A QUANTITATIVE ASSESSMENT OF CARDIOVASCULAR RELATED NON-COMMUNICABLE DISEASE OCCURRENCE AT A SOUTH AFRICAN ACADEMIC ENVIRONMENT: A PHARMACY STUDENTS' HEALTH PROMOTION INITIATIVE.

Pauline Tendai Maniki

Under the supervision of:

Dr Neelaveni Padayachee
Dr Ané Orchard
Mrs. Razeeya Khan
Ms Stephanie Leigh-de Rapper

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DECLARATION

I, Pauline Tendai Maniki. declare that this thesis is my own, unaided intellectual work. It is being submitted for the Degree of Master of Pharmacy at the Department of Pharmacy and Pharmacology, Faculty of Health Sciences, University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Signature:……  …….

Date:……27/08/2021……..

DEDICATION

To

My parents Calisto and Molliece Maniki

My siblings Dr Hilda Maniki, Kudakwashe, Mlungisi and Minenhle Maniki

"*If I have seen further it is by standing on the shoulders of giants*" – Isaac Newton

God for sustaining me - "*In His time He makes all things beautiful*" – Ecclesiastes 3:11

ABSTRACT

The World Health Organisation (WHO) identifies lack of targeted and sustained interventions as a contributing factor to the increasing burden of diseases in developing countries. The South African Department of Health has suggested the implementation of health promotion and monitoring of NCDs at individual, community, and population level as well as motivation of innovative research. Prevention of cardiovascular related NCDs will always be better than cure due to their irreversibility and slow manifestation of symptoms and this prevention depends on identifying the risk-factor profile. This study sought to determine the prevalence of cardiovascular related NCDS at the University of Witwatersrand (Wits). A descriptive, retrospective cross-sectional study design was implemented. The study determined the occurrence of selected cardiovascular related NCDs (hypertension, diabetes mellitus, dyslipidaemia and obesity) amongst students and staff members at Wits by reviewing a questionnaire used for the Screening and Testing Program for Pharmacy Students (STEPPS) conducted in 2019. The prevalence of hypertension was the highest (4.38% students and 18.00% staff). There were more cases of potentially undiagnosed hypertension (13.74% students and 27.06% staff) and obesity (11.68% students and 25.40% staff). Co-occurrence of hypertension and diabetes was highest among diagnosed participants while obesity and hypertension were highest among potentially undiagnosed participants. Increase in BMI was associated with increasing blood pressure, total cholesterol, and blood glucose. The study emphasizes on the importance of screening and the need to implement awareness programs on cardiovascular related NCDS within the academic environment.

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ABBREVIATIONS

AIDS - Acquired Immune Deficiency Syndrome

BMI - Body Mass Index

CM – Centimeters

COVID-19 – Coronavirus

CVD - Cardiovascular Disease

DALY - Disability Adjusted Life Years

DBP – Diastolic Blood Pressure

DM – Diabetes Mellitus

GPP - Good Pharmacy Practice

HAART – Highly Active Antiretroviral Therapy

HCW – Healthcare Workers

HDL - High-Density Lipoproteins

HDL-C - High Density Lipoprotein Cholesterol

HIV - Human Immune Deficiency Virus

KGS - Kilograms

LADA – Latent Autoimmune Diabetes in Adults

LDL - Low-Density Lipoproteins

LDL-C - Low Density Lipoprotein Cholesterol

M - Metres

MMHG - Millimeters of Mercury

MMM – May Measurement Month

Mmol/L - Millimoles Per Litre

MODY – Maturity Onset Diabetes of The Young

NCD - Non-Communicable Diseases

NDoH – National Department of Health

NHI – National Health Insurance

PHC – Primary Health Care

POCT - Point of Care Testing

SBP – Systolic Blood Pressure

STEPPS - Screening and Testing Programme for Pharmacy Students

TC - Total Cholesterol

TG - Triglycerides

WC – Waist Circumference

WHO - World Health Organization

WITS – University of The Witwatersrand

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CHAPTER 1: INTRODUCTION

The purpose of this study was to determine the occurrence of cardiovascular related non-communicable diseases within an academic institution in South Africa. This chapter will cover the background of the study, rationale, its aims, and objectives.

1.1 Background

The term burden of disease generally describes consequences a health problem imposes on a given population. These consequences include the enormous burden of pain, suffering and costs to society (Bloom *et al.,* 2017). Economic repercussions of poor health such as increase in health expenditure, lost income and productivity, and reduced functional capacity can be substantial as they contribute to reduction in economic growth (Bloom *et al.,* 2004). In addition to the above, poor health may adversely impact educational attainment due to recurrent absenteeism and disease-induced poor cognitive functioning (Suhrcke and de Paz Nieves, 2011).

Both developing and developed countries worldwide are facing a double burden of communicable (CD) and non-communicable diseases (NCDs) (Boutayeb and Boutayeb, 2005; Boutayeb, 2006). Communicable diseases being medical conditions that are infectious or contagious such as tuberculosis and measles, while NCDs are medical conditions that are non-infectious such as diabetes and cancer (Kim and Oh, 2013). Non-communicable diseases, which are a notable cause of disability and death globally, are the end result of genetic predisposition and long term exposure to environmental and lifestyle factors such as diets rich in sugar, salt and saturated fat (Li *et al.,* 2013; World Health Organization, 2014, 2017a). The top four NCDs that are responsible for more than 80.00% of global NCD deaths are respiratory diseases, diabetes, cancers and cardiovascular diseases (Pervaiz and Ercantan, 2018; Bigna and Noubiap, 2019).

At one stage, NCDs were regarded as a burden of developed countries, however, recent alarming data show a reverse trend and a substantial increase of NCDs in developing countries (Wagner and Brath, 2012). Approximately 75.00% of the global NCD related deaths and 85.00% of premature NCD deaths are reported in developing countries, with a substantial death toll being expected in Africa by 2030 (World Health Organization, 2018a). This is because developing countries have multiple health demands that limit the capacity of their contending health system from suppressing

the substantial increase in the burden of NCDs (Ibrahim and Damasceno, 2012; Bollyky *et al.,* 2017).

