in the prevalence of risk factors and lack of access to interventions that can 1) prevent an individual from being affected, 2) prevent death during the acute manifestation and 3) prolong survival once CVD manifests (Gersh, 2010). About three-fourths of global mortalities and 82% of the total DALY caused by CHD occur in LMICs (Gaziano et al., 2010; Habib & Saha, 2010; Prince et al., 2015). Stroke as one of the major CVDs, is associated with 43.7 million lost DALYs annually around the world. Among adults, stroke is the fourth leading cause of lost DALYs, second to HIV infection (Mukherjee & Patil, 2011). Due to the continuation of epidemiological,
demographic and nutritional transitions and unstable socio-economic conditions in LMICs, the burden of CVDs is predicted to increase further (Habib & Saha, 2010; Kengne et al., 2013; Nugent & Feigh, 2010).

Although the discussion is on CVDs globally, more focus was placed on Brazil, Russia, India, China and later in the discussion on South Africa (BRICS countries). The reason for highlighting the BRICS countries is that they share key qualities: they are all emerging economies whose recent economic growth is threatened by CVDs; they have all struggled with the onset and spread of HIV/AIDS in recent years and they are the founding members of the summit-level international political BRICS, which has increasingly addressed both development and health (Burki, 2012). Thirty-eight million people have been reported to die each year globally from NCDs, with 14 million of these mortalities occurring in people between the ages of 30 and 70 years and 80% occurring in LMICs (WHO, 2015:7). Research on the prevalence of CVDs in LMICs has also been reported by various other authors (Alwan et al., 2010; Ebrahim et al., 2013; Hosseinpoor et al., 2012). Alwan et al. (2010) conducted a study in twenty-three countries, which included amongst other, the BRICS countries. Their results coincided with the high global mortality rate reported by the WHO (WHO, 2010). According to Alwan et al. (2010), approximately 57 million people died globally in 2008 and 33 million (58%) of these deaths were due to CVDs. In 2007 alone, the mortality rate for Brazil was 1.3 million with approximately 72% of these deaths attributable to CVDs (Schmidt et al., 2011). In both of the studies, CVDs emerged as one of major causes of mortalities (Malta & da Silva, 2012; Schmidt et al., 2011).

The burden of CVDs in LMICs is reported to be increasing rapidly (WHO, 2014) and presents already major adverse social (Bell et al., 2013), economic (Hosseinpoor et al., 2012) and health effects (WEF, 2014). These effects are even more pronounced in the poorest of those countries (Alwan et al., 2010; Schmidt et al., 2011). CVDs have been linked to increased poverty (Di Cesare et al., 2013; Hosseinpoor et al., 2012; Mayosi et al., 2012). Individuals affected by CVDs usually have poor overall health (Hancock et al., 2011) resulting in constant absenteeism from work (Bloom et al., 2014), household earnings being used to get treatment, prolonged disability and reduced productivity (Beaglehole et al., 2011). Loss of productivity in the workplace due to people affected by CVDs reduces a society’s effective labour force, resulting in reductions in overall economic output (Bloom et al., 2014; Kankeu et al., 2013). The increase in the public health demand for treatment from the government will cause the governments to increase tax rates to meet rising health expenditures (Mayosi et al., 2012). In doing so, there may be a limit in the economy’s potential growth and a reduction in the public sector investing in strategic areas such as development of physical capital and workforce (Bloom et al., 2014). Due to these
factors Bloom *et al.* (2014) ranked CVDs as one of the top global threats to economic development. Poor people live in settings where policies, legislation and regulations to tackle diseases either do not exist or are poorly implemented (Beaglehole *et al.*, 2011); resulting in poor access of health care and basic services (Di Cesare *et al.*, 2013).

### 2.3 General picture in BRICS

Age adjusted mortality rates in the BRICS countries and other LMICs are higher compared to HICs (Fuster & Kelly, 2010; Narayan & Murgai, 2016). For example, in Brazil and China, CVDs mortalities are approximately 300 per 100 000, 500 in Russia and between 400-450 for South Africa and India (Fuster & Kelly, 2010; Mújica *et al.*, 2014). In addition to the increased age adjusted CVDs mortality rates in BRICS, they are also seen to onset in a much younger population (Feigin *et al.*, 2016; OECD, 2013). For example, the proportion of CVDs mortality reported for the 34 – 64 years age groups is 41% in South Africa, 35% in India and 28% in Brazil, compared to 12% in the United States of America (Celermaijer *et al.*, 2012; OECD, 2013; Shi *et al.*, 2016).

#### 2.3.1 Brazil

Brazil like many other LMICs around the world experienced an increase in industrialisation (Burki, 2012). Industrialization entails an increase in people’s financial income at workplaces, leading to migration to urban areas (Song *et al.*, 2012). The combination of an increased financial income and urbanisation and other factors such as globalisation and health transition (Hancock *et al.*, 2011; Vorster *et al.*, 2011; Yarahmadi *et al.*, 2013) have been documented to increase the risk of CVDs (Abrahams *et al.*, 2011) which are discussed later. This however also resulted in less privileged ethnic and racial groups bearing a disproportionately large share of the resultant burden (Borghi-Silva *et al.*, 2014; Malta & da Silva, 2012; Schmidt *et al.*, 2011). The incidence and prevalence of major CVD markers such overweight/obesity, physical inactivity and hypertension is increasing among adults while smoking rates are significantly declining (Ribeiro *et al.*, 2016). In Brazil the number of years of life lost due to premature deaths from stroke and ischemic heart disease had the highest ranking, each responsible for about 32% of mortalities in 2011 (Murkherjee & Patil, 2011; Ribeiro *et al.*, 2016).

#### 2.3.2 Russia

Similar to Brazil, Russian studies have also reported that CVDs death rate are highest in the working group population under the age of 70 years. The mortality due to CVDs is significantly higher (60%) compared to its other BRICS counterparts (Petrukhin & Lunina, 2012). The age-standardized mortality rate for CVDs in Russia has been found to be 2-3 times higher compared
to developed countries. Possible reasons for this might be the high prevalence of alcohol and tobacco consumption in this country (Zaridze et al., 2014).

The most common types of CVDs in Russia are also CHD and stroke and individually they are responsible for 49.3% and 35.3% of mortalities, respectively (Savoski et al., 2012). The high incidence and prevalence of CHD in the working group may have adverse impact of the individual’s quality of life, family and also a threat to social and economic welfare of a society (Gaziano, 2010). Russia experienced 78.7% indirect economic losses associated with premature deaths of men in the working age in 2010 (Artyukhov et al., 2016; Petrukhin & Lunina, 2012).

Despite the high mortality rate, Russia has made several efforts to decrease their overall CVD death rates during the period of 2005-2009 (Neufeld & Rehm, 2013). By introducing the alcohol policy, death rates decreased from 908 to 799.9 per 100 000 population. The aim of the alcohol policy was to reduce alcohol related mortalities which includes CVDs, by introducing a legislative act which regulates the production and sale of ethyl alcohol and alcohol-containing products in Russia (Grigoriev & Andreev, 2015). The objective of introducing the said legislative act was to strengthen state control over the volume of alcohol production and sales, as well as the quality of alcohol products (Grigoriev & Andreev, 2015; Neufeld & Rehm, 2013). Although this reduction in the overall decline of alcohol related deaths was due to a decrease in stroke-related mortalities, in the same period however, there was a slight increase of myocardial infarction mortalities (Fuster, 2014).

The most prevalent CVD risk factor in Russia is reported to be hypertension, contributing to about 35% of mortalities (Gaziano, 2010, Kreatsoulas & Anand, 2010). CHD and stroke mortalities due to elevated systolic blood pressure (BP) respectively contributes about 41% and 81% in males and 34% and 73% in females (Fuster, 2014) Russian men and women with hypertension respectively live 12.2 years and six years less than those with normal BP (Sidorenkov et al., 2011). The figures show that Russian men are more likely to die more from CVDs compared to women (Sidorenkov et al., 2011 & b). This could possibly be due to large intake of alcohol and high consumption of tobacco amongst men (Sidorenkov et al., 2012).

2.3.3 India

Although India is considered as a country with an emerging economy, the World Bank has ranked it as a LIC (John et al., 2011). This country is the largest in the region of South Asia (SAR) with about 75% of the region’s population (Gaziano, 2010; Shah & Mathur, 2010). In
India CVDs have contributed to about 25% of all-cause mortality, with CHD and stroke being the first and third top causes of death in the country and responsible for >80% of overall CVDs mortalities (Patel et al., 2011; Prabhakaran et al., 2016). Similar to Brazil and Russia, CVDs affects Indians during their most productive midlife years, currently 52% of the population below 70 years is affected by CVDs (Prabhakaran et al., 2016).

The estimated age-standardised CVDs death rate of 272 per 100 000 has been recorded to be higher than that of the global average of 235 per 100 000 population (Fuster, 2014; Prabhakaran et al., 2016). The rapid rate of epidemiological transition resulted in premature mortality in terms of YLL due to a 59% CVD increase; from 23.2 million in 1990 to 37 million in 2010 (Patel et al., 2011). India accounts for 18% and 20% of all global deaths and DALYs respectively (Bonow et al., 2012). CVDs are the leading causes of mortalities in both the urban and the rural regions of the country (Chauhan & Aeri, 2013). This shows that CVDs are no longer the diseases of the affluent as previously thought many decades ago. The diseases (CVDs) have even been reported to be more severe in low social-economic populations (Jeemon & Reddy, 2010). There is an estimation of 31.8 million people living with CHD in India (Gaziano et al., 2010).

The most common type of stroke among Indians has been reported to be haemorrhagic stroke (Pandian & Sudhan, 2013). Due to this, Prabhakaran et al. (2016) suggested that India is at a less advanced stage of epidemiological transition compared to Western population where the prevalent type of stroke is ischemic stroke. Hypertensive heart disease is also among CVDs that cause significant health problems in India, contributing 261 694 deaths in 2013, increasing by 138% compared to less than 80 000 in 1990 (Prabhakaran et al., 2016).

The incidence of CVDs has increased significantly for young adults (Gaziano, 2010), meaning that by the time they reach the later stages of adulthood they are like to have developed CVDs almost decade earlier (Jeemon & Reddy, 2010). This translates to a substantial number of mortalities in the working group population. Thus, India suffers a tremendous loss of productivity due to increased incidence and prevalence of CVDs, particularly CHD (Shah & Mathur, 2010). This pattern is seen is both genders and various age groups (25-69 years).

Communicable diseases contribute 36% of deaths and 42% of DALYs lost in India. This suggests a protracted epidemiological transition; a double burden of infectious and non-infectious diseases (Balajaran et al., 2011). Shah and Mathur (2010) projected that CHD and stroke are likely to be in the top five causes of DALYs lost in 2020 by India.
2.3.4 China

China is the largest developing country in the world (Celermajer et al., 2012). The leading causes of CVD-related mortalities are stroke and CHD, with stroke being far more prevalent than CHD in both the urban and rural areas (He et al., 2012). Together they account for between 60% and 77% of CVD mortality in China (Bonow et al., 2012). During the period of 2003-2013 the stroke mortality rate was higher in the rural than the urban population and also higher in men compared to women (Outline of the Report on Cardiovascular Diseases in China, 2014). The mortality rate of stroke in 2013 was 125.56 per 100 000 in urban populations and 150.17 per 100 000 in rural populations (GBD, 2015c). Currently in China, 1.3 million people have a stroke each year and 75% live with varying degrees of disability as a result of stroke (Outline of the Report on Cardiovascular Diseases in China, 2014). Among men between the ages of 35 to 65 years in China, stroke mortality rates were found to be 217 – 243 per 100 000 and 64 – 106 for CHD (Wu et al., 2013).

Although CVDs affect people in both urban and rural regions of China, the prevalence is higher in the urban areas (Celermajer et al., 2012). This might partially be attributed to the demographic transition followed by nutritional transition; resulting in populations getting older, more obese and suffering from significantly higher BPs (Yang et al., 2012). Other risk factors such as high total cholesterol composed of high LDL and low HDL are reported even in individuals with no history of CVDs (Natarajan et al., 2010). This is an interesting trend because even though China has developed at a rapid pace compared to other countries in the East Asia Region (EAR) in terms of improved health treatments to reduce CHD, the increase in risk factors still outweighs these developments (Gaziano et al., 2010; Stevens et al., 2016).

Following the demographic transition, life expectancy in China increased from 37 years in the mid-1950's to 71 years in 2000 (Bonow et al., 2012; Eggleston & Fuchs, 2012). Traditional risk factors including large volumes of rural-to-urban migration, rapid urban modernisation, decreased birth rates, are all interlinked to explain the rise of CVDs in the country (Li & Ge, 2015).

A report on CVDs in China in 2011 documented that there were about 230 million patients affected with different types of CVDs (National Bureau of statistics, 2011). Two hundred million of the patients had a major CVD risk factor; hypertension, seven million patients had a stroke an event, two million had myocardial infarction and 4.2 million had heart failure (National Bureau of statistics, 2011). The report has added that China experience about three million mortalities
annually due to CVDs, translating that CVDs are responsible for about 41% of deaths in the country.

2.3.5 Sub-Saharan Africa

Sub-Saharan Africa (SSA) is not exempted from this incoming tsunami of CVDs, whereby CHD and stroke are considered as the leading causes of mortality, especially in older people (Mathenge et al., 2010). CVDs were previously not as common in Africa, possibly due to the fact that they lived a more traditional lifestyle that was more active (Schutte et al., 2012), consumed a prudent diet with less fat (Pisa et al., 2012). The other reason is that communicable disease such HIV/AIDS and others were more dominant resulting in a shorter life span (Damasceno et al., 2012; Mocumbi, 2012). However, over the past 20 years, the life expectancy of people living in SSA has increased from 42 years to 50 years (Dalal et al., 2011), increasing the number of elderly people. Population aging is inevitable and unfortunately poses the greatest risk for the development of CVDs (Vissers et al., 2016). However, due to factors such as urbanisation, CVDs are now affecting not only older people but young adults as well (Hunter & Reddy, 2013). Earlier studies on CVDs in SSA have linked the rise of CVDs to an increase in risk factors such as hypertension, diabetes, obesity and high cholesterol (Addo et al., 2007). Hypertension and obesity were found to be more prevalent in urban areas, than rural areas (Christen et al., 2008) and later studies confirmed this, although these trends are now becoming a more visible reality within the rural areas (Cois & Day, 2015; Habib & Saha, 2010; Vissers et al., 2016).

2.3.6 South Africa

Chiu et al. (2015 & 2010) and Kreatsoulas et al. (2010) documented that there is paucity in data about the relative distribution of cardiovascular risk factors and conditions across the world’s largest ethnic groups, such as the South Asian, Chinese, African and Caucasian populations. This is also the case for South Africa (SA). Most studies on CVDs reporting on the black populations were conducted in developed countries such as the United States of America (USA), which have different social macro-environments, under different health care systems and also differences in access to health care and also different rates of epidemiological transition compared to SA and Africa as a whole (Chiu et al., 2010; Spanakis & Golden, 2013). This is worth mentioning since many cardiovascular risk factors may be influenced by the environment in which one resides (e.g. smoking rates are influenced by cigarette prices and anti-smoking legislation, obesity rates are influenced by the availability of health foods and the nature of the built environment) (Kreatsoulas et al., 2010; Lee et al., 2012).
Although the prevalence of CVDs within the black population was almost non-existent, recent data indicates that this is not the case anymore. The Global Burden of Diseases (GBD, 2015b) highlighted in their report that South Africa has a significantly increased number of DALYs lost from CVDs with 176 per 100 000 in 2000 to 264 per 100 000 in 2012. The early onset of CVDs in SSA, SA and other BRIC countries cause serious implications on the quality of life of the society and also on the economy of the country because more people will need medical treatment from the government and rely on a health system that is already heavily overburdened (Sliwa et al., 2016).