Cardiovascular diseases (CVDs) are an important aspect in NCD management as they contribute to NCD related morbidity and mortality (Bigna and Noubiap, 2019). Defined as disorders associated with the vascular system and cardiac muscles, CVDs represent a collection of diseases that include hypertension and coronary heart disease (Mendis *et al.,* 2011; Al-Mawali, 2015). Cardiovascular diseases represent 31.00% of deaths worldwide, and account for 18.00% of NCD related deaths in South Africa (Heart and Stroke Foundation South Africa, 2017a). The underlying CVD risk factors that have been prioritized for monitoring by the WHO include an elevated blood glucose level, dyslipidaemia, raised blood pressure and obesity (World Health Organization, 2018a).

The trend for CVD risk factors in sub-Saharan Africa is suspected to be similar to that of other regions in the world, however, complete data sets from the continent regarding the extent of the burden of CVD-related risk factors are lacking due to lack of resources to strengthen surveillance system (Celermajer *et al.,* 2012). Governments in many countries are advocating for the provision of services such as point of care testing (POCT) that provide a cost effective access to healthcare while strengthening disease surveillance systems (Mashamba-Thompson *et al.,* 2016; Engel *et al.,* 2018).

1.2 Point of care testing

Point of care testing (POCT) is a diagnostic test that is done at or near the site of patient care and is an effective investment in fighting the growing epidemic of NCDs. Point of care testing facilitates an earlier diagnosis, management and monitoring of diseases (Vashist, 2017). The Good Pharmacy Practice (GPP) guidelines, govern that pharmacists may practice POCT in order to effectively manage a patient's chronic condition, hence they provide screening and monitoring services such as cholesterol testing, blood pressure monitoring and blood glucose testing (The South African Pharmacy Council, 2010).

The South African Bachelor of Pharmacy degree provides exit level outcomes that include the requirement for pharmacy students to exhibit essential knowledge and skills in promoting public health (South African Pharmacy Council, 2014). One of these skills includes performing screening tests that aid in monitoring of therapeutic outcomes, early diagnosis, patient referral and counselling (South African Pharmacy Council, 2014). As part of the University of the Witwatersrand (Wits) pharmacy curriculum, fourth year pharmacy students learn how to screen for chronic diseases through an existing work-based learning program called the Screening and Testing Programme for Pharmacy Students (STEPPS). The STEPPS curriculum was implemented in 2017 and uses multiple screening tools and point of care tests (POCT) to clinically assess willing participants. The screening program includes a variety of tests such as obesity measurement, cholesterol measurement, uric acid test, peak flow determination, blood pressure and blood glucose measurements. However, the ambit of this study was to focus on results of the four globally prioritized screening tests for cardiovascular related NCDs as defined by the WHO; which are blood glucose, blood pressure, obesity and cholesterol measurement (World Health Organization, 2010a).

1.3 Rationale

In addition to identifying risks and pursuing the individual to seek further investigation to establish a diagnosis, screening also creates awareness and provides statistics for epidemiological reports (Vashist, 2017). Increased awareness promotes primordial prevention and early diagnosis which is a crucial response to NCDs, as addressing the burden of NCDS, requires changing the goal from being "sick-care" to "health and wellness" oriented in order to establish preventative-care solutions (Bigna and Noubiap, 2019; Ganju *et al.,* 2020).

Many studies have highlighted the presence of unhealthy behaviors and lifestyles among university students which are likely to contribute to increased development of NCDs (Bharucha and Kuruvilla, 2003; Desouky *et al.,* 2014; Gresse *et al.,* 2015).

The coronavirus (COVID-19) pandemic has highlighted the importance of constant screening, as people with cardiovascular related NCDs such as hypertension and diabetes are at a higher risk of complications (Kluge *et al.,* 2020; World Health Organization, 2020a). The vulnerability of people

with NCDs has been worsened because the true scale of groups at risk is probably underestimated as many cases of diabetes and hypertension are either undiagnosed or uncontrolled (Holman *et al.,* 2020; Kluge *et al.,* 2020). In a bid to reduce the impact of this pandemic, the WHO has emphasized the importance of implementing COVID-19 response strategies that encompass the prevention and management of NCD risks (World Health Organization, 2020a).

It is well documented that health systems in developing countries lack the capacity and surveillance infrastructure to effectively decrease the NCD burden and this needs to be strengthened urgently (Celermajer *et al.,* 2012). Most of the available NCD profiles have been generated from developed countries and it is unclear how effective this causation and prevention data is to developing countries as they differ in economic, social and cultural status (Unwin *et al.,* 2001). Establishing risk factor epidemiology in specific populations contributes to the development of health programs that are tailored to the needs of the community and contribute to the development of pragmatic measures (Patel and Webster, 2016; Badr *et al.,* 2019).

The South African Department of Health has suggested the implementation of health promotion and monitoring of NCDs at individual, community and population level as well as motivation of innovative research on NCDs as they require a multi-sectorial approach (Department of Health, 2017). Determining occurrence of related conditions thus makes more sense as it would allow for earlier diagnosis and management of more cardiovascular related NCDs. This study will therefore be beneficial in providing initial surveillance data for cardiovascular related NCDs at the University of Witwatersrand, an initiative that would contribute to the development of health interventions tailored to the needs of the community.

1.4 Aim of the study

To retrospectively review the data from the STEPPS screening events conducted amongst students and staff at the University of Witwatersrand in 2019 to determine the occurrence of hypertension, dyslipidaemia, diabetes and obesity.

1.5 Objectives of the study

1.5.1 To determine the occurrence of diagnosed and uncontrolled hypertension, dyslipidaemia and diabetes amongst students/ staff at the University of Witwatersrand.

1.5.2 To determine the occurrence of potentially undiagnosed hypertension, dyslipidaemia, diabetes and obesity amongst students/ staff at the University of Witwatersrand.

1.5.3 To determine disease co-occurrence of screened conditions in individuals with chronic conditions and in individuals with potentially undiagnosed conditions.

1.5.4 To determine correlations between BMI and occurrence of hypertension, dyslipidaemia and diabetes.

CHAPTER 2: LITERATURE REVIEW

"*The growing incidence of noncommunicable diseases causes great individual hardship and places enormous burden on society, untenable in the long run for any country or economy. Many of these diseases can be substantially controlled and the pressure eased by adopting active, healthy lifestyles. To strive to remain healthy seems natural but most often remains a neglected solution. We must accelerate progress in this regard and galvanize action within our organizations and communities, promoting and evangelizing the benefits of health, as this is a grave challenge that concerns all of us*.**"** ~ Malvinder Singh Executive Chairman, Fortis Healthcare, India (Bloom *et al.,* 2014).

2.1 Introduction

In this review, factors determining the current prevalence statistics of cardiovascular-related non-communicable diseases (NCDs) in developing countries and the impact of NCDS in South Africa will be reviewed. Subsequent sections will focus on the four cardiovascular related diseases (hypertension, diabetes mellitus, dyslipidaemia and obesity) and review the co-occurrence of these conditions. The management of NCDS and opportunities for better outcomes will then be explored. Finally, disease surveillance systems are briefly discussed. This serves as a base to plan suitable interventions that can be implemented to manage and reduce the occurrence of these conditions at Wits University.

2.2 Background

2.2.1 Gaps contributing to the increasing prevalence statistics

The increasing rate of NCD-related mortality in African countries suggests that if health interventions are not directed towards NCDs, most African countries will not meet the Sustainable Development Goal set by the WHO to reduce NCD related deaths by 30.00% by 2030 (Kengne *et al.,* 2019). Owing to the constrained access to chronic care and limited medical resources, most people in developing countries are likely to die or become disabled at a young age due to complications of uncontrolled or undiagnosed NCDs (Prince *et al.,* 2015; Feigin *et al.,* 2016). It is therefore crucial that more attention is directed towards the prevention and control of these diseases.

Despite the fact that information on NCDs and their risk factors is limited in developing countries, the available information is not adequately utilized to call for action due to limited resources (Krishnan, 2016). Bollyky *et al.,* (2017) highlights that the burden of NCDs is greater in developing countries and ascribes this to poorly equipped health systems. The inadequacy of clinical data in Sub-Saharan Africa on the prevalence of NCDs affects resource allocation significantly; with communicable diseases receiving more attention and resources due to enhanced factual data profiles (Muchira *et al.,* 2015; Kassa and Grace, 2019). To make matters worse, the burden for fighting NCDs is being placed on local budgets, thus adding pressure to vulnerable countries (Allen, 2017; Collins *et al.,* 2018). For instance, in 2014, only 2.00% of international health aid funding was channeled towards NCDs despite them accounting for 50.00% of the global burden of disease, whereas 29.00% was allocated to HIV, which accounted for 4.00% of the global disease burden (Dieleman *et al.,* 2016).

Due to the lack of authentic data on NCD profiles in developing countries, health sectors resort to adopting international recommendations instead of implementing pragmatic interventions (Boutayeb and Boutayeb, 2005). The WHO identifies lack of targeted and sustained interventions as a contributing factor to the increasing burden of diseases in developing countries (World Health Organization, 2010b).

2.3 The impact of NCDs in South Africa

The South African health care system is currently contending with the quadruple burden of disease as it has limited resources but multiple demands (Mayosi *et al.,* 2009; Basu, 2018). The burden is to such an extent that South Africa is featured among the 23 countries responsible for 80.00% of the NCD related deaths in developing countries (Abegunde *et al.,* 2007). South Africa has been identified as being 'in the midst of a profound health transition', however, without the expected health care provision resources resulting in an unequal access to health care services (Mayosi *et al.,* 2009). As a result, cardiovascular related NCDs do not get significant attention when competing with urgent and acute conditions such as communicable diseases and injuries, hence supplies made for cardiovascular related NCDs are unlikely to be sufficient (Steyn *et al.,* 2006). In 2010, the National burden of disease study for South Africa showed that NCDs are among the major causes of deaths in South Africa (Groenewald *et al.,* 2017). It is estimated that NCDs

account for approximately 51.00% of deaths in South Africa, with cardiovascular diseases responsible for 18.00% of these deaths (World Health Organization, 2018b).

The prevalence of cardiovascular related NCDs is set to increase, as South Africans continue to adopt urbanization and its perils such as sedentary lifestyles and unhealthy diets (Nojilana *et al.,* 2016; Juma *et al.,* 2020). Moreover, South Africa has been listed as one of the countries with the highest number of people living with HIV (Gilbert and Walker, 2002; Mabaso *et al.,* 2019). This adds to the overwhelming burden of NCDs in South Africa as the complex interaction between cardiovascular diseases and HIV increases the pathogenesis of CVDs due to stimulation of inflammatory markers and adverse reactions resulting from use of antiretroviral therapy (Zungu *et al.,* 2019; Mathebula *et al.,* 2020). For instance, protease Inhibitors which are part of the highly active anti-retroviral therapy (HAART) are associated with cardiovascular related NCDs such as diabetes, hypertension, dyslipidaemia and obesity *(*Palios *et al., 2012;* Zungu *et al.,* 2019; Mathebula *et al.,* 2020).

2.4 Cardiovascular related non-communicable diseases

2.4.1 Hypertension

Hypertension, also referred to as high blood pressure, is the chief modifiable risk factor associated with cardiovascular disease (Ataklte *et al.,* 2015). The relationship between hypertension and risk of cardiovascular diseases is continuous and consistent even without being dependent on other risk factors (Okpara *et al.,* 2015*)*. Hypertension is often referred to as a silent killer because it can cause damage to the body for years before symptoms present, hence diagnosis is usually done when patients experience severe target organ damage, such as nephropathy and retinopathy, or die (Okpara *et al.,* 2015; Singh *et al.,* 2017). In addition to severe target organ damage, delayed diagnosis of hypertension can result in poor blood pressure control, resulting in the need for combination therapy, which is more expensive and has an increased potential for adverse effects (Ataklte *et al.,* 2015).

Diagnosis of hypertension is done by measuring blood pressure using either a calibrated electronic device or mercury sphygmomanometer. Blood pressure is written as two numbers, with the first (systolic) number representing pressure in the arteries as a result of contraction of the heart and

the second (diastolic) number representing the pressure in arteries between heart beats (World Health Organization, 2019a). Hypertension is defined as a systolic blood pressure (SBP) reading ≥ 140 mmHg and/or a diastolic blood pressure (DBP) reading ≥ 90 mmHg (Seedat *et al.,* 2014; Rayner *et al.,* 2019; The National Department of Health, 2019). Several studies have investigated the effect of the independent blood pressure components (DBP and SBP) on CVD risk (Basile, 2002; Franklin and Wong, 2013). Reports from the Framingham investigators identified DBP as a stronger predictor of coronary heart disease risk in young people and SBP in middle aged people and geriatrics (Franklin and Wong, 2013). In a similar study, SBP was identified as a better indicator of cardiovascular risk and as the more difficult type to control (Basile, 2002). Flint *et al.,* (2019) acknowledge that as much as SBP has a greater effect on outcomes, DBP cannot be ignored as it also influences the risk of CVDs.