An earlier study by Voster (2002) reported that the most common CVD amongst the black population was stroke. Black South Africans were found to have higher levels of HDL cholesterol (Voster, 2002), which is regarded as the good type of lipoprotein due to its protective properties against other CVDs such ischemic heart disease (IHD), CHD and other heart conditions (Pérez-Méndez et al., 2014). The author (Voster, 2002) explained the prevalence of stroke in black South Africans could be linked to multiple risk factors; hypertension, obesity and hyperfibrinogenaemia (excessive fibrogen in the blood) in women and hypertension, smoking and hyperfibrinogenaemia in men. Despite limited published studies on the epidemiology of CVDs in South Africa, a current study published by Sliwa and Mayosi, (2013) reported that the incidence and prevalence of stroke is still on the rise. Stroke and CHD are respectively the second and fourth leading causes of mortalities in South Africa (Ayinde & Gillum, 2014; Bertram et al., 2013). Furthermore, Sliwa and Mayosi (2013) reported that in addition to the rising prevalence of stroke and CHD in South Africa; the country still faces other consequences due to infectious-CVDs such as rheumatic heart failure, tuberculous pericarditis and cardiomyopathies.

Another important issue that cannot be ignored about the health predicament in SSA, including SA, is the burden of diseases due to HIV, tuberculosis (TB) and diabetes that are still the leading causes of mortalities and morbidity in these countries (de Souza et al., 2012). HIV patients receiving ARV treatment are at a higher risk of developing heart conditions (Boccara et al., 2013; Freiberg et al., 2013; Hemkens & Bucher, 2014). These co-infections add to the already high burden of disease in the countries (Cook et al., 2014). HIV and TB are still responsible for high rates of mortalities in both genders under the age of 70 years (Cook et al., 2014).

Due to the high burden of HIV and TB infections in South Africa; large proportions of funding are dedicated to curbing the burden of these diseases (Mayosi et al., 2012). Although the
The government has made a significant milestone in controlling HIV by administering antiretroviral treatment (ART) to infected patients and treating TB patients, both of these diseases are still putting a huge burden on the current health system (Lalkhen & Mash, 2015). Achieving this milestone required more funding, leaving less funding and resources to tackle other health conditions such as CVDs that have been seen to rise in South Africa (Beaglehole et al., 2011; Gersh, 2010; Mayosi et al., 2012).

The epidemiological transition in SA can be described as that of ‘protracted polarized model’ as mentioned in the paper published by Agyei-Mensah and de-Graft Aikins (2010). This model is strongly aligned with SAs quadruple burden of disease” of communicable and NCDs along with high levels of HIV, TB and maternal and child health conditions (Bertram et al., 2013; Roth et al., 2015a). TB has been linked to diabetes (Kalra & Agrawal, 2013; Martinez & Kornfeld, 2014) and ART has been linked to metabolic complications leading to CVDs (Hemkens & Bucher, 2014; Hsue et al., 2012) and diabetes (Karla & Agrawal, 2013; Schoffelen, 2015). The impact of co-morbidities on the cumulative burden of infectious and CVDs is likely to be strongest in SA and other African cities due to high levels of rural–urban migration, urbanisation and urban poverty and increasing risk factors for CVDs (Mayosi et al., 2012).

2.4 Risk factors for cardiovascular diseases

A risk factor is an attribute, characteristic or exposure of an individual increasing their chance of developing a disease or injury (WHO, 2015). CVDs have multiple risk factors which operate at different levels, from biological to structural (Marais et al., 2013; Puoane et al., 2013; Yarahmadi et al., 2013). These risk factors can be classified as proven risk factors and putative risk factors. Proven risk factors are those that have been proven in epidemiological studies to be causal (Chopra et al., 2013; Gansevoort et al., 2013) and include alcohol consumption, smoking, dyslipidaemia, hypertension, elevated glucose, sedentary lifestyle, obesity, nutrition, urbanisation, ethnicity and genetics, gender and age (Chopra et al., 2013; Gehani et al., 2014; Shehab et al., 2015). Some of the proven risk factor are also classified as predisposing; explained as risk factors that are presumed to work, at least in part, through an impact on other risk factors that act directly (Morris et al., 2015; Hale et al., 2015). For example, a sedentary lifestyle exacerbates the risk of obesity, which may lead to raised blood pressure, dyslipidaemia and increased blood glucose (Kaur, 2014a; Kaur, 2014b; Strasser, 2013; Tchernof & Després, 2013). Putative risk factors are those that show associations with CVDs but a cause and effect association is yet to be proven (Rossow & Norström, 2012; Sahu et al., 2015). Examples of putative risk factors are low socio-economic status and psychological factors (Gallo et al., 2014; Rosengren et al., 2015; Von Kånel, 2012).
The risk factors mentioned above are reported to significantly increase in populations that undergo economic development resulting in various transitions that are discussed below.

2.4.1 Transitions as driving forces for increased CVD risk factors

2.4.1.1 Demographic transition

The improved economy due to industrialisation in the demographic transition contributes to the country’s improved infrastructure and increasing access to basic services such as; water, electricity, sanitation and improved health services (Eastwood & Kipton, 2011). Due to improved health services women are able to receive birth control medicines from local health care facilities (Canning, 2011). The access to birth control and other health treatments contributes to the decline in birth rates and mortality rates respectively (Cervellati & Sunde, 2011). Women in economically improved countries also have opportunities to work in industries and unlike in the pre-industrial era where they were left to be responsible for managing household and childbearing (Galor, 2012). This opportunity for women also reduces the birth rate as women will choose not to have many children because they are now employed, resulting in generally smaller families (GBD 2013 DALYs & HALE Collaborators, 2015). Due to improved income per person, people can also afford better medical services in private health care centres, which increases life expectancy (Cervellati & Sunde, 2011). Industrialization also leads to urbanisation, which influences rural-urban migration (Turok & McGranahan, 2013).

SA is a developing country going through a rapid urbanisation since after democracy (Mayosi et al., 2012). Since then, urban and most rural communities have been receiving basic services such as water electricity (Turok, 2012). Due to the country’s economic improvements and urbanisation, more Africans who were previously based in rural settlements are now migrating to urban areas (Mayosi et al., 2012; Turok, 2012). There are now more opportunities for Africans in various industries and this leads to their improved personal income and socio-economic status improving. The improved socio-economic status may lead to a change in diet, physical activity and lifestyle (Defo, 2014; Eastwood & Kipton, 2011).

Previously in rural areas, very few families had access to electricity, use of generators and other sources of electricity (Pereira et al., 2011). This meant there was limited access to televisions which have the danger of encouraging physical inactivity due to continuous programmes that are being watched (Botha et al., 2013; Puoane et al., 2012). Demographic transition has also influenced nutritional transition among Africans who used to eat mainly traditional food which they used to plant themselves (Crush et al., 2011; Kimani-Murage et al., 2011; van den Berg et
Land cultivation was part of a routine, growing corn, various vegetables and ‘morogo’ (Crush et al., 2011; Puoane et al., 2012). The produce from those fields used to be part of their daily eating diet. Most families would also have trees of various seasonal fruits in their yards. The advantage of living in rural areas was that there was sufficient space and land for all these activities. Urbanisation has come with good changes, but there are also negative changes (Dye et al., 2011). Due to large volumes of rural-urban migration, most urban houses and yards usually do not have enough space for cultivating vegetables and fruits compared to rural areas (Faber et al., 2013). Although sometimes there can space for small vegetable garden, but due to busy lifestyles and other contributing factors such as high water bills, most people do not have these gardens (Faber et al., 2013; Msangi, 2014:43). This results in families having to buy fruits and vegetables in order to have healthy balanced diets and this place a burden on poor families in urban areas (Popkin et al., 2012). Increased access to markets that sells low cost unhealthy fast foods also attracts African people (Popkin et al., 2012; Puoane et al., 2012).

Access to alcohol is easy in urban areas; some young African people even start drinking earlier than their peers growing up in rural areas (Gale et al., 2012). There is also a social status attached to consumption of alcohol, those who feel more affluent buy more expensive drinks with higher alcohol content such as whiskey and brandy, which also come in different types depending on how much one can afford (Jones, 2013). Alcohol consumption in urban area is seen in both males and females, with higher numbers males consuming alcohol (Schmidt et al., 2011; Peer et al., 2012). Access to social places such bars and clubs have also encouraged abuse of alcohol and even smoking (Malik et al., 2013).

The use of tobacco has increased amongst black African communities, due to the easy access of cigarettes, even some street vendors sell it (Hussain et al., 2015). Smoking tobacco can be addictive and this habit usually starts from a young age and proceed to adulthood (Zhu et al., 2012). This is seen in urban areas where the pace of lifestyle and civilisation is faster for example Western Cape and Gauteng provinces (Puoane et al., 2013).

Because of all these transitions, many non-communicable diseases particularly; CVDs are starting to be common in black African communities which were not the case previously (Collinson et al., 2014). Diseases such as heart failure, CHD and stroke are becoming prominent amongst Africans due to large consumption of tobacco and alcohol (Bygbjerg, 2012). Easy access to foods that contain high salt, sugar, saturated fats combined with sedentary lifestyles exacerbate conditions like hypertension, diabetes and obesity (Collinson et al., 2014; Kengne et al., 2013).
2.4.1.2 Epidemiological transition

The increasing prevalence of etiological risk factors such as obesity, diabetes and high blood pressure are a characteristic of epidemiological transition (Assah et al., 2011). Rapid urbanisation in many SSA countries may contribute to the epidemiological transition in the region (Assah et al., 2011). The main drivers of the epidemiological transition are increased life expectancy (Roth et al., 2015a), urbanisation (Davis & Grier, 2015), increased household income resulting from economic growth (Gong et al., 2012), globalisation affecting food production and marketing (Hove et al., 2013) and unhealthy lifestyle characterised by poor diet and physical inactivity (Steyn & Mchiza, 2014). Although SSA is usually cited as a region generally in the earliest stage of epidemiological transition (Tollman et al., 2008), the risk factors and morbidity profile suggest a population in a later stage of transition, one that is typically dominated by hypertension-related disease (Moran et al., 2013). The epidemiological polarised model mentioned earlier in concept clarification, describes the relationship between social class inequalities and higher morbidity and mortality rates, among poor populations who experience higher rates of infectious and nutrition-related diseases (Santosa et al., 2014). This model is strongly aligned with current discussions on Africa’s “double burden of disease” which recognises the coexistence of communicable diseases such as HIV and TB (Mayosi et al., 2012) and NCDs such as hypertension, stroke and diabetes (Agyei-Mensah & de-Graft Aikins, 2010; Masquelier et al., 2014).

There is a relationship between poverty and Africa’s rising burden of CVD’s (Santosa et al., 2014). A key factor is the role of co-morbidities: major infectious diseases of poverty increase the risk of chronic diseases (Kimani-Murage et al., 2010; Santosa et al., 2014). TB has been linked to diabetes and ART for HIV has been linked to metabolic complications leading to CVDs and diabetes (Kahn, 2011). The impact of co-morbidities on the cumulative burden of infectious and chronic diseases is likely to be strongest in African cities including SA (Kimani-Murage et al., 2010), because the country is also experiencing high levels of rural–urban migration, urbanisation and urban poverty (Kahn, 2011). This makes the epidemiological polarised model a useful conceptual framework to examine the epidemiological transition in African cities (Masquelier et al., 2014). As Smallman-Raynor & Phillips (1999) observed, the key elements of the model are evident in the large cities of some developing countries, where “the richer sections” of the population may develop more or less ‘modern’ health and disease profiles whilst some poorer sectors may experience the double jeopardy of infectious and non-communicable diseases (Agyei-Mensah & de-Graft Aikins, 2010; Kahn, 2011; Santosa et al., 2014).
A South African case study of epidemiological transition on the “new South Africa” conducted by Kahn et al. (2007) suggested that the polarised model may also be appropriate for examining epidemiological trends in rural Africa (Kahn et al., 2012). Kahn et al. (2007) examined trends in age-specific mortality in a rural South African population and reported a “counter transition” of increasing mortality among children and young adults (Kahn et al., 2012). The authors explained this observation an “epidemiologic polarisation” of a higher mortality burden among vulnerable, poor groups and a “protracted transition” with a coexistence of HIV and chronic diseases in older adults (Agyei-Mensah & de-Graft Aikins, 2010; Kahn et al., 2012).

2.4.2 Proven risk factors

2.4.2.1 Age
Due to significant improvement in the control of infectious diseases (Abrahams et al., 2011; Yarahmadi et al., 2013) the life expectancy of adults has been prolonged. However, because people are now living longer, they are becoming more prone to the development of CVDs (Yarahmadi et al., 2013). Amongst other reasons, one explanation might be that older people become less active and the immune system also becomes weak. Bloom et al. (2014) reported in the World Economic Forum (WEF) that because the older generation become less active and the immune system weakens with age, the risk of getting CVDs also increases. Mentioning this however, CVDs do not usually affect people only in the elderly ages (Bloom et al., 2014). Most people get affected by CVDs in their youth ages due to the lifestyle choices and proceed with these CVDs into adulthood (Wu et al., 2015).

2.4.2.2 Alcohol consumption
Urbanisation has increased access to alcohol and tobacco products in the black communities (Ferreira-Borges et al., 2015). This is due to increased access to open supermarkets and taverns within the community surroundings and they are able to receive stock from retail suppliers (Moodie et al., 2013; Davis & Grier, 2015). Because of increased access to alcohol, it is reported by Peer et al. (2012) that the consumption of alcohol already starts in the early stages of life (sometimes as early as 15 years) amongst black people in both urban and rural communities.

2.4.2.3 Diabetes
Elevated plasma glucose (>7.0mmol/L) on two repeated measurements and/or glycated haemoglobin (HbA1c) >7% have been linked with early development of hypertension and later multiple end organ damage (Mancia et al., 2013). Uncontrolled diabetes can cause damage on the blood vessels, making them more prone to damage from atherosclerosis (WHO, 2014).
According to Seedat and Rayner (2011), hypertension, stroke and heart attack is twice as common in people with diabetes, compared to people with normal blood glucose levels. The risk for developing diabetes is reported to be more prevalent in urban individuals, due to the high prevalence of overweight and obesity (WHO, 2014). The SANHANES-1 study reports that 18.5% of participants throughout South Africa had elevated blood glucose and 9.5% were diagnosed with diabetes (Shisana et al., 2013).

2.4.2.4 Dyslipidaemia
Cholesterol travels in the bloodstream in small packages called lipoproteins (Patel, 2013). As mentioned earlier, there are two major kinds of cholesterol; LDL and HDL (Parish et al., 2012). LDL cholesterol is sometimes called "bad" cholesterol. This is because it carries cholesterol to tissues, including heart arteries (Glynn & Bhikha, 2017). HDL cholesterol is sometimes called "good" cholesterol (Fisher et al., 2012). This is due to its protective role by removing cholesterol from arteries (Fisher et al., 2012). Higher HDL plasma levels could be related to lower risk of CHD and have major vascular protective effects against atherosclerosis (Fisher et al., 2012; Turnbull et al., 2010). An individual is considered at risk of CVDs when the HDL is lower than the LDL (Fisher et al., 2012; Perk et al., 2012). Total cholesterol (TC) is calculated by the sum of HDL, LDL and triglycerides. Increased TC is commonly accepted as an important predictor of CHD (Perk et al., 2012). High cholesterol is also associated with westernised lifestyle such as sedentary lifestyle leading to overweight or obesity (Hu, 2011) and intake of fatty foods (Wagner & Brath, 2012). High cholesterol has been reported to increase the risk of heart attack and stroke (Ruiz-Núñeza et al., 2013). The prevalence of hypercholesterolemia has been associated with systolic hypertension and hyperglycaemia (Mancia et al., 2013). According to Schutte et al. (2009), Africans exhibit lower triglyceride and higher HDL levels than Caucasians, but these levels are still related to obesity and CVD risk (Schutte et al., 2008).

2.4.2.5 Ethnicity and genetics
Some population groups are genetically predisposed for the development of CVDs (WHO, 2015). CVD tends to manifest itself in specific ways that is unique to different communities (Barouki et al., 2012). Hypertension is known to develop at an earlier age within the black population (Ibrahim & Damasceno, 2012). For example, African communities tend to have strokes as a result of CVDs, while south Asians are more prone to suffer from heart attacks (Barouki et al., 2012; WHO, 2015). According to an article by Phaswana-Mafuya et al. (2013), the prevalence of self-reported hypertension-related CVDs amongst South Africans, the prevalence was highest amongst the black population compared to other population groups (Asians, Mixed-race and White population groups).
2.4.2.6 Gender
Several studies (Al-Daghri et al., 2014; Anish et al., 2013; AWHN, 2014) have indicated the existence of gender differences regarding the susceptibility towards CVDs. Anish et al. (2013) has reported that there has been an increase in the prevalence of CVDs amongst women due to social factors. The authors (Anish et al., 2013) explain that women are not encouraged to be physically active by participating in sports like men and this happens from a young age. As a result, more women become obese than men (Oladapo et al., 2010) putting them at risk for CVDs (Anish et al., 2013). The impact, risk factors and other social determinants of CVDs on women’s’ lives are highlighted next. Hypertension (high blood pressure) and high body mass are the two biggest contributors to the total burden of disease among women compared to men (WEF, 2010). Hypertension accounts for 42% of the CVD burden for women although the burden is less for females than males (AIHW, 2010). Factors such as pregnancy, pre-eclampsia, gestational diabetes, use of oral contraceptives and use of hormone treatments are reported to be associated with increased risk of stroke in women (Roeters et al., 2002; Peters et al., 2014).

2.4.2.7 Hypertension
Hypertension (also referred to as high or raised blood pressure) is the force of blood pushing against the walls of the arteries as the heart pumps blood (Kaur & Kaur, 2014). If this pressure rises and stays high over time, it can damage the body in many ways. Hypertension could be the result of an increased cardiac output or total peripheral resistance, or both (Windmaier et al., 2013). This condition can lead to atherosclerosis and narrowing of the blood vessels making them more likely to blockage from blood clots or particles of fatty material breaking off from the lining of the blood vessel wall (Tranfield & Walker, 2012). Damage to the arteries can also create weak places that rupture easily resulting in myocardial infarction, kidney damage and stroke (Windmaier et al., 2013). It is generally a symptomless condition, hence the reference to the “silent killer”. Hypertension is defined as values ≥140 mmHg systolic blood pressure (SBP) and/or a ≥90 mmHg diastolic blood pressure (DBP) (Mancia et al., 2013:1288).

High blood pressure has been reported to be linked to various factors, but strongly linked to lifestyle factors (Du Plessis et al., 2010; Wagner & Brath, 2012) that are seen due to rapid urbanisation. Westernised diets such as food high in fat and salt, as mentioned earlier, have been reported by Wagner and Brath (2012) to account for a significant number (30%) of high blood pressure cases in the black population. Tobacco smoking including second hand smoke has also been reported to be associated with high blood pressure (Afridi et al., 2010). High
blood pressure has also been reported to be associated with the stress of trying to cope with the rapid rate urbanisation amongst black people (Du Plessis et al., 2010; Wagner & Brath, 2012) also mentioned that raised blood pressure is a major risk factor for cardiovascular disease (Clark et al., 2012; Whelton et al., 2012).

2.4.2.8 Nutrition
Nutrition is a major modifiable determinant of CVDs (Puoane et al., 2013). In black populations where there is urban exposure, the traditional diet comprising of high carbohydrates and fibre, has been abandoned (Bowry et al., 2015; Moodie et al., 2013). Currently diets have shifted towards what is termed Western diets; moving away from staple foods rich in starch and dietary fibre towards a diet high in saturated fats, sugar and highly processed or salty foods (such as pickles, salty fried snacks and salted potato chips) (Hu, 2011; Misra et al., 2011; Voster et al., 2011). Fat intake amongst black populations in urban areas has increased from 16.4% to 26.2% of total energy, while carbohydrate intake has decreased from 69.3% to 61.7% of total energy (Mayosi et al., 2009; Wright & Ramukumba, 2008). This shift in diet reflects that of HIC as Mayosi et al. (2009) reports that the same dietary shift is taking place in the rural parts on South Africa. Intake of fruits and vegetables has also decreased in the black population (Voster et al., 2011). This could be due to high prices of fruits and vegetables in market places, impacting negatively on the poor, struggling to meet basic household needs (Angkurawaranon, 2014). These changes in dietary patterns were reported to be associated with an increased risk of overweight (Popkin et al., 2012), obesity (Misra et al., 2011), hypertension (Song et al., 2014) leading to CVDs (Voster et al., 2011; Wagner & Brath, 2012).

Furthermore, studies done in Russia Minicuci et al. (2014) and Peasey et al. (2006) reported insufficient intake of fruits and vegetables also contributed to CVDs. This is in addition to the risk factors already mentioned above. In another study (Wu et al., 2015) investigating risk factors in India, Russia, China and South Africa the other additional risk factors found in these countries were hypertension, central obesity and also low intake of fruits and vegetables.

2.4.2.9 Sedentary lifestyle
Due to industrialisation and globalisation people have become accustomed to sedentary lifestyles (Mayosi et al., 2009). In most countries where the pace of industrialisation is ahead, work-related activities have decreased with people spending most of their time seated with less physical movement (Held et al., 2012). Due to urbanisation there is no longer a need for hunting, gathering fruit from veld and fetching water far from home, as it was once part of the daily occupation (Ojiambo et al., 2012). Children do not travel long distances by foot to attend
because schools are either close by or there is transport to school and back home (Ojiambo et al., 2012; Wagner & Brath, 2012). Black people previously performed most of their chores using their hands, for example cleaning the house, washing clothes, fetching and cutting wood from the veld (Pretorius & Sliwa, 2011). This is no longer the case, most households have washing and cleaning machines, cars to travel, reducing physical activity (Ojiambo et al., 2012). Currently almost every household in both rural and urban areas own a television, some families that have a higher socio-economic status (SES) also own computers, which encourage sedentary behaviour (Held et al., 2012; Pretorius & Sliwa, 2011). Shopping malls have physical activity limiting devices such escalators, elevators and carts to drive children during shopping; this also reduces physical activity (Held et al., 2012). Physical inactivity has been shown to be associated with obesity (Malik et al., 2013) and CVDs (Ojiambo et al., 2012).

2.4.2.10 Smoking

Smoking doubles an individual’s CVD risk according to Mancia et al. (2013). Chemicals such as carbon monoxide in tobacco get into the bloodstream through the lungs (Samet, 2013). They diminish the oxygen in the blood and damage the blood vessels (arteries) by triggering a build-up of plaque inside (Ulintz & Sun, 2016). Smoking also increases the risk of blood clots forming in the arteries. Blood clots can block plaque-narrowed arteries and cause a heart attack (Adams et al., 2011). The risk of having a stroke and developing other diseases such as lung cancer are also increased (Björkegren et al., 2015). The Cancer Association of South Africa (Cansa, 2012) reports a very high prevalence rate of 35% of males and 10% of females classified as smokers. In a study conducted by Zatu et al. (2011) African smokers had significantly increased arterial stiffness, which can contribute to the development of cardiovascular dysfunction. Peer et al. (2012) also reported that the social and cultural constraints that previously prevented black females from smoking are weakening especially in urban areas and traditional constraints can no longer be relied on convince or encourage females from smoking tobacco.

2.4.2.11 Urbanisation

A research article published by Wu et al. (2015) reported that risk factors such diet, obesity, hypertension and a decrease in physical activity are associated with urbanisation. The authors (Wu et al., 2015) further reported that because over half of the global population resides in urban areas, the mentioned risk factors will all have significant impact on the health of the population. In India, historically there were low levels CVDs risk factors documented (Celermajer et al., 2012), particularly on diabetes, hypertension and blood lipid levels. However, in the 2000s there has been a rise in the prevalence of CVDs that was documented, especially in the urban areas (Celermajer et al., 2012). Research done by different authors in the major
cities on India reported that urban residing participants from the age of 20 years and older were found to have increased rate of hypertension (12-15%) compared to 5% in the 1960s (Joshi et al., 2012; Ramachandran et al., 2012; Shaw et al., 2010).

The same trend of increased CVDs risk factors due to urbanisation was also reported in Russia by Boytsov and Potemkina (2014) together with Wu et al. (2015). The authors (Boytsov & Potemkina, 2014; Wu et al., 2015) mentioned that 74% of Russians live in the urban areas. From these findings conclusions can be drawn that high prevalence of CVDs may be due to lifestyle patterns that come with urbanisation that encourage sedentary lifestyles, poor diets and alcohol and tobacco abuse. Because of these westernised lifestyles, Russian men were found to have lost ten years of life expectancy compared to European men (Boytsov & Potemkina, 2014).

The CVDs risk factors (premature deaths) and urbanisation link was also reported in South Africa by the Institute for Health Metrics and Evaluation (IHME, 2015). The IHME reported a decrease in life expectancy at birth for all sexes between year 1990 and 2010, with an average of 64.6 in 1990 and 59.9 in 2010 due to an increase in the prevalence of CVDs (IHME, 2015).

2.4.3 Putative risk factors

2.4.3.1 Low-socio-economic status

SES refers to an individual's social position relative to other members of a society (Kraus & Callaghan, 2014). Low SES and low education level is associated with large increases in CVDs risk in men and women (Arokiasamy et al., 2015). The inverse association between SES and CVDs risk observed in HIC countries is often the result of the high prevalence and compounding effects of multiple behavioural and psychosocial risk factors seen in people of low SES (Prince et al., 2015). However, strong and consistent evidence shows that parental SES, childhood and early-life factors, also contribute to elevated CVDs risk in people of low SES (Bijker & Agyemang, 2016; Lagraauw et al., 2015). Although it is known that people with low SES status have a greater risk for developing heart disease and other health problems (Kelly et al., 2016), the reason is often attributed to reduced health-care access (Lagraauw et al., 2015) or poor adherence to treatments such as smoking cessation or medication (Prince et al., 2015). In addition, place of residence can also affect CVDs risk (Di Cesare et al., 2013). Studies on the effects of SES on CVDs risk in LMICs are scarce, but evidence is emerging that the increasing wealth of these countries is beginning to lead to replication of the patterns seen in HIC countries (BeLue et al., 2009).

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2.4.3.2 Psychological factors

Available research indicates that chronic stress often predicts the occurrence of CHD (Gallo et al., 2014; Lagraauw et al., 2015). Employees who experience work-related stress and individuals who are socially isolated or lonely have an increased risk of a first CHD event (Fishta & Backé, 2015). Short-term emotional stress can also act as a trigger of cardiac events among individuals with advanced atherosclerosis (Steptoe & Kivimaki, 2013). Among patients with CHD, acute psychological stress has been shown to induce transient myocardial ischemia and long-term stress can increase the risk of recurrent CHD events and mortality (Lagraauw et al., 2015; Steptoe & Kivimaki, 2013).
2.5 Framingham risk score for coronary heart disease

The Framingham risk score (FRS) is one of the scoring systems used to determine an individual's chances of developing CVDs, particularly CVDs that are grouped under CHD: angina pectoris, myocardial infarction, heart failure and coronary death (Hu, 2013). The FRS was first developed based on data obtained from the Framingham Heart Study, to estimate the risk of developing CHD over the period of ten years or more (Nishimura et al., 2014). The FRS uses major risk factors discussed above to calculate the risk (Lee et al., 2015). The measurement reading of each risk factor is used into equations below to calculate the risk score (Wang & Hoy, 2005). The FRS risk score gives an indication of the possible future CHD outcomes of the individual (Gibbs et al., 2016). These FRS scores are useful for both the individual patient and for the clinician in helping decide whether lifestyle modification and preventive medical treatment are necessary (Burgers et al., 2014). CHD risk at ten years in percentage can be presented in three categories based on the calculation results (Nishimura et al., 2014). Individuals with low risk scores have 10% or less CHD risk at ten years, with intermediate risk 10-20% and with high risk 20% or more (Gibbs et al., 2016).

\[
\begin{align*}
\mu &= \sum \beta_i x_i \\
\sigma &= e^{\theta_0 + \theta_1} \\
\sigma &= e^{\theta_0 + \theta_1} \\
\sigma &= e^{\theta_0 + \theta_1} \\
\sigma &= e^{\theta_0 + \theta_1}
\end{align*}
\]

Where, \( x_i \) are risk factors (e.g., blood pressure or age) and \( \beta_i, \theta_0, \) and \( \theta_1 \) are coefficients estimated from the Framingham study; \( t \) is the time of follow-up and \( p \) is the predicted probability of CHD by time, \( t \) (Wang & Hoy, 2005).

2.6 Summary

Despite having mentioned the risk factors above, the health framework as outlined in Chapter 1 has shown that there are many factors that affect populations at different levels that can put them at risk of having CVDs. As mentioned in Chapter 1 that cardiovascular diseases are interactive and multidimensional, depending on the general environment, lifestyle, age and other factors illustrated in the health framework, certain CVD risk factors can be more dominating in the population than others. For example, having easy access to tobacco and alcohol may encourage smoking and drinking more than nutrition as a risk factor. Determining dominating risk factors and correlating how some behaviour may lead to the increase in the
prevalence of such risk factors in a specific community may assist in curbing the associated CVDs in those populations. Information produced from this research may assist the Provincial Department of Health (DoH), health promotion and other stakeholders on which interventions are necessary for these communities.
2.7 References


Han, K., Heo, S.H., Lee, S., Jeon, S.H & Yoo, K., H. 2010. Comparison of urodynamics between ischemic and hemorrhagic stroke patients; can we suggest the category of urinary dysfunction in patients with cerebrovascular accident according to type of stroke? *Neurology and urodynamics*, 29(3):387–390.