More than 1 billion people in the world have hypertension, and less than one in every five have the condition under control (World Health Organization, 2019a). According to sub-Saharan Africa epidemiological data, South Africa has the highest prevalence of hypertension as well as a huge number of hypertensive patients with uncontrolled blood pressure, despite being on medication (Peer *et al.,* 2013). For instance, the 2018 May Measurement Month (MMM) analysis of blood pressure screening results from South Africa recorded 34.60% hypertension cases and 42.50% uncontrolled cases (Woodiwiss *et al.,* 2020). Prevalence of hypertension is estimated at 27.40% for men and 26.10% for women in South Africa (World Health Organization, 2017b). In addition to the difference in prevalence by gender, hypertension has been identified as the predominant CVD risk factor amongst the african population in South Africa as urbanization predisposes them to developing hypertension (Peer *et al.,* 2013).

2.4.2 Diabetes

Diabetes mellitus is a metabolic disorder which is characterised by high levels of blood glucose, referred to as hyperglycemia. This chronic disorder results from the incompetency of beta cells which lead to defects in insulin production, insulin action, or both (Asmat *et al.,* 2016). Defects in insulin action or production increase the amount of glucose circulating in blood, resulting in damage to vessels that supply blood to vital organs, by decreasing their elasticity causing them to

narrow thereby affecting their proficiency (American Diabetes Association, 2009; Huo *et al.,* 2016; Bertoluci and Rocha, 2017).

Diabetes mellitus is a prime risk factor for cardiovascular disease as it affects the heart muscle, causing both diastolic and systolic heart failure (Leon, 2015). A 1.00% increase in glycated haemoglobin levels is equated to 18.00% increased risk of experiencing CVDs (Gerstein *et al.,* 2005). Diabetes mellitus has been identified as a leading risk factor for myocardial infarction in black South Africans (Steyn *et al.,* 2005). To complicate matters further, diabetes mellitus predisposes patients to conditions that result in CVDs such as hypertension and dyslipidaemia (Song and Hardisty, 2009; Leon, 2015). For instance, a recent systematic review by Einarson *et al.,* (2018) reported CVDs as the most prevalent cause of comorbidity and death in diabetic patients.

There are 4 main types of diabetes, namely type 1 diabetes, type 2 diabetes, gestational diabetes and pre-diabetes (impaired glucose tolerance) (Piero *et al.,* 2015). There are atypical forms of diabetes that don't fit perfectly into the above-mentioned groups such as MODY (maturity-onset diabetes of the young) and LADA (latent autoimmune diabetes in adults). However, Type 2 diabetes is the type mostly associated with the development of CVDs, were more than 32.20% of type 2 diabetes patients have one or more CVDs (Einarson *et al.,* 2018b). Approximately 90.00% of diabetes cases are type 2 diabetes which is mainly caused by modifiable risk factors such as physical inactivity and obesity (American Diabetes Association, 2010; Saeedi *et al.,* 2019; World Health Organization, 2020a). Advancing age is a common risk factor for type 2 diabetes, however, due to increased rates of childhood obesity, type 2 diabetes is becoming more common in youths (15 to 24 years) (American Diabetes Association, 2010; World Health Organization, 2020). Diabetes is diagnosed based on plasma glucose or HbA_1C criteria. The plasma glucose criteria measures the quantity of glucose in the blood at a single point in time whereas, the HbA_1C test measures the average blood glucose concentration over a period of weeks or months (SEMDSA, 2017a,b). Diabetes is defined as a fasting blood glucose reading $\geq$ 5.6 mmol/L and $\geq$11.1 mmol/L for a random glucose reading or a HBA_1C reading $\geq$ 6.50% (SEMDSA, 2017a; National Department of Health, 2019b).

The prevalence of diabetes has been on the rise globally (Saeedi *et al.,* 2019). In 2017, it was estimated that 425 million people had diabetes, whereas in 2019 just under half a billion people were living with diabetes (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018; Saeedi *et al.,* 2019). This number is projected to increase to 578 million cases by 2030 and to increase further to 700 million cases by 2045 due to technological advancements that promote sedentary lifestyle (Saeedi *et al.,* 2019). And as with hypertension, the disease may often be asymptomatic, with 50.00% of people being unaware of their condition (Saeedi *et al.,* 2019). In addition to its contribution to the burden of disease, diabetes also has a significant global impact on mortality directly causing 1.6 million deaths in 2016 and 4 million deaths in 2017 (Saeedi *et al.,* 2019). The burden of diabetes in South Africa is also unacceptably high, with a reported estimate of 4.6 million (12.80%) diagnosed and 66.00% undiagnosed cases (Sahadew *et al.,* 2016; The International Diabetes Federation, 2020).

2.4.3 Dyslipidaemia

Dyslipidaemia is defined as high levels of low density lipoprotein cholesterol (LDL-C), total cholesterol (TC) or triglycerides (TG), and low levels of high density lipoprotein cholesterol (HDL-C) (Robinson, 2014; Opoku *et al.,* 2019). Studies show that individuals with higher cholesterol levels are more prone to developing CVDs as they are exposed to atherosclerosis (Karaye and Habib, 2014). Atherosclerosis is a condition that is characterized by the narrowing and hardening of arteries resulting from a buildup of cholesterol plaque. As the plaques continue to build up, they become hard or form clots, thereby obstructing blood flow. In severe cases this can lead to stroke, heart attack or even death (Rafieian-Kopaei *et al.,* 2014).

Untreated or undiagnosed dyslipidaemia has serious cardiovascular implications as it can result in peripheral or coronary artery disease, and both these conditions have complications which increase disability adjusted life years (DALYs) (Canadian Cardiovascular Society, 2016). The level of blood lipids is determined using either a cholesterol test which gives the quantity of TC only or a lipid panel which gives results for TC, LDL-C, HDL-C and TG (Hofman, 2014). Dyslipidaemia is defined as TC $\geq$ 5.0 mmol/L or LDL > 3.0 mmol/L or TG > 1.7 mmol/L or HDL < 1.0 mmol/L for men and < 1.02 mmol/L for women (National Department of Health, 2019c).

Dyslipidaemia is one of the leading contributors to mortality and cardiovascular disease and has a global prevalence of 39.00%, with 40.00% prevalence in females and 37.00% in males (WHO, 2015, 2019). A 2012 South African survey recorded that 28.00% of women and 19.00% of men above 18 years of age had elevated total cholesterol, whereas 52.00% of men and 44.00% women had low levels of HDL (Reiger *et al.,* 2017). Another report indicated that approximately 67.00% of rural South Africans have dyslipidaemia, while there is insufficient data within the urban sector to determine the prevalence (Ntusi, 2018). It has been reported that gender-related differences also exist in diagnosis, pathophysiology and management of lipid disorders (Zhao *et al.,* 2019). A recent study by Opoku *et al.* (2019) reported that dyslipidaemia was more prevalent in women, however, the prevalence was higher in men than in women under the age 50 and higher in women than in men above the age of 59.

It is important to note that HIV/AIDS treatment is directly linked to metabolic changes that elevate serum lipids, hence this affects the occurrence of dyslipidaemia, as HIV/AIDS also contributes to the quadruple burden of disease in South Africa (Reiger *et al.,* 2017). Again, dyslipidaemia is associated with other chronic conditions with more than 15.00% of patients with hypertension or diabetes having abnormal lipid patterns (Gulati *et al.,* 2012; Bekele *et al.,* 2017). For instance, dyslipidemia causes endothelial damage and loss of physiological vasomotor activity which can result in elevated systemic blood pressure (Gulati *et al.,* 2012). Furthermore, the defects in insulin action associated with diabetes suppresses the action of lipoprotein lipase resulting in increased TG and LDL-C level and reduced HDL-C (Ginsberg and Tuck, 2001; Wu and Parhofer, 2014).

2.4.4 Obesity

Obesity or being overweight is the abnormal accumulation of fat in the adipose tissue (Ofei, 2005). The excessive accumulation of fat leads to impaired health if not effectively managed (Ofei, 2005; Bray *et al.,* 2018). In addition to being an independent CVD risk factor, obesity increases the risk of developing cardiovascular related conditions such as hypertension, diabetes and dyslipidaemia (Pi-Sunyer, 2009; Dagan *et al.,* 2013; Bray *et al.,* 2018). As much as the causes of obesity are multifactorial, the primary cause has been identified as an imbalance between energy consumption and energy expenditure in favour of the former (Romieu *et al.,* 2017; Petridou *et al.,* 2019).

There are numerous measures used to determine obesity, however, the body mass index (BMI) is the most commonly used as it is more acceptable amongst patients and eliminates the effect of height on weight, thereby giving a reliable estimate of total body fat (Shah and Braverman, 2012; Post *et al.,* 2015).The measurement of BMI is provided in the equation below (Equation 1) with obesity defined as a BMI ≥ 25 kg/m^2 for Asians and ≥ 30 kg/m^2 for other ethnic groups (World Health Organization, 2000; Kushner, 2012).

Equation 1: Body Mass Index

$$\mathbf{BMI} = \frac{\mathbf{weight\ (kg)}}{[\mathbf{height}\ (\boldsymbol{m})^{\mathbf{2}}]}$$

As much as BMI is an accurate reflection of body fat percentage in the majority of the adult population, it is less accurate for people such as body builders as it takes lean mass into consideration (Tam *et al.,* 2020). Waist circumference (WC) is regarded as a better indicator of CVD risk than BMI as CVD risk is associated with truncal obesity which can be determined using WC (Dagan *et al.,* 2013; Leahy *et al.,* 2014). Obesity is defined as a WC which is ≥ 80 cm for all women and ranges from ≥ 85 to ≥ 94 cm for men (subject to ethnicity) (Kushner, 2012; SEMDSA, 2017a). Although measures such as WC, waist to hip ratio are predicted to be better indicators of adiposity, additional studies are needed to support the claim (Tam *et al.,* 2020).

Globally, approximately 39.00% of adults were overweight and 13.00% were obese in 2016 (World Health Organization, 2020b). In 2019, 38.2 million children worldwide under the age of five years were either obese or overweight, with Africa reporting a 24.00% increase in prevalence of childhood obesity since 2000 (World Health Organization, 2020b). According to South African statistics, 50.00% of adults older than 18 years of age are either overweight or obese; with this value expected to increase to 60.00% by 2025 due to the impact of technological advancements on lifestyle (Heart and Stroke Foundation South Africa, 2017b). These advancements have made people more reliant on gadgets to perform tasks, thereby promoting a sedentary lifestyle which is a key player in the development of obesity (Lakdawalla and Philipson, 2009).

According to research, the factors that determine the degree of health impairment are: amount of fat, its distribution in the body and the presence of other risk factors (Elffers *et al.,* 2017; Frank *et*

al., 2019). Truncal and peripheral obesity are the two main types, where truncal obesity speaks to the accumulation of fat around the thoracic and abdominal area and peripheral obesity refers to the accumulation of fat around the gluteofemoral area (Elffers *et al.,* 2017; Frank *et al.,* 2019; Nauli and Matin, 2019). Several studies have highlighted that the location of adipose tissue impacts metabolic health differently (Hetherington-Rauth *et al.,* 2018; Frank *et al.,* 2019; Nauli and Matin, 2019; Yamamoto *et al.,* 2020). Peripheral obesity comprises of subcutaneous deposits and is not associated with increased CVD risk whereas truncal obesity comprises of both subcutaneous and visceral fat deposits which makes it strongly associated with metabolic changes that increase the risk of CVDs (Hetherington-Rauth *et al.,* 2018; Nauli and Matin, 2019; Yamamoto *et al.,* 2020).

Several factors affect fat distribution including age, gender and ethnicity (Mittal, 2019; Nauli and Matin, 2019). Nauli and Matin (2019) describe the impact of sexual dimorphism on fat distribution; acknowledging that females have a higher percentage of body fat while males have an increased propensity towards accumulation of abdominal visceral fat. In past studies, ageing has been associated with an increased risk of obesity as people usually become less active as they age and there is a depletion in sex and growth hormones which promote abnormal metabolism and accumulation of body fat (Wilborn *et al.,* 2005; Jura and Kozak, 2016). However, in recent years, the occurrence of obesity in children has mirrored the adult trend resulting in a shorter life expectancy and an early onset of conditions such as diabetes and hypertension (Jura and Kozak, 2016; Kinlen *et al.,* 2018). Tam *et al*., (2020) suggest that the link between obesity and ageing should be researched as there is an indication, however, the reasoning behind the evidence accumulated in their study suggests that obesity accelerates ageing.