**CHAPTER 3**

**Research article**

**3.1 Instructions for authors: Atherosclerosis**

Original articles should present original research not previously published or considered for publication elsewhere. Manuscripts should not exceed 4000 words (excluding legends to figures...
and tables) and no more than 50 references. Flexibility on word count may be offered after
discussion with the Editor. Basic and Clinical Research papers must have no more than 5
figures and tables in total (authors are encouraged to include additional figures and tables as
Supplementary Material). Manuscripts should be written in the English language (using either
American or British spelling. As a rule, research papers should be divided into sections headed
by a caption (e.g. Abstract, Introduction, Materials, Methods, Experimental results, Discussion,
etc.). Include a short paragraph of conclusions (at the end of the text), indicating the relevance
of the study with regard to the basics and/or clinical aspect of atherosclerosis. A statement
concerning the source of funding, conflicts of interests and disclosures of financial support is
highly recommended. SI units must be used throughout (e.g. mmol/L).

References
There are no strict requirements on reference formatting at submission. References can be in
any style or format as long as the style is consistent. Where applicable, author(s) name(s),
journal title/book title, chapter title/article title, year of publication, volume number/book chapter
and the pagination must be present. Use of DOI is highly encouraged. The reference style used
by the journal has been applied to the accepted article by Elsevier at the proof stage. Note that
missing data is highlighted at proof stage for the author to correct.

Essential title page information
- Title: Concise and informative. Titles are often used in information-retrieval systems. Avoid
  abbreviations and formulae where possible.
- Author names and affiliations. Where the family name may be ambiguous (e.g., a double
  name), please indicate this clearly. Present the authors’ affiliation addresses (where the
  actual work was done) below the names. Indicate all affiliations with a lower-case
  superscript letter immediately after the author's name and in front of the appropriate
  address. Provide the full postal address of each affiliation, including the country name and, if
  available, the email address of each author.

Abstracts
A structured abstract (objective, methods, results and conclusion) of 50-250 words must be
included.

Keywords
A keyword summary must be provided; normally 3-7 items should be included. Authors are
encouraged to choose their own keywords but, if in grave doubt which items to select.
Medical Subject Headings (issued with the January Index Medicus, 1969) may be used as a guideline.

Tables
Tables with titles and legends must be on separate pages with double spacing; they may be included in the same file as the manuscript text or in separate file(s). Authors must list on the title page or in the covering e-mail, the number of figures and/or tables to be found in the paper.

For examination purposes, all tables and figures are inserted between the texts.

3.2 Title page:

Prognostic value of modifiable risk factors for the development of non-fatal and fatal cardiovascular events in black South Africans

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Word count: Text: 3977
Tables/Figures: 3 tables; 2 figures; 1 supplementary table

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Abstract

Background: The prevalence and incidences of cardiovascular diseases (CVDs), along with its associated risk factors, may be influenced by the environment in which one resides. Therefore, it is important to have data on CVD risk factors associated with fatal and non-fatal cardiovascular (CV) events on black populations in the African context. This study aimed to identify the most significant modifiable CV risk factors associated with fatal and non-fatal CV events over a period of five years within a selected group of black South Africans residing in the Dr Kenneth Kaunda District.

Methods: This study included 746 males and 1 263 females from rural and urban areas, aged 35-70 years. Risk factors associated with fatal and non-fatal CV events were assessed.

Results: A positive correlation between suffering from a non-fatal CV event and age ($r_{pb}=0.14$, $p<0.01$) were reported, as well as all blood pressure parameters with systolic blood pressure (SBP) revealing the strongest correlation ($r_{pb}=0.14$, $p<0.01$). Binary logistic regression analysis found age ($\beta=0.044$), education ($\beta=0.645$), weighted physical activity index ($\beta=-0.893$) and Framingham risk score (FRS) ($\beta=0.038$) to be important predictors of non-fatal CV events, whereas age ($\beta=0.074$) and glycated haemoglobin ($\beta=-1.163$) were important predictors of fatal CV events. ROC curve analyses reported all blood pressure measurements and FRS to be likely associated with both fatal and non-fatal CV outcomes.

Conclusions: The study found that elevated blood pressure is the most significant predictor for both fatal and non-fatal cardiovascular events in a selected group of black South Africans.

Keywords: Cardiovascular disease, fatal cardiovascular events, non-fatal cardiovascular events, black adults, urban, rural, PURE-SA study
3.3 Introduction

The incidence and prevalence of cardiovascular diseases (CVDs) have been on the rise in Sub-Saharan Africa (SSA), including South Africa since the 1990’s [1]. Researchers have since turned the spotlight on CVDs and its risk factors onto the African context, particularly black people [2]. This is because most studies regarding CVDs in black populations were conducted in high-income countries such as the United States of America, which have different social macro-environments [3, 4], fall under different health care systems, have different access to health care [5] and also different rates of epidemiological transition compared to Africa [6, 7]. Research regarding the prevalence and incidences of CVDs and its associated modifiable risk factors within the black populations in the African context is therefore crucial [8, 9, 10].

In South Africa, CVDs such as coronary heart disease (CHD), stroke, angina, myocardial infarction and heart failure are steadily emerging as the leading causes of mortality in the working group and older people [11]. In the past, these CVDs were not common amongst black South African population, due to a number of possible reasons [12]: i) most black populations lived in rural areas and followed a traditional prudent diet, rich in high-density lipoproteins (HDL), serving as a barrier from CHD [13], ii) had limited technology and were very physically active (i.e. walking distances, fetching wood, water etc.) [14], iii) had a short life expectancy due to poverty and scarcity of health facilities. A few years ago, the most common cause of death within the black population was communicable diseases [15] and malnutrition [16, 17]. However, since the dawn of democracy, this picture has changed due to the rapid epidemiological transition rate [18]. More so, the epidemiological transition has led to a health transition, rural-urban migration and improved living conditions in rural South Africa. [19].

The increase in CVD prevalence among black South Africans has been linked to the increase in modifiable risk factors such as hypertension, diabetes, obesity and high cholesterol [20, 21] in both young adults and old people. The aim of this research was to identify the five-year prognostic value of modifiable risk factors for fatal and non-fatal cardiovascular (CV) events within a selected group of black South Africans residing in the Dr Kenneth Kaunda District.

3.4 Methods

Study design and population

The international Prospective Urban and Rural Epidemiology (PURE) study is a longitudinal study aiming to examine the relationship of societal influences on human lifestyle behaviours, CV risk factors and incidence of chronic non-communicable diseases [22]. Baseline data was collected in 2005 and follow-up data in 2010. This study falls under the South African leg (North
West Province) of the PURE study and used pre-collected, data from the larger study. This study followed a quantitative research approach and pursued a non-experimental research design (descriptive and correlational). Relevant data was investigated retrospectively by identifying associations between exposure (modifiable CV risk factors) and the outcomes (fatal and non-fatal CV events) over the period of five years. Since the aim of this study is to identify the five-year prognostic value of modifiable risk factors for fatal and non-fatal CV events only participants who suffered a CV event(s) five years after baseline data was collected, were included into the analyses. Hence, we included data from 746 males and 1 263 females, aged 29-94 years, who had suffered or passed away from any of the following CV events: angina pectoris, coronary heart disease, stroke, myocardial infarction and heart failure throughout the course of five years (2005-2010). Each participant had to sign a written informed consent form at the time of enrolment and participation in this study was voluntary. Participants could withdraw from the study at any given point. The study protocol complied with the Declaration of Helsinki (as revised in 2004) and was approved (04M10 and NWU-00016-10-A1) by the Health Research Ethics Committee of the Faculty of Health Sciences, North-West University, Potchefstroom, South Africa. Reporting of the study conforms to the STROBE statement along with references to STROBE [23] and the broader EQUATOR guidelines [24].

Questionnaires
Trained Setswana speaking African fieldworkers conducted the interviews using semi-structured questionnaires. Participants’ educational level, socio-demographic information and smoking and alcohol consumption habits were collected as well as their level of physical activity using the validated International Physical Activity Questionnaire (BAECKE), respectively [25].

Outcome variables
Participants were asked whether they had a medical diagnosis of CVD (angina pectoris, CHD, stroke, myocardial infarction and heart failure), whether they were receiving any medication and a list of all their medications was recorded. CVDs were ascribed on the basis of self-reported information and verified with medical records (clinic cards) brought along with them during the first annual follow-up. Verbal autopsies were performed by qualified researchers with the assistance of trained health care workers for all participants who had suffered a fatal CV event. All of the reported events along with the supporting documents were sent to a trained medical doctor who adjudicated and verified each individual case, after which ICD-10 codes were assigned.

Anthropometrical measurements
Anthropometric measurements were performed at baseline and follow-up according to standardised methods of the International Society of Advancement of Kinanthropometry (ISAK). Height was measured to the nearest 0.1 cm with a stadiometer (Leicester height measure, Seca, Birmingham, UK) and weight was recorded on a portable electronic scale (Precision Health Scale, A & D Company, Japan) to the nearest 0.01 kg with participants in light underwear and shoes removed. Waist and hip circumference was measured at the narrowest point between the lower rib border and the iliac crest and recorded to the nearest 0.1 cm with a steel tape (Lufkin, Cooper Tools, Apex NC, USA). Body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared and classified using the WHO categories of BMI of <18.5 kg/m$^2$ as underweight, 18.5–24.99 kg/m$^2$ as normal weight, 25–29.99 kg/m$^2$ as overweight and ≥30 kg/m$^2$ as obese.

**Cardiovascular measurements**

After a 10-minute rest period, brachial blood pressure measurements were performed in duplicate (5 minutes apart), on the right upper arm, while the participants were seated upright with the right arm supported at heart level. Systolic blood pressure (SBP), diastolic blood pressure (DBP) and heart rate were measured with a validated OMRON HEM-757 device (Omron Healthcare, Kyoto, Japan).

**Biochemical analyses**

Fasting blood samples were collected by a qualified nurse from the antecubital vein. Serum and plasma samples were prepared according to standard protocol. Plasma samples were stored on ice until processing, whereas serum samples were allowed to clot at room temperature for 30 minutes. All samples were stored at -80°C in cryotubes until further processing.

A Sequential Multiple Analyser Computer (SMAC), using the Konelab analyser (Thermo Fisher Scientific Oy, Vantaa, Finland), was used to analyse serum lipids. Low-density lipoprotein (LDL) cholesterol was calculated using the Friedewald formula [26]. Plasma glucose was measured with a hexokinase method using the Vitros DT6011 Chemistry Analyser (Ortho-Clinical Diagnostics, Rochester, New York, USA) and reagents. Glycated haemoglobin was determined from whole blood (EDTA) samples, based on ion-exchange high-performance liquid chromatography, with the D-10 Haemoglobin testing system from Bio-Rad (Bio-Rad Laboratories Ltd., Hercules, CA, USA, #220-0101).

**HIV testing**
Written informed consent was obtained individually from each participant after pre-counselling was done. Participants were given a choice to proceed with the testing. Participants' HIV status was determined using the First Response rapid HIV card test (PMC Medical, India) using whole blood. This test was performed according to the protocol of the National Department of Health of South Africa. If the First Response test was positive, it was confirmed with the Pareeshak card test (BHAT Bio-tech India). Feedback on results was given by two trained counsellors during individual sessions just before the participants were transported back to their homes. Infected participants were referred to their local clinic or hospital for follow-up and determination of CD4 cell counts.

**Framingham risk score**

The Framingham risk score (FRS) was first developed based on data obtained from the Framingham Heart Study to estimate the risk of developing CHD over the period of ten years or more [27]. The FRS uses major risk factor measurements, including age, sex, diabetes, LDL and HDL cholesterol, SBP and smoking to calculate a score indicative of the possible future CHD outcome risk of an individual [28]. This score is useful for both the individual patient and the clinician to decide whether lifestyle modification and preventive medical treatment are necessary [29]. Ten-year CHD risk can be presented in three categories based on the calculated results, i.e. ≤10% is regarded as low risk, 10-20% as intermediate risk and >20% as high risk [30].

**Statistical analyses**

All analyses were performed using the Statistical Package for Social Sciences (SPSS) version 24 (IBM SPSS, Chicago, USA). Frequencies (N) were reported as percentage (%) values, while arithmetic means, medians, standard deviations (SD) and 95% confidence intervals (CI) were used to summarise the data.

Depending on the data, either parametric statistical analyses (continuous data) or non-parametric statistical analyses (categorical data) were used. Data is presented as mean and interquartile ranges (IQR) [Q1-Q3] in the case where data is not normally distributed. One-way analysis of variance (ANOVA) and two-sample z-tests were performed to compare means and proportions, respectively. Point-biserial correlations were used to determine associations between risk factors (continuous data) and CV event outcomes (categorical dichotomous data). Binomial logistic regression was used to determine associations between categorical dependent variables (CV event outcomes) and categorical risk factors. Receiver Operating Characteristic (ROC) curves were assessed for the analysis of the prognostic value of independent predictors.
on CV event outcomes. All probabilities were two-tailed and p values of <0.05 were reported to show associations or differences between groups. 95% confidence intervals (CI) were also reported.

3.5 Results

The baseline characteristics of the participants are portrayed in Table 3-1. Participants who suffered fatal CV events were on average 60.43 years old, while those who suffered non-fatal CV events were 57.12 and those with no CV events were 47.81 years old (p-trend<0.001). Among those who suffered fatal CV events, 56.0% lived in rural areas, compared to 34.8% of those who suffered non-fatal CV events (p-trend=0.010). Thirty six percent of the fatal CV events group were found to have some form of education which is low compared to the 62.9% reported in the non-CV events group (p-trend=0.010). Those suffering non-fatal CV events had significantly higher blood pressure levels (144/94mmHg) compared to both other groups (p-trend<0.001). Interestingly though is that the reported use of blood pressure lowering medication was highest within the non-fatal group (p-trend=0.002). Furthermore, this group reported the lowest weighted physical activity index (p-trend=0.001) and the highest diabetic prevalence (9.7%) and FRS (10.00) (both p-trend<0.001). No difference was however observed in lipid and body composition measures between the groups.

We performed point-biserial correlations between CV events (non-fatal CV events or fatal CV events, respectively) versus no CV events (Table 3-2). There was a positive correlation between suffering both a non-fatal ($r_{pb}=0.14$, p<0.010) and fatal ($r_{pb}=0.11$, p<0.010) CV event and age. Suffering a non-fatal CV event related to all blood pressure parameters, where SBP revealed the strongest correlation ($r_{pb}=0.14$, p<0.010), though the strength of the correlation is considered as very small [37]. No relationships were observed between either of the CV events and any biochemical or body composition risk factors.
Table 3-1: Baseline demographic characteristics of study participants

<table>
<thead>
<tr>
<th>Variable</th>
<th>No CV events</th>
<th>Non-fatal CV events</th>
<th>Fatal CV events</th>
<th>P-trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=1918</td>
<td>N=69</td>
<td>N=25</td>
<td></td>
</tr>
<tr>
<td><strong>Socio-demographic profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>47.81 (41.62–55.73)</td>
<td>57.12 (48.93–65.68)</td>
<td>60.43 (50.34–65.90)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Gender (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37.0</td>
<td>36.2</td>
<td>52.0</td>
<td>NS</td>
</tr>
<tr>
<td>Female</td>
<td>63.0</td>
<td>63.8</td>
<td>48.0</td>
<td>NS</td>
</tr>
<tr>
<td>Locality (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>49.5*a</td>
<td>65.2*a</td>
<td>44.0</td>
<td>0.010</td>
</tr>
<tr>
<td>Rural</td>
<td>50.5*a</td>
<td>34.8*a</td>
<td>56.0</td>
<td>0.010</td>
</tr>
<tr>
<td>Educated (%)</td>
<td>62.9*a</td>
<td>69.6</td>
<td>36.0*a</td>
<td>0.010</td>
</tr>
<tr>
<td>HIV status, positive (%)</td>
<td>16.6</td>
<td>11.6</td>
<td>4.2</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Body composition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>77.25 (70.20–87.80)</td>
<td>80.18 (70.04–87.43)</td>
<td>74.88 (64.53–84.74)</td>
<td>NS</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>93.20 (84.90–106.08)</td>
<td>93.48 (84.75–104.86)</td>
<td>86.85 (76.33–98.28)</td>
<td>NS</td>
</tr>
<tr>
<td>Waist: hip ratio</td>
<td>0.83 (0.78–0.88)</td>
<td>0.85 (0.80–0.90)</td>
<td>0.86 (0.80–0.91)</td>
<td>NS</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>22.98 (19.31–28.96)</td>
<td>23.53 (19.33–28.64)</td>
<td>21.27 (16.00–25.51)</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td><strong>Lifestyle</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Currently using tobacco, (%)</td>
<td>51.8</td>
<td>53.6</td>
<td>52.0</td>
<td>NS</td>
</tr>
<tr>
<td>Currently using alcohol, (%)</td>
<td>39.2</td>
<td>46.4</td>
<td>36.0</td>
<td>NS</td>
</tr>
<tr>
<td>Physical activity index</td>
<td>2.87 (2.54–3.23)</td>
<td>2.64 (2.28–2.90)</td>
<td>2.66 (2.42–2.92)</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Glycemic status</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plasma glucose (mmol/l)</td>
<td>4.80 (4.30–5.50)</td>
<td>4.90 (4.00–5.50)</td>
<td>5.00 (4.45–5.35)</td>
<td>NS</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>5.50 (5.30–5.80)</td>
<td>5.50 (5.20–5.95)</td>
<td>5.40 (5.03–5.98)</td>
<td>NS</td>
</tr>
<tr>
<td>Diabetic (%)</td>
<td>5.2*a</td>
<td>9.7*a</td>
<td>4.8</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Cardiovascular measurement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>129 (116–146)</td>
<td>144 (130–171)</td>
<td>127 (106–150)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>87 (77–96)</td>
<td>94 (87–108)</td>
<td>80 (72–93)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MAP (mmHg)</td>
<td>100 (91–12)</td>
<td>110 (100–132)</td>
<td>96 (87-111)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BP lowering medication (%)</td>
<td>7.3*a</td>
<td>17.4*a</td>
<td>12.5</td>
<td>0.002</td>
</tr>
<tr>
<td>Framingham risk score</td>
<td>5.0 (3.0–8.0)</td>
<td>10.0 (4.0–16.0)</td>
<td>7.0 (2.5–10.0)</td>
<td>&lt;0.010</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lipid profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDL (mmol/l)</td>
<td>1.41 (1.07–1.87)</td>
<td>1.44 (1.00–1.82)</td>
<td>1.61 (1.22–2.25)</td>
<td>NS</td>
</tr>
<tr>
<td>LDL (mmol/l)</td>
<td>2.77 (2.07–3.64)</td>
<td>2.91 (2.07–3.51)</td>
<td>2.72 (1.71–3.70)</td>
<td>NS</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>1.07 (0.82–1.54)</td>
<td>1.21 (0.88–1.67)</td>
<td>1.06 (0.80–1.49)</td>
<td>NS</td>
</tr>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>4.81 (3.40–5.87)</td>
<td>4.98 (4.33–5.98)</td>
<td>4.54 (3.83–6.51)</td>
<td>NS</td>
</tr>
<tr>
<td>Triglyceride:HDL ratio</td>
<td>0.78 (0.49–1.25)</td>
<td>0.83 (0.55–1.35)</td>
<td>0.62 (0.46–1.21)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Two tailed hypothesis z-test and p-values were calculated between the three groups, only the lowest p-trend was reported between group differences. NS: not significant; HIV: Human immunodeficiency virus; HbA1c: Glycated hemoglobin; SBP: systolic blood pressure; DBP: diastolic blood pressure; MAP: mean arterial pressure; HDL: High density lipoprotein; LDL: Low density lipoprotein
Table 3.2: Point-biserial correlations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-fatal cardiovascular event vs. no cardiovascular event</th>
<th>Fatal cardiovascular event vs. no cardiovascular event</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>rpb-value</td>
<td>p-value</td>
</tr>
<tr>
<td>Age (years)</td>
<td>0.140</td>
<td>&lt;0.010*</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>0.030</td>
<td>NS</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>0.010</td>
<td>NS</td>
</tr>
<tr>
<td>Waist: hip ratio</td>
<td>0.040</td>
<td>NS</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>-0.040</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>-0.020</td>
<td>NS</td>
</tr>
<tr>
<td>Body mass index (kg/m(^2))</td>
<td>0.000</td>
<td>NS</td>
</tr>
<tr>
<td>Framingham risk score</td>
<td>0.130</td>
<td>&lt;0.010*</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>0.140</td>
<td>&lt;0.010*</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>0.100</td>
<td>&lt;0.010*</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>0.130</td>
<td>&lt;0.010*</td>
</tr>
<tr>
<td>Fasting glucose (mmol/l)</td>
<td>0.020</td>
<td>NS</td>
</tr>
<tr>
<td>HbA1c (%)</td>
<td>0.030</td>
<td>NS</td>
</tr>
<tr>
<td>Total cholesterol (mmol/l)</td>
<td>0.000</td>
<td>NS</td>
</tr>
<tr>
<td>HDL-cholesterol (mmol/l)</td>
<td>-0.010</td>
<td>NS</td>
</tr>
<tr>
<td>LDL-cholesterol (mmol/l)</td>
<td>-0.010</td>
<td>NS</td>
</tr>
<tr>
<td>Triglycerides (mmol/l)</td>
<td>0.040</td>
<td>NS</td>
</tr>
<tr>
<td>Triglycerides: HDL ratio</td>
<td>0.050</td>
<td>0.030*</td>
</tr>
</tbody>
</table>

* Association between groups was reported at (p<0.05)

NS: not significant; HbA1c: Glycated hemoglobin; HDL: High density lipoprotein; LDL: Low density lipoprotein

Table 3.3 shows the results of a binary logistic regression analysis, performed in order to determine the most important risk factors to predict a CV event. The enter method variable selection procedure was employed to select the important predictor variables. The statistical importance of the individual regression co-efficient was tested using the Wald chi-square statistic. Age (β= 0.044), education (β=0.645), weighted physical activity index (β=-0.893) and FRS (β=0.038) were found to be important predictors of non-fatal CV events (all p≤0.050), whereas age (β=0.074) and glycated haemoglobin (β=-1.163) were important predictors of fatal CV events (all p≤0.024). Hence, for each increase in age by one year (holding any other variables constant), the odds of developing a non-fatal CV event is 1.045 times higher (or increase by 4.5%) at 95% CI: 1.015-1.077. An increase in age by one year (holding any other variables constant), the odds of developing a fatal CV event is 1.076 times higher (or increases
by 7.6%) at 95% CI: 1.030-1.125. A CV risk assessment was done by means of the FRS and results indicated that for each unit increase in the risk score (holding any other variables constant), the odds of developing a non-fatal CV event is 1.038 times higher (or increased by 3.8%) at 95% CI: 1.001-1.077.

Table 3-3: Maximum likelihood estimates for binary logistic regression of predicting non-fatal and fatal cardiovascular outcome

<table>
<thead>
<tr>
<th>Variables</th>
<th>Non-fatal cardiovascular outcomes</th>
<th>Fatal cardiovascular outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Β</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.044</td>
<td>0.004*</td>
</tr>
<tr>
<td>Education</td>
<td>0.645</td>
<td>0.050*</td>
</tr>
<tr>
<td>Weighted physical activity index</td>
<td>-0.893</td>
<td>0.001*</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg)</td>
<td>0.012</td>
<td>NS</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg)</td>
<td>0.008</td>
<td>NS</td>
</tr>
<tr>
<td>Glycated haemoglobin (%)</td>
<td>-0.427</td>
<td>NS</td>
</tr>
<tr>
<td>Fasting glucose (mmol/l)</td>
<td>0.106</td>
<td>NS</td>
</tr>
<tr>
<td>Framingham risk score</td>
<td>0.038</td>
<td>0.042*</td>
</tr>
<tr>
<td>Blood lowering meds (yes)</td>
<td>-0.550</td>
<td>NS</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.112</td>
<td>NS</td>
</tr>
</tbody>
</table>

*Statistical significant at level p< 0.05; NS: not significant

Adequacy of the models used

Chi-square test results greater than 0.050 indicate that there is no difference between the observed and the models' predicted values and hence estimates of the models adequately fit the data. For non-fatal CV events results were \( \chi^2 = 5.672, df = 8, p = 0.683 \) and for fatal CV events results were \( \chi^2 = 9.683, df = 8, p = 0.279 \).

ROC curve analyses were performed for continuous risk factors associated with both non-fatal and fatal CV outcomes. Only the risk factors with an area greater than 0.550 (marked with an asterisk) were reported and results displayed in the form of ROC curve graphs (Fig 1, Supplementary Table 1, Fig 2). In Figure 3-1, all blood pressures (SBP, DBP and MAP) measures and FRS were found to be likely associated with both fatal and non-fatal CV outcomes. The curve however does not show a clear distinction between the blood pressure measures and the FRS in terms of being the most significant predictor for CV outcomes. Supplementary Table 1 shows that, at higher SBP, DBP, MAP cut-offs, there is a slightly higher specificity or probability to identify participants with a non-fatal CV event. The area under the
curve for these risk factors is fairly good (SBP=0.682, DBP=0.655, MAP=0.676) providing good evidence that blood pressure is indeed an important predictor for non-fatal CV events (P<0.001).

Only FRS had a negligible chance of predicting fatal CV outcomes (Supplementary Table 1). Participants with the highest FRS had a negligible chance of having a fatal CV outcome due to low specificity (area =0.582). All of the risk factors with an area greater than 0.550 were further analysed as shown in Figure 3-2. This was to ascertain their chances of predicting fatal CV events in the future. Although the sensitivity is not strong, Figure 3-2 shows that FRS is more likely to be associated with fatal CV outcomes compared to other risk factors.

![ROC curve](image.png)

**Figure 3-1: ROC curve to estimate the cut-off points of continuous risk factors related to non-fatal CV outcomes**
3.6 Discussion

The main aim of this research was to identify the five-year prognostic value of modifiable risk factors for fatal and non-fatal CV events within a selected group of black South Africans residing in the Dr Kenneth Kaunda District. Not surprisingly, we found that age plays a significant role in the development of both fatal and non-fatal CV events. Participants who suffered fatal CV events were older (average age of 60.43 years) compared to those who have suffered non-fatal CV events (average age of 57.12 years). An interesting finding was that the prevalence of HIV positive participants was higher in those with no cardiovascular events. This finding is in contrast with previous findings by Yarahmadi et al. who found that, due to improvements in curbing communicable diseases like HIV [31] and freely available antiretroviral treatment [32], people are becoming more prone to the development of CVDs because they are now living longer [33]. An increased life expectancy however has been proven to increase the risk of developing CVDs due to physical inactivity and a weakened immune system in older people [34]. CVDs however do not affect only elderly people [35]. Most people suffer from CVDs in their youth ages as a result of poor lifestyle choices and proceed with these CVDs into adulthood. Their immune system is still stronger when they do have a CV episode at a younger age and this may therefore result in a non-fatal event [34, 36].
Rural areas reported a higher prevalence of fatal CV events whereas urban areas reported high non-fatal CV events. These results agree with the findings from Subramanian et al. [37] who reported that CV-related mortalities were higher in rural than in urban communities. Other studies also reported that although CV-related mortalities were found to be higher in rural than in urban communities, the risk-factor burden was higher in the urban than in the rural communities in the countries included in their studies [37, 38]. The reason for this status quo could be the difficulty in accessing preventative health care programmes and the fact that health care services generally remain substantially underdeveloped [39]. In addition, rural populations generally tend to be poorer than their urban counterparts, which make them more vulnerable to social determinants of health and less likely to have the means to access care [40]. Some barriers that are faced by people in the rural communities of South Africa and which could have an impact on the high CV mortality rates reported in these areas have been listed: (1) cost and time for patients travelling long distances to access services are more significant for rural people, (2) cost and time of conducting outreach services and the resulting need for more health-care workers per capita compared to urban areas, are higher, (3) diseconomies of scale exists, making the cost of delivering services per capita higher, (4) ambulances take longer to reach patients, (5) healthcare workers may be reluctant to live in rural areas as these are often far from desirable amenities (schools, banks, malls, gyms, etc.) and (6) fewer opportunities exist for employment of other family members, e.g. spouses [41].

This current study also found a positive relationship between education and CV events. From this finding, it can be assumed that educated people will be more likely to reside in urban areas where the socio-economic status is higher compared to that in the rural areas [42]. Educated individuals tend to have relatively greater knowledge about disease conditions compared with to those uneducated [41]. Education also plays a role in the socio-economic status of people; people who are better educated have more opportunities than those who are not and that impact on the quality of life of an individual [42]. Health literacy and knowledge of cardiovascular risk factors may encourage people to make behavioural changes and thereby improve risk factors within the communities [41, 42].

High blood pressure is an important modifiable risk factor in black people [43]. We found all blood pressure measurements (SBP, DBP and MAP) to be important risk factors for CV events. Further analysis using the point-biserial correlation methods revealed that SBP is the most significant modifiable predictor for non-fatal CV events. The importance of SBP in this study agrees with other studies that have highlighted SBP as a crucial indicator of increased risk of CVD, particularly in the elderly stages, compared to DBP [43]. Other studies, however, state
that both SBP and DBP are important measures of CV risk, but at different ages of an individual [44, 45]. DBP has been found to rise until approximately age 50, then tend to level off over the next decade and may remain the same or decrease further later in life, whereas SBP continues to rise throughout life [44]. DBP therefore seem to be a more potent CV risk factor than SBP until the age of 50 and thereafter, SBP becomes more important [45]. This is an important finding in sub-Saharan Africa, particularly in South Africa, where the life expectancy has been increasing beyond the age of 50 [46]. There are progressive changes in the structure and function of the heart and arteries that occur throughout life. Such changes may include intima-media thickening, increased stiffening and reduced distensibility of the central arteries [47]. These changes start to become significantly visible generally after the age of 35 years [43].

The association of CV events with anti-hypertensive medication use that we found as reported in Table 3-1 may suggest that influences other than traditional risk factors, are important in determining outcomes in this area of study. Possible contributing factors could include access to and affordability of health services and medications, thresholds for diagnoses and treatments and the educational level of the population [48]. There may be greater differences between urban and rural communities in the educational level of the population, as well as in the access to, quality and affordability of health care, which may contribute to higher rates of death from CVDs in rural areas, despite a lower risk factor burden [36, 39].