Furthermore, researchers have identified the existence of disparities in obesity occurrence across ethnic/racial groups (Arroyo-Johnson and Mincey, 2016; Wang *et al.,* 2017). Racial groups are classified according to biological characters such as genes, skin colour and other physical features, whereas ethnic groups are classified according to cultural factors such as nationality and dietary preferences (Caprio *et al.,* 2008). These factors influence lifestyle, which is a key player in the development of obesity, hence accounting for the difference in patterning of obesity occurrence in different racial/ethnic groups (Falconer *et al.,* 2014). For instance, the South African population consist of a diversity of ethnic groups with different eating patterns. The White, Indian and

Coloured populations consume a typical Western diet, which has high fat intake and low carbohydrate intake, while the black population has two distinct types of eating patterns (Steyn *et al.,* 2006b; Pretorius and Sliwa, 2017). The black rural population still follows a traditional diet, which is high in carbohydrates, low in fat and moderately high in fibre while the black urban population consumes a western diet (Bourne *et al.,* 2002; Pretorius and Sliwa, 2017). The traditional diet is linked to a low prevalence of obesity, whereas the western diet is linked to increased prevalence of obesity (Bourne *et al.,* 2002).

2.4.5 The risk of multimorbidity

Multimorbidity is the presence of two or more chronic diseases in the same person (Eyowas *et al.,* 2019). Global epidemiology of multimorbidity estimates that the prevalence for such among different age groups varies from 14.00% to 90.00%, with the highest prevalence being recorded in developed countries (Oni *et al.,* 2014; Garin *et al.,* 2016). Xu *et al.,* (2017) confirms the presence of substantial knowledge gaps on multimorbidity, especially in developing countries and highlights the need for more studies in this area.

Non-communicable disease multimorbidity is progressively becoming common in developed countries, whereas little is known about its epidemiology in developing countries (Pati *et al.,* 2014). In high-income countries, the issue of NCD multimorbidity has become a major challenge (Lalkhen and Mash, 2015). For example, results from a study conducted in Scotland found that over half of the patients (54.90%) had NCD multimorbidity (Barnett *et al.,* 2012). Despite insufficient data, multimorbidity is posing a challenge to South Africa's already overwhelmed healthcare system (Lalkhen and Mash, 2015). For instance, a study by Lalkhen and Mash (2015) recorded a 14.40% prevalence of NCD multimorbidity in South Africa, however, this study did not include all provinces, hence findings may underestimate national prevalence.

Multimorbidity management requires a patient centered and multidisciplinary approach as it is associated with numerous unfavorable health outcomes, as summarized in figure 1.1, which makes it a challenge to manage (Smith and O'Dowd, 2007; Moffat and Mercer, 2015; Xu *et al.,* 2017; Vetrano *et al.,* 2018).

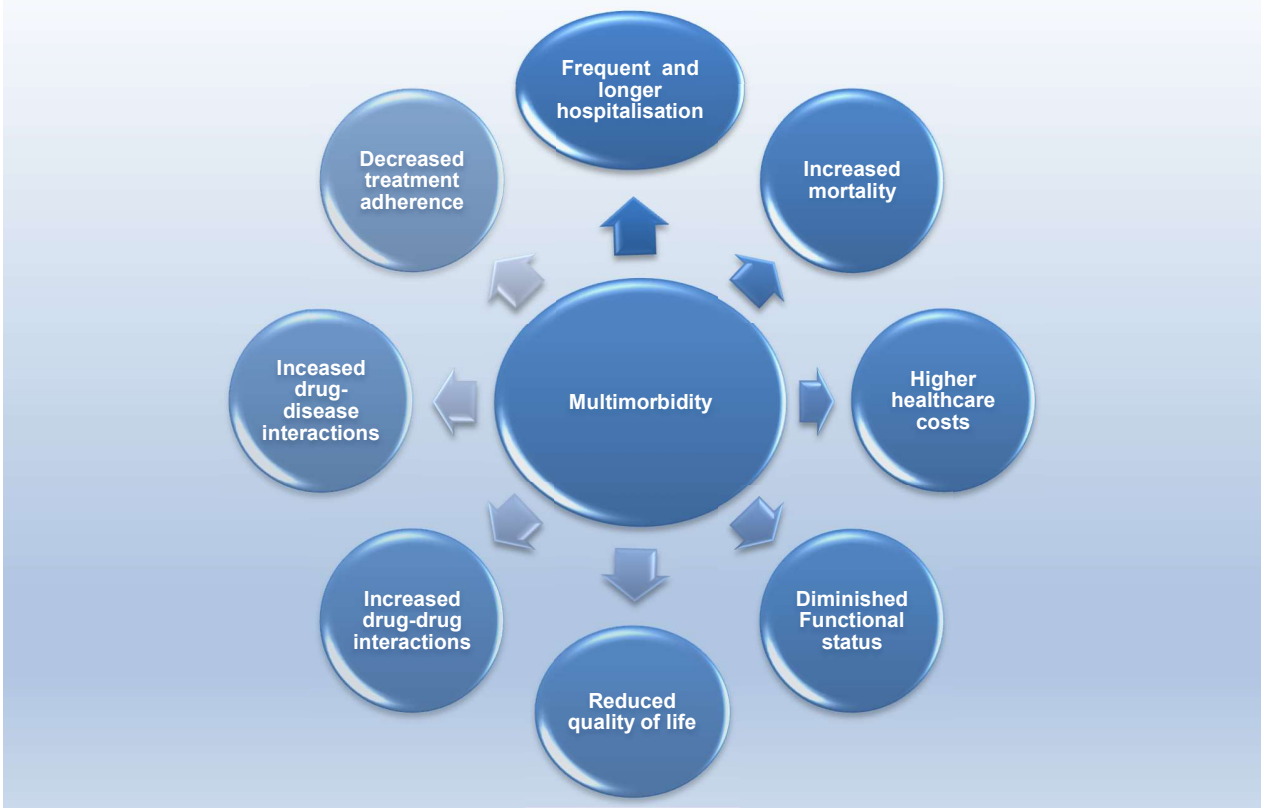

Figure 1.1: Unfavourable consequences of multimorbidity

Exposure to risk factors that are associated with more than one disease is one possible explanation for development of multimorbidity in patients with NCDs (Violan *et al.,* 2014; Mounce *et al.,* 2018). A 20-year cohort study by Xu *et al.,* (2017), reported that the prevalence of diabetes, heart disease, and stroke multimorbidity had increased rapidly and this increase was driven by interaction of common risk factors. Furthermore, a study by Kivimäki *et al.,* (2017) concluded that the risk of cardio metabolic multimorbidity was positively associated with BMI. In contrast, Melis *et al.,* (2014) did not show any link between lifestyle factors and a 3-year incidence of multimorbidity among geriatrics. Melis *et al.,* (2014) did not, however, dismiss the possibility of a link between multimorbidity and common risk factors but rather highlighted that multimorbidity has a higher incidence in geriatrics. Few studies to date have investigated the association of lifestyle factors with multimorbidity and there is still more work to be done in this area in order to understand multimorbidity (Freisling *et al.,* 2020).