In the Framingham study, researchers examined nearly 5,000 untreated hypertensive men and women, aged on average 58 years [49]. They determined each person's blood pressure stage using both SBP and DBP according to prescribed guidelines [50]. Researchers then compared these blood pressure stage classifications with those obtained from using either SBP or DBP only, to see which method would come closest to the JNC VI stage classification [49]. They found that SBP alone correctly classified the blood pressure stage in about 96% of patients, while DBP alone classified only 68% of patients correctly. Among patients older than 60 years, researchers found that SBP alone correctly classified 99% of patients, whereas DBP alone correctly classified only 47% [50]. However, in their conclusion, the Framingham Heart Study researchers agreed that both measurements were important in identifying and treating patients with high blood pressure, but suggested that future blood pressure treatment guidelines might consider a greater emphasis on SBP [49].
Our results from ROC curve analyses further identified all blood pressure measurements (but most importantly SBP) and the FRS as important predictors for non-fatal CV events. These findings add to the longstanding knowledge that the control of high blood pressure and its risk factors deserves attention in the black population [48]. Results from this study indicated that the FRS is also suitable for prediction of future fatal CV events in black populations, as opposed to only Caucasians, as mentioned in other studies [48, 49].

3.7 Study limitations
There are limitations to this study that should be recognised. Considering that data was collected at different intervals, there could have been issues with missing data. Some variables did not show a normal distribution and the median with interquartile ranges had to be reported instead of the mean and standard deviation. The sampling framework was not nationally representative and therefore the information from this study cannot be used as a representative of the status of the country. However, this study could be used as a guide for future studies. The findings from this study have an impact on the community and primary healthcare practice, research, education and policy development that may contribute to primary prevention and control of the prevalence of CVDs in South Africa.

3.8 Conclusion
In conclusion, we found that high blood pressure has a significant prediction value in this population under study. The finding of having a higher level of education in the no CV events group compared to the fatal CV events group further emphasizes the importance of health education to this population. Health promotion on CVD risk factors prevention and management will benefit this population.

3.9 Acknowledgements
The authors would like to thank all supporting staff and the participants of the PURE study and in particular:

1. **PURE-South Africa**: Prof A Kruger (posthumous), Prof. M Greeff, Ms PG Molaudzi, Dr. IM Kruger, Ms V Kruger, Ms J Brits, Ms Paula Jardim working in the Africa Unit for Transdisciplinary Health Research (AUTHeR), Faculty of Health Sciences, North-West University, Potchefstroom, South Africa, as well as all the field workers over the years. Me Melissa Maritz (Hypertension in Africa Research Team) for her contribution towards finalising the mortality data.
2. **PURE International**: Dr. S Yusuf and the PURE project office staff at the Population Health Research Institute (PHRI), Hamilton Health Sciences and McMaster University. ON, Canada.

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3.10 **Disclosure**

All authors declared no conflict of interest.
3.11 References


DOI:10.7196/SAMJ.8369


Supplementary table 1: Area under ROC curves to estimate accuracy of continuous risk factors related to cardiovascular outcomes

<table>
<thead>
<tr>
<th>Non-fatal cardiovascular outcomes</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables</td>
<td>Area</td>
<td>Std. Error^a</td>
<td>Asymptotic p-value^b</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>---------</td>
<td>--------------</td>
<td>----------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg);</td>
<td>0.682*</td>
<td>0.033</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg);</td>
<td>0.655*</td>
<td>0.032</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg)</td>
<td>0.676*</td>
<td>0.033</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Framingham risk score</td>
<td>0.670*</td>
<td>0.034</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Blood pressure lowering meds</td>
<td>0.551</td>
<td>0.038</td>
<td>0.154</td>
</tr>
</tbody>
</table>

**Fatal cardiovascular outcomes**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Area</th>
<th>Std. Error^a</th>
<th>Asymptotic p-value^b</th>
<th>Asymptotic 95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Systolic Blood Pressure (mmHg);</td>
<td>0.477</td>
<td>0.068</td>
<td>0.701</td>
<td>0.345</td>
</tr>
<tr>
<td>Diastolic Blood Pressure (mmHg);</td>
<td>0.427</td>
<td>0.063</td>
<td>0.219</td>
<td>0.304</td>
</tr>
<tr>
<td>Mean arterial pressure (mmHg);</td>
<td>0.447</td>
<td>0.063</td>
<td>0.371</td>
<td>0.324</td>
</tr>
<tr>
<td>Framingham risk score</td>
<td>0.582*</td>
<td>0.058</td>
<td>0.165</td>
<td>0.469</td>
</tr>
<tr>
<td>Blood pressure lowering meds</td>
<td>0.526</td>
<td>0.062</td>
<td>0.661</td>
<td>0.405</td>
</tr>
</tbody>
</table>

* area under curve above 0.55 has chance of causing future non-fatal cardiovascular diseases
a. Under the nonparametric assumption
b. Null hypothesis: true area = 0.5
CHAPTER 4
Summary of main results, limitations, conclusions and recommendations.

4.1 Introduction
In this chapter, the researcher reflects on the findings by means of an evaluation of the objectives set in Chapter 1. The limitations encountered during the study are discussed, followed by recommendations for individual, family, workplace and community.

4.2 Evaluation of the study and conclusions
The main aim of this study was to identify the most significant modifiable risk factors for cardiovascular events within a selected group of black South Africans residing in the Dr Kenneth Kaunda District. Furthermore, the study sought to determine possible changes in the order of significance of these risk factors over a period of five years. To achieve the aim of the study, four objectives were set. Firstly, to determine the frequency of non-fatal cardiovascular events (angina pectoris, myocardial infarction, stroke and heart failure) in terms of prevalence and incidence over a period of five years within a selected group of black South Africans residing within the Dr Kenneth Kaunda District. Secondly, to determine the frequency of fatal cardiovascular events (angina pectoris, myocardial infarction, stroke and heart failure) in terms of prevalence and incidence over a period of five years within the same population. Thirdly, to determine the most significant cardiovascular risk factors (age, gender, locality, smoking, alcohol consumption, blood pressure, body composition, glycaemic status, lipids and physical activity) associated with non-fatal cardiovascular events over a five-year period. Fourthly, to determine among the same risk factors mentioned which are the most significant that are associated with fatal cardiovascular events over a five-year period.

The objectives of the study were obtained. This study found the most important risk factors within this population were age, locality, education and hypertension (high blood pressure). Our study found that age contributes to whether an individual has fatal or non-fatal cardiovascular events. Younger participants were found to have non-fatal cardiovascular events while the older participants suffered more from fatal cardiovascular events. Non-fatal cardiovascular events were also more prevalent in urban participants as opposed to fatal cardiovascular events. The reason for this outcome may be that the urban area has better access to health facilities and information or education on how to manage the disease once affected, so that it does not become fatal. The use of antihypertensive medication is very important particularly in the black population where the prevalence of hypertension is normally high (Schutte et al., 2017) as our
study also confirmed. This research confirmed other studies that reported using antihypertensive medication can delay the progression from non-fatal to fatal cardiovascular events. In order to achieve this, education on the use of antihypertensive medication and adherence are very important (Schutte et al., 2017; Salinas et al., 2015).

The use of questionnaires to collect data was appropriate. However, there were challenges in getting clear answers from participants because some questions had to be translated from English to the participant’s preferred language. Data on whether participants had been medically diagnosed with CVD events (angina pectoris, myocardial infarction, stroke and heart failure) was self-reported. Some participants had limited education to answer this question satisfactorily and information on some participant’s clinical cards was insufficient to support the reports. This posed a challenge because full information on patients’ medical history is kept in a file at the health centre premises where participants attend treatment and is not taken home. To remedy this, all the reported CVD events along with available supporting documents were sent to a medical doctor to adjudicate and verify each participant’s case and assign ICD-10 codes were appropriate.

4.3 Limitations, adjustments and confounding

When doing research, it is important to evaluate the reliability and validity of the study. This is important because the research objectives can be answered incorrectly because of a methodology flaw. Therefore, it is crucial to acknowledge these threats and issues so that the research results can be interpreted usefully. Although the research was well designed, followed a strict protocol and was carried out under controlled conditions. There were limitations requiring recognition in this study. Data for this study was collected at different intervals; there could have been issues with missing data. During statistical analysis some variables did not show normal distribution then the median with interquartile ranges had to be reported instead of mean and standard deviation. Multiple adjustments were made for known confounders in regression analyses. These adjustments may have caused over- or underestimation of the associations observed between cardiovascular event outcomes and categorical risk factors. The sampling framework was not nationally representative and therefore the information from this study cannot be used a representative of the status of the country. We suggest further studies with larger population samples to ensure generalisation in the wider population. The findings of our study may, however, lead to practical and educational implications for health care workers in community and primary healthcare settings in both rural and urban areas. It clearly demonstrates the need for effective community-based prevention and education programs.
4.4 Recommendations

Based on the finding of the study recommendations are made following holistically using the socio-economic model focusing on different spheres of life in a table below.
Table 4-1: Recommendations for health promotions cardiovascular risk factors

<table>
<thead>
<tr>
<th>Health promotion action</th>
<th>Individual</th>
<th>Family</th>
<th>Work environment</th>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Empowerment of people</strong></td>
<td>• Empower individuals through health education towards self-care about the importance of eating healthy food and teaching them about food that can cause cardiovascular diseases.</td>
<td>• Families, especially mothers since they are generally responsible for shopping and feeding their families, can be empowered through health education about food preparation, regarding the amount of salt, making fruits and vegetables part of every day’s diet.</td>
<td>• Increase awareness through education on risk factors and behaviours that may lead to cardiovascular diseases, e.g. spending too much time sitting while working which lead to obesity and other heart diseases.</td>
<td>• Identify health skills and knowledge gaps within communities and implement education and training programmes to bridge these gaps between communities and the health sector.</td>
</tr>
<tr>
<td></td>
<td>• Individuals already affected by risk factors such as hypertension should be educated about the benefits of adherence to treatment.</td>
<td></td>
<td></td>
<td>• Target populations in several community locations (e.g. schools, church and clinics) to teach community members about cardiovascular diseases and their risk factors.</td>
</tr>
<tr>
<td><strong>Strengthening of health systems</strong></td>
<td>• Early identification of risk factors such as hypertension, blood glucose, BMI status could be performed through screening programmes when patients attend clinics. This can lead to health and risk awareness for disease.</td>
<td>• Support the ward based outreach teams targeted at households to educate patients on the prevention and promotion of cardiovascular health. Activate self-care support groups for all members of the family to attend in the event of one family having a cardiovascular disease.</td>
<td>• Working organisations to support cardiovascular health promotion through regular screening opportunities as part of employee wellness initiatives.</td>
<td>• National awareness campaign about the role of cardiovascular health promotion as an essential part of public and private healthcare in South Africa.</td>
</tr>
<tr>
<td></td>
<td>• Wellness campaigns can also contribute to health screening and awareness of one’s own health status.</td>
<td></td>
<td></td>
<td>• Healthcare facilities to activate cardiovascular health promotion by means of post-discharge adherence clubs.</td>
</tr>
<tr>
<td></td>
<td>• Establish each patient with a cardiovascular</td>
<td></td>
<td></td>
<td>• Promote the message that the patient, through active self-care, is the primary collaborator with the health systems, in the management of his/her cardiovascular health.</td>
</tr>
<tr>
<td>Advocacy</td>
<td>• Voice the inability of the poor to afford healthy food when they cannot event afford any type of food.</td>
<td>• Promote the marketing of fresh food as part of balanced family meals against the detrimental impact of fast foods.</td>
<td>• Employers to advocate healthy lifestyles by its employees for example by allowing employees time to do short exercises like Tabatha workout which takes 10 minutes and can be done in the boardroom. • Workplace canteen to prepare healthy menus for staff members.</td>
<td>• National marketing campaign given citizens basic information on the actual risks associated with fast foods versus that of home-made fresh food.</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Policy</td>
<td>• Increase price of Tobacco and alcohol through legislature. • Subsidise fruits and vegetables.</td>
<td>• Limit advertisements of alcohol and cigarettes.</td>
<td>• Work with the private sector and labour unions to promote healthy lifestyle practices within the workplace. This includes promoting physical activity, smoking cessation programmes. • Ensuring that health screening services are available for cardiovascular disease risk factors such as diabetes, hypertension, obesity.</td>
<td>• Promote healthy living through television, radio and health campaigns that are cultural congruent and aimed at behaviour change.</td>
</tr>
<tr>
<td>Control over environment</td>
<td>• Make individual aware of habits, activities or places in their environment that encourage them to lead unhealthy lifestyles and how to avoid them, for example the affordable yet unhealthy vetkoek</td>
<td>• Support families to build upon their strengths to support one another and grow towards improved cardiovascular health, for example gardening together for exercise and food security, motivating</td>
<td>• Limit number of smoking areas in the workplaces and have laws against public smoking. • Build gymnasiums at workplaces to increase accessibility of health facilities.</td>
<td>• Work together with community members to identify factors (i.e. language, cultural trends, religious beliefs, social class, literacy and education) that may encourage unhealthy behaviour and find realistic and sustainable ways of</td>
</tr>
</tbody>
</table>
| sold by a street food vendor covered with monosodium glutamate.  
- Build structures such as gym parks where an individual can easily access them in their local surrounding without paying, therefore being accessible. | family members and accompany family members to exercise and eat healthy. | overcoming such behaviours and start practicing healthy lifestyles.  
- Team up with other community members to exercise together. |
4.5 Summary

This chapter offered a reflection on the objectives by means of an evaluation of the study. Limitations and recommendations were also provided. To conclude, age, being educated, locality (whether rural or urban), are very important in the outcome of participant; whether they may be affected with non-fatal or fatal cardiovascular events. Empowering communities to adhere to using antihypertensive medication and to be aware of the risk factors that may lead them to cardiovascular diseases is crucial in order for them to prolong their lives and possibly make decisions to change their lifestyle habits. To conclude: “Luckily we know the answer. Unluckily, we often lack the willpower to change our lifestyles” (Opie, 2011:31).
4.6 References


4.7 Addendum A

Ethics approval certificate of study

NORTH-WEST UNIVERSITY
Private Bag X6001, Potchefstroom,
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Tel: (018) 259-4900
Fax: (018) 259-4910
Web: http://www.nwu.ac.za
Institutional Research Ethics Regulatory Committee
Tel: +27 18 259 4849
Email: Ethics@nwu.ac.za

2016/09/02

ETHICS APPROVAL CERTIFICATE OF STUDY

Based on approval by Health Research Ethics Committee (HREC), after being reviewed at the meeting held on 13/07/2016, the North-West University Institutional Research Ethics Regulatory Committee (NWU-IREC) hereby approves your study as indicated below. This implies that the NWU-IREC grants its permission that provided the special conditions specified below are met and pending any other authorisation that may be necessary, the study may be initiated, using the ethics number below.

Study title: Cardiovascular diseases and associated risk factors in a selected group of black South Africans.

Study Leader/Supervisor: Dr IM Kruger
Student: JT Kganakga

Ethics number: NWU-000077-16-A1

Application Type: Single study
Commencement date: 2016-08-26

Continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation up to a maximum period of three years.