2.5 Management of non-communicable diseases and opportunities for better outcomes

2.5.1 Management of non-communicable diseases in South Africa

South Africa has a two-tiered health care system comprising of the public and private sector (National Planning Commission., 2010). The public sector, which is state-funded, covers approximately 68.00% of the population who rely entirely on public sector and another 16.00% of the population (84.00% in total) who rely on both the public and private sector (World Health Organization, 2011; Mahlathi and Dlamini, 2015). In a bid to provide quality health care, the South African government has proposed the introduction of a National Health Insurance (NHI) that finances the health system (Department of Health, 2016). The NHI is expected to address the limited access to health care that results in a large number of people dying due to treatable conditions that are not being treated timeously and poor management of chronic conditions (Department of Health, 2016).

The Department of Health has formulated a range of disease-specific policies and guidelines to ensure the prevention and control of NCDS in South Africa (Ndinda *et al.,* 2018). In addition to trying to reduce the risk factor profile through implementation of population wide interventions, the South African health care system aims to improve on diagnosis and management of NCDs by promoting screening, testing and wellness programs (National Department of Health, 2011). Moreover, the National Department of Health has identified disease prevention and health promotion as two of the three main pillars in the implementation of the National Health Insurance (National Department of Health, 2020).

The National Department of Health (NDoH) introduced the Primary Health Care (PHC) re-engineering policy to promote NCD prevention and management within the public sector (Naledi *et al.,* 2011). The re-engineering policy uses outreach teams to provide NCD screening in communities, however, accessibility of healthcare workers (HCWs) remains a challenge (Naledi *et al.,* 2011). The NDoH has highlighted the need to support the use of community-based institutions such as schools, churches and workplaces as sites for health education promotion and approaches that recognize the centrality of individual behavior (National Department of Health, 2011).

Despite the fact that the greater part of the population utilizes public services, the private sector is a step ahead in implementing NCD management programs whereas the public sector has plans that are not being implemented due to shortage of resources (Young, 2016; Ndinda *et al.,* 2018). For instance, most medical aid schemes have implemented chronic disease management programs which allow the health care practitioner to actively manage a patient's condition to ensure adequate management and control (Bonitas Medical Aid for South Africa, 2020; Discovery Health Medical Scheme, 2020; Momentum, 2020). Moreover, these disease management programs include integrated care, which allow a team of health care practitioners such as doctors, nurses and pharmacists to work together and give a patient the best support needed (Bonitas Medical Aid for South Africa, 2020; Discovery Health Medical Scheme, 2020; Momentum, 2020).

2.5.2 Universities as a possible sector to address the burden of NCDs

Studies have highlighted the presence of unhealthy behaviors and lifestyles among university students which are likely to contribute to increased development of NCDs (Desouky *et al.,* 2014; Gresse *et al.,* 2015). Most NCDs risk factors are likely to be aggravated during the university academic years as this phase introduces a different routine that leads to the adoption of a new lifestyle, which can often result in unhealthy habits that may endanger the health of the student (Lopez et *al.,* 2017). Studies on occurrence of cardiovascular related NCDs in academic environments have yielded results that justify the need to address the burden of NCDs within academic environments. For instance, Tee *et al.,* (2016) reported a 24.00% occurrence of potentially undiagnosed hypertension and 30.00% obesity cases amongst university staff members. Similarly, Suleiman *et al.,* (2009) reported a 28.50% prevalence of obesity and Rao *et al.,* (2017) recorded 2.36% diabetes cases and 17.57% prediabetes cases among university students. Above all, university students are great knowledge disseminators; therefore, educating them on the risk factors for NCDs and their prevention can contribute to the reduction of NCDs occurrence (Lopes *et al.,* 2017).

2.5.3 Wellness programs

A wellness program is a comprehensive health initiative that is intended to promote or improve health outcomes within a group of people. These programs include health screening, preventative

care, disease management and fitness programs (Arena *et al.,* 2014). The WHO has called for the implementation of workplace wellness programs that target primary prevention of risk factors, early detection and management of NCDs as working conditions are powerful determinants of health care outcomes (World Health Organization, 2014b). Implementing wellness programs within a targeted population allows for continuous engagement that can effect a positive change in lifestyle choices (Carnethon *et al.,* 2009). For example, a community based wellness program that focused on cardiovascular health was associated with the decrease in blood pressure for participants who attended more than one session (Ye *et al.,* 2013).

Wellness screening in the workplace has been identified as a promising strategy for early detection of established risk factors for NCD's, with the hope of preventing the development of NCDs, or management and prevention of complications for individuals with diagnosed conditions (Mattke *et al.,* 2013; Arena *et al.,* 2014). Findings from a randomized clinical trial that assessed the effect of workplace wellness programs reported that employees with access to a workplace wellness program showed more positive health behaviors compared to those without access (Song and Baicker, 2019). Similarly, a systematic review that evaluated the effectiveness of wellness programs reported a favorable change in health behaviors relevant to CVDs (Soler *et al.,* 2010). The WHO has identified key risk factors that can be addressed in wellness programs namely; alcohol consumption, smoking, obesity, blood glucose level, cholesterol level, blood pressure, exercise and nutrition (World Health Organization, 2008).

Despite broad access to wellness programs, the impact of wellness programs depends on population participation (Arena *et al.,* 2014; Mattke *et al.,* 2015). Barriers such as time limitations, trust and privacy concerns and lack of knowledge on the importance of these programs have been identified as key players in limiting the uptake of wellness programs (Tjoa *et al.,* 2012). However, use of incentives seems to be effective in boosting wellness programs participation and encouraging individuals to take ownership of their health (Mattke *et al.,* 2015; Barleen *et al.,* 2017a). For example, a study by Volpp *et al.,* (2009) reported higher rates of smoking-cessation among participants who were given both information and financial incentives than those who were given information but no financial incentives.