Special conditions of the approval (if applicable):
- Translation of the informed consent document to the languages applicable to the study participants should be submitted to the HREC (if applicable).
- Any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the HREC. Ethics approval is required BEFORE approval can be obtained from these authorities.

General conditions:
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following:
- The study leader (principal investigator) must report in the prescribed format to the NWU-IREC via HREC:
  - annually (or as otherwise requested) on the monitoring of the study, and upon completion of the study;
  - without any delay in case of any adverse event or incident (or any matter that interrupts sound ethical principles) during the course of the study.
- Annually a number of studies may be randomly selected for an external audit.
- The approval applies study to the proposal as stipulated in the application form. Would any changes to the proposal be deemed necessary during the course of the study, the study leader must apply for approval of these amendments at the HREC, prior to implementation. Would there be deviation from the study proposal without the necessary approval of such amendments, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the study may be started.
- In the event of ethical responsibility the NWU-IREC and HREC retains the right to:
  - request access to any information or data at any time during the course or after completion of the study;
  - to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.
  - withdraw or postpone approval if:
    - any unethical principles or practices of the study are revealed or suspected;
    - it becomes apparent that any relevant information was withheld from the HREC or that information has been false or misrepresented, the required amendments, annual (or otherwise stipulated) report and reporting of adverse events or incidents was not done in a timely manner and accurately.

The IRERC would like to reiterate at your service as scientist and researcher, and wishes you well with your study. Please do not hesitate to contact the IRERC or HREC for any further enquires or requests for assistance.

Yours sincerely

Prof LA Du Plessis

Date: 2016.09.05
17:27:52 +02'00'

Prof Linda du Plessis
Chair NWU Institutional Research Ethics Regulatory Committee (IRERC)
We are very grateful to you for your participation in this study. All information given by you will be held in strict confidence, and will be used for the purpose of this study only after removing any personal identifying information.

Adult Questionnaire

INSTRUCTIONS

Please answer EACH question by marking an X in ONE BOX on each line:
(unless otherwise instructed)

X

OR

By writing number(s) in the spaces provided:

1 8

OR

By specifying the answer on the line(s) provided

April 28, 2005
Subject ID
Centre #  Community #  Household #  Subject #

Today's date:  
year  month  day

1. Name: ____________________________  ____________________________
   Given name  Surname

2. Not applicable in South Africa

3. National identity # or equivalent: ____________________________  N/A  

4. DOB:  
year  month  day  OR  Age  yrs

5. Sex:  □ Female  □ Male

6. Marital status:  (check one only)
   □ Never married  □ Currently married  □ Common law/Living with partner
   □ Widowed  □ Separated  □ Divorced

7. Ethnicity:  □□□□□□  (Please refer to facing page for codes)

8. Caste/Tribe:  ____________________________

9. What level of formal education have you completed?  (check highest level only):
   □ None
   □ Primary
   □ Secondary/highschool/higher secondary
   □ Trade School
   □ College/University
   □ Unknown
Adult Questionnaire

11. Occupation

**Group 1: Legislators, senior officials and managers**
- Legislators and senior officials
- Corporate managers
- General managers
- Businessman

**Group 2: Professionals**
- Physical, mathematical and engineering science professionals
- Life science and health professionals
- Teaching professionals
- Other professionals

**Group 3: Technicians and associate professionals**
- Physical, mathematical and engineering-science associate professionals/technicians
- Life science and health associate professionals/technicians
- Teaching associate professionals/technicians
- Other associate professionals/technicians

**Group 4: Clerks**
- Clerks
- Customer service clerks

**Group 5: Service workers and shop and market sales workers**
- Personal and protective services workers
- Models, salespersons and demonstrators

**Group 6: Skilled agricultural and fishery workers**
- Market-oriented skilled agricultural and fishery workers
- Subsistence agricultural and fishery workers

**Group 7: Craft and related trade workers**
- Extraction and building trade workers
- Metal, machinery and related trades workers
- Precision, handicraft, printing and related trades workers
- Other craft and related trades workers

**Group 8: Plant and machine operators and assemblers**
- Stationary plant and related operators
- Machine operators and assemblers
- Drivers and mobile plant operators

**Group 9: Elementary occupations**
- Sales and services elementary occupations
- Agricultural, fishery and related labourers
- Labourers in mining, construction, manufacturing and transport

**Group 10: Armed forces**
- Armed forces

**Group 11: Homemaker**
- Housewife/Househusband
Subject ID

Centre #  Community#  Household #  Subject #  Subject Initials F  M  L

10. Not applicable in South Africa

11a) Not applicable in South Africa

b) Please indicate which group best describes your main occupation.
   (Please refer to facing page for definitions of groups and Instruction manual for detailed definitions)

☐ Group 1  ☐ Group 2  ☐ Group 3  ☐ Group 4  ☐ Group 5
☐ Group 6  ☐ Group 7  ☐ Group 8  ☐ Group 9  ☐ Group 10  ☐ Group 11

c) Not applicable in South Africa

d) What is your main source of income? ____________________________________________

If occupation is group 11 (homemaker) go to question 13

12. Are you currently employed?

☐ No → (answer 12a - 12b)  ☐ Yes → Go to #13

a) Are you retired/stopped work from your primary occupation due to old age?  ☐ No  ☐ Yes

b) Have you stopped working due to illness?  ☐ No  ☐ Yes
Subject ID

Centre #  Community #  Household #  Subject #

Subject Initials F  M  L

13. CURRENT DISABILITY:

a) Do you have any problems using your fingers to grasp or handle?  

b) Do you have any trouble walking about?  

c) Do you have any trouble bending down and picking up an object from the floor?  

d) Do you require a walking stick cane/walker to move about?  

e) Do you have any trouble reading or seeing the individual grains of rice/corn on your plate? (with glasses worn)  

f) Do you have trouble seeing a person from across the room? (12 feet/3.5 meters) (with glasses worn)  

g) Do you have trouble speaking and being understood?  

h) Do you have any trouble hearing what is said in a normal conversation?  

Subject Medical History

14. Have you experienced any of the following in the last six months?

a) Chest pain or tightness with usual activity  
   If Yes, does the pain spread to the back, neck or inner border of arm

b) Breathlessness with usual activity

c) Cough for at least 2 weeks

d) Any sputum while coughing

e) Blood in sputum

f) Wheezing or whistling in the chest

g) Early morning cough with chest tightness

h) Loose stools/diarrhea for at least 3 days

i) Vomiting

j) Loss of appetite

k) Painful or bleeding teeth/gums

l) Jaundice

m) Burning while passing urine

n) Swelling of feet

o) Swelling of face

p) Blood in urine

q) Involuntary weight loss of > 3kg

15. Not applicable in South Africa

16a) Do you use glasses/spectacles/contact lenses at present?  
   No  Yes

b) Do you use a hearing aid?  
   No  Yes
Adult Questionnaire

Cancer Sites

1 = Mouth
2 = Esophagus
3 = Stomach
4 = Small intestine
5 = Large intestine including rectum
6 = Pancreas
7 = Liver
8 = Lung
9 = Breast
10 = Cervical/uterine/ovarian
11 = Prostate
12 = Head and neck
13 = Other, specify
17. Have you ever been diagnosed with any of the following? (check all that apply)

a) Diabetes
b) Hypertension/high blood pressure
c) Stroke
d) Angina/heart attack/Coronary artery disease
e) Heart failure
f) Other heart disease
h) Hepatitis/Jaundice
g) Cancer

Please refer to facing page for cancer sites

No Yes # of yrs since diagnosis

i) COPD
j) Asthma
k) Tuberculosis
l) Malaria
m) Chagas
n) HIV/AIDS

Not answered

18. Have you been taking any medications regularly (i.e. at least once per week) in the last month?

□ No → go to 19 □ Yes

a) If yes, for what conditions:

Blood pressure
Cholesterol lowering drugs
Stroke
Diabetes
Asthma
Chinese medicine
Others
Unknown

□ □ □ □ □ □ □ □

If Yes, specify ____________________________
Adult Questionnaire

18b) If name of medication is unknown, please list as unknown.
18b) List all the medications you are currently consuming at least once a week for the last month?

i) 

ii) 

iii) 

iv) 

v) 

vi) 

vii) 

viii) 

Men go to question #23

For Women Only (Questions 19 - 22)

19. Are you currently pregnant?  □ No  □ Yes → Go to #21

20. Do you still have periods?  □ No → (answer 20a)  □ Yes → Go to #21

21a) How many years since you stopped menstruating?  □ □ years

21. Have you ever used an oral/ injectable contraceptive?  □ No  □ Yes

22a) How many live children have you given birth to?  □ □ Boys  □ □ Girls

b) Did you breast feed any of your children?  □ No  □ Yes
Adult Questionnaire

23. Accidents and Injuries

Location of Injury
1 = Factory/industrial place
2 = Office
3 = Agriculture field/farm
4 = Home
5 = Road
6 = Sport/game e.g. track, court, field, etc.
7 = Public building
8 = Mine/quarry
9 = Construction site e.g. building, road-works, etc.
10 = Other

Type of Injury
1 = Burns
2 = Scalds
3 = Fractures
4 = Muscle and ligament sprains/tears
5 = Cuts and lacerations
6 = Bruises and abrasions
7 = Suffocation
8 = Head injury (where person did not lose consciousness)
9 = Head injury (where person lost consciousness for some time)
23. During the past 12 months, have you had any injuries that were serious enough to limit your normal activities? (check all that apply)

<table>
<thead>
<tr>
<th>If yes, please provide details:</th>
<th>Location</th>
<th>Type</th>
<th>Absence from work or usual activities (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Motor vehicle accident (as a passenger)</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>b) Motor vehicle accident (as a pedestrian)</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>c) Struck by an object</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>d) Explosion</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>e) Natural/environmental factors (gales/cyclones/lightning, etc.)</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>f) Suffocation</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>g) Poisoning</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>h) Snake/scorpion bite</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>i) Fall</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>j) Fire/Flames, resultant burns</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>k) Physical assault (gun, kidnapping, etc.)/violent crime</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>l) Domestic violence (beaten by a family member)</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>m) Drowning/submersion</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>n) Hot or corrosive liquids/floods/substances</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>o) Crush injuries (boulders, building materials, etc.)</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>p) Accident caused by machinery</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>q) Attempted suicide</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>r) Armed conflict</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
<tr>
<td>s) Other(specify): ____________________________</td>
<td>No ☐</td>
<td>☐ Yes</td>
<td>☐</td>
</tr>
</tbody>
</table>
Location of Fractures
1= Hip/pelvis
2= Thigh
3= Leg
4= Forearm
5= Wrist
6= Hand/finger
7= Vertebrae (back)
8= Other

Fractures: In situations where subjects are in a cast and cannot differentiate between ligament tear or fracture, include as fracture only if doctor confirmed it as a broken bone.

25c) Tobacco: Regular use is defined as consuming at least one tobacco product per day.

Duration of use:
For those that have consumed tobacco for <1 year, please enter "0"
Subject ID

Centre #  Community#  Household #  Subject #  Subject Initials  F  M  L

**Question 26 to be answered by non-smokers and former smokers only**

26. During the past 12 months, have you been regularly (at least once per week) exposed to other people's tobacco smoke?
   (*"Exposed" is defined as a minimum of 5 consecutive minutes, during which you inhale other people's smoke.*)

   □ No  → Go to #27  □ Yes  → Please answer questions 26a

a) Over the past 12 months, what has been your typical exposure to other people's smoke?
   (*"Exposed" is defined as a minimum of 5 consecutive minutes, during which you inhale other people's smoke*)
   Select ONE only

   □ 1-2 times/week  □ 3-6 times/week  □ at least once a day  □ 2-3 times/day  □ 4 or more times/day

27. Not applicable in South Africa

<table>
<thead>
<tr>
<th>Past users only</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average amount/day</strong></td>
</tr>
<tr>
<td>(i) Cigarettes (all kinds)</td>
</tr>
<tr>
<td>(ii) Beedies</td>
</tr>
<tr>
<td>(iii) Cigars</td>
</tr>
<tr>
<td>(iv) Pipes</td>
</tr>
<tr>
<td>(v) Sheesha/water pipe Hookah</td>
</tr>
<tr>
<td>(vi) Chewing tobacco</td>
</tr>
<tr>
<td>(vii) Snuff</td>
</tr>
<tr>
<td>(x) Other</td>
</tr>
</tbody>
</table>
28c) Alcoholic Beverage: Regular use is defined as at least once a month.
28. Which best describes your history of alcohol use?

a) [ ] Formerly used alcohol products    [ ] Currently use alcohol products    [ ] Never used alcohol products  Go to #29

b) At what age did you start? [ ] yrs

c) What forms of alcohol have you regularly used? (check all that apply)

<table>
<thead>
<tr>
<th>Form of Alcohol</th>
<th>Approx. size of one “drink”</th>
<th>Frequency</th>
<th>Average # of drinks</th>
<th>Duration (years)</th>
<th>Past users only When Stopped (years ago)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Spirits (rum, whisky, gin, vodka etc)</td>
<td>30ml</td>
<td>Daily</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Wine</td>
<td>125ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vi) Beer</td>
<td>375ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vii) Country liquor (arrack, sugar cane spirit)</td>
<td>30ml</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

29. a) During your longest or nocturnal sleep period, what time do you normally go to bed? [ ] (00:00-23:59)

b) During your longest or nocturnal sleep period, what time do you normally wake up? [ ] (00:00-23:59)

c) Do you usually take naps/siestas? [ ] No    [ ] Yes  Total nap duration [ ] mins

d) At least once a month, do you consume >5 alcoholic drinks/day? [ ] No  Go to #29  [ ] Yes  If yes, (i, ii)

i) How many times per month do you consume >5 alcoholic drinks in a day?

ii) What is the average number of drinks that you consume each time?
Adult Questionnaire

33. **Civic organization:** are defined as non-profit, voluntary organization societies, self help groups and clubs.

   **Religious organization:** are defined as different types of formal and informal groups set up on a religious basis.
30. Are you a member of any of the following: How often do you participate in the activities of this group? (choose only one option for each)

(i) Self help group, Co-operative, Social club, Sports club, □ No □ Yes → □ □
(ii) Religious Group (e.g: church group, etc.) □ No □ Yes → □ □
(iii) Other Specify □ No □ Yes → □ □

31. Please answer the following: (choose only one option for each)

(i) People are generally honest and want to help others. □ Strongly Disagree □ Somewhat Disagree □ Somewhat Agree □ Strongly Agree
(ii) If I do nice things for someone, I can anticipate that they will respect me and treat me just as well as I treat them. □ □ □ □

32a) The television, radio, newspaper or magazine advertisements help me decide to buy the type of: (choose only one option for each)

(i) Cooking oil □ □ □ □
(ii) Flour □ □ □ □
(iii) Rice/ Maize meal □ □ □ □

b) The television, radio, newspaper or magazine advertisements influence whether I buy: (choose only one option for each)

(i) Soft drinks □ □ □ □
(ii) Snacks □ □ □ □
(iii) Cigarettes □ □ □ □
(iv) Alcohol □ □ □ □

33. In a difficult situation, whose help can you count on from? (Please see facing page for definitions)

(i) Civic organizations: specify ____________________________
   □ none □ little □ moderate/average □ a great deal

(ii) Religious organizations: specify ____________________________
    □ none □ little □ moderate/average □ a great deal
34. Have you experienced any of the following events during the last 12 months?

<table>
<thead>
<tr>
<th>Event</th>
<th>No response</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Loss of job</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii) Retirement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii) Loss of crop/business failure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iv) Household break in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(v) Marital separation/divorce</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vi) Other major intra-family conflict</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(vii) Major personal injury or illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(viii) Violence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ix) Armed conflict/war</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(x) Death of a spouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xi) Death/major illness of another close family member</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xii) Other major stress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xiii) Wedding of family member</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xiv) New job</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xv) Birth in the family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xvi) Separation from family</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(xvii) Unavailability of food/food insecurity</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please specify ________________________________

Please specify ________________________________
35. Please answer the following: (Choose only one option for each)

For the following question, stress is defined as feeling irritable or filled with anxiety, or as having sleeping difficulties as a result of conditions at work or at home.

<table>
<thead>
<tr>
<th></th>
<th>No response</th>
<th>Never Experienced Stress</th>
<th>Some Period of Stress</th>
<th>Several Periods of Stress</th>
<th>Permanent Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) How often have you felt stress at work in the last 12 months?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(Mark here if not applicable: i.e. no longer working ☐)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) How often have you felt stress at home in the last 12 months?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

36. What level of financial stress have you felt in the last 12 months?

☐ No response ☐ Little/none ☐ Moderate ☐ High/severe

37. During the past twelve months, was there ever a time when you felt sad, blue, or depressed for two weeks or more in a row?

☐ No ☐ Yes → If yes, during those times, did you:

<table>
<thead>
<tr>
<th></th>
<th>No response</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Lose interest in most things like hobbies, work or activities that usually give you pleasure?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Feel tired or low on energy?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) Gain or lose weight?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) Have more trouble falling asleep than you usually do?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e) Have more trouble concentrating than usual?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f) Think a lot about death (either your own, someone else’s, or death in general)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g) Feel down on yourself, no good or worthless?</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
38. Please answer the following: (Choose only one option for each)

<table>
<thead>
<tr>
<th></th>
<th>Strongly Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) I can do most of my regular shopping (food, household necessities, etc.) at stores within easy walking distance (less than 15 minutes) of my home.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b) Walking or bicycling in my neighbourhood is difficult because of the speed and/or amount of traffic.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c) My neighbourhood is generally free from pollution (litter, air pollution and noise pollution).</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d) My neighbourhood streets are well lit at night.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e) I can see other people when I am walking in my neighbourhood.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f) I can speak to other people when I am walking in my neighbourhood.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g) There is a high crime rate in my neighbourhood.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>h) There is a problem with unattended dogs in my neighbourhood.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
38a) Please answer the following: (Please check all that apply)

i) Has your household been a victim of the following crime(s) in the last 12 months?

1. Armed robbery  
2. Violent attacks  
3. Murder  
4. Vehicle hijacking  
5. House breaking  
6. Theft  
7. Rape  
8. Women abuse eg. (beat, swear-words, sexual)  
   please specify ____________________________  
9. Child abuse eg. (burn, swear-words, rejection)  
   please specify ____________________________  
10. Child sexual abuse  
11. Other, please specify ______________________

ii) Do you think that crime in your area has increased in the past 5 years?  
   No  Yes

   if yes, which of the following crime(s)?
   
   □ Armed robbery  
   □ Violent attacks  
   □ Murder  
   □ Vehicle hijacking  
   □ House breaking  
   □ Theft  
   □ Rape  
   □ Women abuse  
   □ Child abuse  
   □ Child sexual abuse  
   □ Other, please specify ____________________________
38b) Questions on HIV:

i) Do you know people who have HIV/AIDS?  ☐ No  ☐ Yes
   If yes, which of these people: (please mark all that apply)
   ☐ Your children
   ☐ Your grandchildren
   ☐ Your spouse
   ☐ Your family members
   ☐ Your friends
   ☐ People in the community

ii) What would you consider the mean age of the people who are ill/have died of HIV/AIDS?
   ☐ Younger than 10 years  ☐ Between 11-20 years  ☐ Between 21-30 years
   ☐ Between 31-40 years  ☐ Between 41-50 years  ☐ Over 50 years

iii) If someone in your household is HIV positive, who is the primary caregiver?
   ☐ Spouse
   ☐ Parents
   ☐ Family member
   ☐ Child/children
   ☐ Friends
   ☐ Volunteer

38c) Do you care for any orphans in your family?  ☐ No  ☐ Yes
40b) Health History:

Cancer Sites

1 = Mouth
2 = Esophagus
3 = Stomach
4 = Small Intestine
5 = Large intestine including rectum
6 = Pancreas
7 = Liver
8 = Lung
9 = Breast
10 = Cervical/uterine/ovarian
11 = Prostate
12 = Head and neck
13 = Other, specify
39. How long would it take you to get from your house to the nearest facility if you walked?

   i) grocery/convenience store
   
   ii) bank
   
   iii) post office
   
   iv) video store
   
   v) non-fast food restaurant
   
   vi) fast food restaurant

40a) Total number of siblings

b) Health History: Complete for all parents and siblings, alive or dead

   Diabetes

   Coronary Heart Disease

   High Blood Pressure

   Stroke

   Cancer

   If Yes, indicate site

   Other, Specify
Subject ID
Centre #  Community#  Household#  Subject #  Subject Initials F M L

41. Physical Measurements

Sitting
a) Right arm blood pressure
   #1 Systolic  Diastolic mmHg
   #2 Systolic  Diastolic mmHg

b) Heart Rate
   #1 beats/min
   #2 beats/min

c) Waist
   #1 cm
   #2 cm

   □ minimal/no clothing
   □ full clothing

d) Weight
   kg

   □ minimal/no clothing
   □ full clothing

e) Hip
   #1 cm
   #2 cm

   □ minimal/no clothing
   □ full clothing

f) Height
   cm (without shoes)

42a) Circumference of mid upper right arm:
   cm

42b) Circumference of right calf:
   cm

c) Head Circumference:
   cm

d) Upper flexed arm circumference
   cm

43a) Right arm triceps skinfold:
   #1 mm
   #2 mm
   #3 mm

43b) Right calf skinfold:
   #1 mm
   #2 mm
   #3 mm
Subject ID
Centre #  Community #  Household #  Subject #

Subject Initials F M L

c) Biceps skinfold
#1  . mm
#2  . mm
#3  . mm
d) Subscapular skinfold
#1  . mm
#2  . mm
#3  . mm

e) Supra spinal skinfolds
#1  . mm
#2  . mm
#3  . mm

44 a) Humerous breadth  . cm
b) Femur breadth  . cm

45. Grip Strength (Maximal contraction):
a) Non-dominant hand: #1  . kg.
#2  . kg.
#3  . kg.
b) Dominant hand: #1  . kg.
#2  . kg.
#3  . kg.
Adult Questionnaire

If subject refuses to provide any of the measures, enter a value of "0" into each of the boxes for that question

For more detailed instructions please refer to the instruction manual

46. Spirometry:

American Thoracic Society criteria for acceptable spiromgrams:
Spiromgrams are acceptable if they are free from:

1. Cough during exhalation
2. Early termination or cut-off
3. Variable effort
4. Leaks
5. Obstructed mouth piece
46. Spirometry:

a) FEV1 (Litre):  #1 .  #2 .  #3 .

b) Does FEV1 obtained meet ATS criteria?
   No → (answer (i) to (iii))  Yes → Go to c)

   Reasons for not meeting the ATS criteria: (check all that apply)
   i) Cough  
   ii) Values not within 0.2L of each other  
   iii) Less than 3 values  

c) FVC (Litre):  #1 .  #2 .  #3 .

d) Does FVC obtained meet ATS criteria?
   No → (answer (i) to (iii))  Yes → Go to e)

   Reasons for not meeting the ATS criteria: (check all that apply)
   i) Cough  
   ii) Values not within 0.2L of each other  
   iii) Less than 3 values  

e) PEFR (Litre/min):  #1  #2  #3

f) Does PEFR obtained meet ATS criteria?
   No → (answer (i) to (ii))  Yes → Go to Q#47

   Reasons for not meeting the ATS criteria: (check all that apply)
   i) Cough  
   ii) Less than 3 values  

Subject ID
Centre #  Community #  Household #  Subject #

Subject Initials  F  M  L

47. Not applicable in South Africa

48. ECG obtained?  No  Go to #49  Yes
   a)  2 0  [ ]  [ ]  [ ]
       year  month  day

   [Place ECG File Label Here]

   b) Please print ECG label #:  [ ]  [ ]  [ ]  [ ]

49 a) Blood sample obtained?  No  Go to #50  Yes
   b)  [ ]  Fasting sample  [ ]  Non-fasting sample
   c)  2 0  [ ]  [ ]  [ ]
       year  month  day

   [Time:]  [ ]  [ ]  [ ]
   (00:00-23:59)

   Hours since any food/beverage consumed (excluding water)

   d) Please print Blood label #:  [ ]  [ ]  [ ]  [ ]

50 a) Urine sample obtained?  No  Go to #51  Yes
   b)  [ ]  Fasting sample  [ ]  Non-fasting sample
   c) Please print Urine label #:  [ ]  [ ]  [ ]  [ ]

51. Name of Interviewer:  [ ]  [ ]
   (please print)  [ ]   [ ]
   First Initial  Last Name

Interviewer Code:  [ ]  [ ]
4.9 Addendum C

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(August 2002)
SHORT LAST 7 DAYS TELEPHONE FORMAT

For use with Young and Middle-aged Adults (15-69 years)
The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ
The development of an international measure for physical activity started in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ
Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation
Translation from English is supported to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Data Entry and Coding
Attached to the response categories for each question are suggested variable names and valid ranges to assist in data management and interviewer training. We recommend that the actual response provided by each respondent is recorded. For example, “120 minutes” is recorded in the minutes response space. “Two hours” should be recorded as “2” in the hours column. A response of “one and a half hours” should be recorded as either “1” in hour column and “30” in minutes column.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an International Physical Activity Prevalence Study is in progress. For further information see the IPAQ website.

More Information

SHORT LAST 7 DAYS TELEPHONE version of the IPAQ. Revised August 2002.
Short Last 7 Days Telephone IPAQ

READ: I am going to ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Think about the activities you do at work, as part of your house and yard work, to get from place to place and in your spare time for recreation, exercise or sport.

READ: Now, think about all the vigorous activities which take hard physical effort that you did in the last 7 days. Vigorous activities make you breathe much harder than normal and may include heavy lifting, digging, aerobics, or fast bicycling. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities?
   ______ Days per week [VDAY; Range 0-7, 8,9]

2. How much time did you usually spend doing vigorous physical activities on one of those days?
   ___ ___ ___ Hours per day [VDHRS; Range: 0-16]
   ___ ___ ___ Minutes per day [VDMIN; Range: 0-960, 998, 999]

998. Don’t Know/Not Sure
999. Refused

[Interviewer clarification: Think only about those physical activities that you do for at least 10 minutes at a time.]

[Interviewer note: If respondent answers zero, refuses or does not know, skip to Question 3]

2. How much time did you usually spend doing vigorous physical activities on one of those days?
   ___ ___ ___ Hours per day [VDHRS; Range: 0-16]
   ___ ___ ___ Minutes per day [VDMIN; Range: 0-960, 998, 999]

998. Don’t Know/Not Sure
999. Refused

[Interviewer clarification: Think only about those physical activities you do for at least 10 minutes at a time.]

[Interviewer probe: An average time for one of the days on which you do vigorous activity is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, ask: “How much time in total would you spend over the last 7 days doing vigorous physical activities?”
   ___ ___ _______ Hours per week [VWHR; Range: 0-112]
   ___ ___ ___ Minutes per week [VWMIN; Range: 0-6720, 9998, 9999]
3. During the last 7 days, on how many days did you do moderate physical activities?
   _____ Days per week [MDAY; Range: 0-7, 8, 9]
8. Don’t Know/Not Sure
9. Refused

[Interviewer clarification: Think only about those physical activities that you do for at least 10 minutes at a time]

[Interviewer Note: If respondent answers zero, refuses or does not know, skip to Question 5]

4. How much time did you usually spend doing moderate physical activities on one of those days?
   ___ ___ Hours per day [MDHRS; Range: 0-16]
   ___ ___ Minutes per day [MDMIN; Range: 0-960, 998, 999]
998. Don’t Know/Not Sure
999. Refused

[Interviewer clarification: Think only about those physical activities that you do for at least 10 minutes at a time.]

[Interviewer probe: An average time for one of the days on which you do moderate activity is being sought. If the respondent can’t answer because the pattern of time spent varies widely from day to day, or includes time spent in multiple jobs, ask: “What is the total amount of time you spent over the last 7 days doing moderate physical activities?”
   ___ ___ ___ Hours per week [MWHRS; Range: 0-112]
   ___ ___ ___ Minutes per week [MWMIN; Range: 0-6720, 9998, 9999]
9998. Don’t Know/Not Sure
9999. Refused

SHORT LAST 7 DAYS TELEPHONE version of the IPAQ. Revised August 2002.
READ: Now think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 minutes at a time?
   ____ Days per week [WDAY; Range: 0-7, 8, 9]

8. Don't Know/Not Sure
9. Refused

[Interviewer clarification: Think only about the walking that you do for at least 10 minutes at a time.]

[Interviewer Note: If respondent answers zero, refuses or does not know, skip to Question 7]

6. How much time did you usually spend walking on one of those days?
   ____ Hours per day [WDHRS; Range: 0-16]
   ____ ____ Minutes per day [WDMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure
999. Refused

[Interviewer probe: An average time for one of the days on which you walk is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: “What is the total amount of time you spent walking over the last 7 days?”

   ____ ____ ____ Hours per week [WWHRS; Range: 0-112]
   ____ ____ ____ Minutes per week [WWMIN; Range: 0-6720, 9998, 9999]

9998. Don't Know/Not Sure
9999. Refused

READ: Now think about the time you spent sitting on week days during the last 7 days. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

7. During the last 7 days, how much time did you usually spend sitting on a week day?
   ____ ____ Hours per weekday [SDHRS; Range: 0-16]
   ____ ____ ____ Minutes per weekday [SDMIN; Range: 0-960, 998, 999]
998. Don't Know/Not Sure
999. Refused

[Interviewer clarification: Include time spent lying down (awake) as well as sitting]

[Interviewer probe: An average time per day spent sitting is being sought. If the respondent can't answer because the pattern of time spent varies widely from day to day, ask: “What is the total amount of time you spent sitting last Wednesday?”

___ ___ Hours on Wednesday
Minutes on Wednesday [SWMIN; Range: 0-960, 998, 999]

998. Don't Know/Not Sure
999. Refused

SHORT LAST 7 DAYS TELEPHONE version of the IPAQ. Revised August 2002.
Certificate of language editing

DECLARATION

I, C Vorster (ID: 710924 0034 084), Language editor and Translator, and member of the South African Translators’ Institute (SATI member number 1003172), herewith declare that I did the language editing of a dissertation written by Ms JT Kganakga from the North-West University (student number: 22896716).

Title of the dissertation: Fatal and non-fatal cardiovascular events in a selected group of South Africans

3 November 2017

C Vorster

Date
4.11 Addendum E

**Turnitin declaration**

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