2.5.4 Student-led health programs

Student-led health programs have been identified as a novel arena to enhance students' clinical skills and address public health concerns within communities, thereby alleviating overburdened healthcare systems by improving access to healthcare (Simpson and Long, 2007; Meah *et al.,* 2009; Suen *et al.,* 2020). Following the prevailing burden of NCDs, Mokdad (2016) highlights the urgent need to incorporate training programs in all medical schools that focus on surveillance, prevention and control of NCDs. Similarly, Mendelsohn (2014) recommends the implementation of student-run clinics at medical schools throughout South Africa as it would simultaneously benefit students and the community by improving access to healthcare.

Literature demonstrates that student-led health programs improve cardiovascular markers amongst patients with cardiovascular diseases and their associated risk factors (Nuffer *et al.,* 2012; Gorrindo *et al.,* 2014; Wahle *et al.,* 2017). For example, Nuffer *et al.,* (2012) and Martin *et al.,* (2015) reported a significant decline in HbA1c amongst diabetic patients, following student-led health programs that provided pre-consultation tests and self-care management education to patients with diabetes. Similarly Wahle *et al.,* (2017) documented the effectiveness of student-led programs in the management of hypertension through provision of patient centered disease management tips. However, research on the effectiveness of student-led health interventions on early diagnosis is lacking.

Expanded health care benefits have also been documented, following improvements in blood pressure and cholesterol values among patients with diabetes who were enrolled in a diabetes student-led healthcare program which provided self-care management education (Nuffer *et al.,* 2012). In addition to expanded healthcare options, is interprofessional student-led health programs which promote the establishment of working relations amongst healthcare providers (Janson *et al.,* 2009). For instance, a study by Martin *et al.,* (2015) that focused on a partnership between a pharmacy school, occupational therapy school and a tribal health center observed a decline in HbA1c level amongst patients with uncontrolled diabetes. Alternatively, Nuffer *et al.,* (2019) introduces a different collaboration between pharmacists and pharmacy students that yielded positive results in managing patients with cardiovascular related conditions through provision of disease management education.

2.6 Surveillance systems

The WHO has recommended the implementation of disease monitoring and surveillance in a bid to collect, interpret and disseminate data to responsible authorities so that action can be taken on development of pragmatic interventions (World Health Organization, 2015b). This intervention has been identified as a crucial tool for public health. In addition to determining disease occurrence, surveillance systems can also stimulate research through the generation of hypotheses (Centers for Disease Control and Prevention, 2013).

The WHO adopted a "STEPwise" approach in order to promote and strengthen NCD surveillance in countries. This approach is centered around establishing risk factor statistics for conditions that are burdening health care systems in order to promote primary prevention (World Health Organization, 2020). The Global Action Plan for the Prevention and Control of NCDs 2013–2020 by the WHO recommends that each country commits to setting targets and mechanisms to decrease the burden of NCDs (World Health Organization, 2014c).

More attention is often paid to the prevention and treatment of NCDs while intervention opportunities such as uptake for screening and early interventions lag behind (Saudi Arabia Ministry of Health, 2005). The poor prognosis for individuals with diseases that are diagnosed at a later stage make early diagnosis and intervention a valuable strategy (Strong *et al.,* 2005). For that reason, screening has been identified as an important tool for surveillance systems as it establishes risk factor statistics while prompting for early diagnosis (Mishra *et al.,* 2016).

Screening individuals for NCDs is receiving more attention as studies have demonstrated the advantages of early detection and intervention which are effective in preventing morbidity and mortality (Strong *et al.,* 2005; Pangtey *et al.,* 2019). For example, May Measurement Month (MMM), a world-wide screening program for hypertension, has shown substantial benefits by contributing to epidemiological statistics and increasing awareness regarding hypertension. In 2018, MMM identified more than 220 000 individuals with undiagnosed hypertension and 111 214 individuals with inadequately controlled hypertension through screening programs (European Society of Cardiology, 2019). Similarly, a study that examined three NCD screening programs in

Malawi showed that it is not only viable to introduce NCD screening into a public structure, but screening also contributes to increased uptake of NCD care which leads to good treatment outcomes (Kachimanga *et al.,* 2017).

In conclusion, prevention of NCDs is better than cure as most NCDs are irreversible and have a slow manifestation of symptoms (Saudi Arabia Ministry of Health, 2005). In any setting, this prevention strategy is governed by identifying the risk-factor profile and managing the predisposing risk factors (Van Zyl *et al.,* 2010; Gebremariam *et al.,* 2018) whilst a favorable prognosis depends on early diagnosis, timely treatment and treatment adherence (Strong *et al.,* 2005, Singh *et al.,* 2017). The magnitude of cardiovascular related NCDs among students and staff at the University of Witwatersrand (Wits) is not well documented, hence this study was carried out to determine the occurrence of cardiovascular related NCDs among students and staff at the University of Witwatersrand following a screening program by pharmacy students.

CHAPTER 3: METHODOLOGY

This study was a retrospective review to determine the occurrence of cardiovascular related NCDs (hypertension, diabetes, dyslipidaemia and obesity) following a screening program conducted by pharmacy students in 2019. This chapter describes the study design, setting, scope and population. The description of variables, data collection and management techniques are discussed followed by data analysis and ethical considerations.

3.1 Study design

A descriptive, retrospective cross-sectional study design was implemented to review results obtained from the Screening and Testing Program for Pharmacy Students (STEPPS) conducted at the University of the Witwatersrand (Wits). The study design and classification were chosen as the study describes the characteristics of the population and aimed to determine occurrence of cardiovascular related NCDs within a particular group of people at a given point in time. Moreover, the cross sectional study design was appropriate for this study as cross sectional studies are deemed to be appropriate for studies that focus on persistent conditions (Checkoway *et al.,* 2007).

3.2 Study setting

The questionnaires reviewed were obtained from students and staff members during a Screening and Testing Program for Pharmacy Students (STEPPS) conducted at the University of Witwatersrand. The University of Witwatersrand is a multi-campus public university situated in the northern areas of central Johannesburg in South Africa. It provides a huge range of academic programs for both undergraduate and post graduate studies such as, Health Sciences, Humanities, Commerce and Law. In 2019 the university had 40 881 students (54.63% female, 45.14% male and 0.24% other) and 1152 academic staff members (50.35% female and 49.65% male). According to the 2019 headcount enrolment, the student population ethnic stratification identified 59.09% African, 0.35% Chinese, 3.96% Coloured, 11.60% Indian and 15.55% White students. The ethnic stratification identified 17.62% African, 0.17% Chinese, 5.30% Coloured, 9.38% Indian,42.01% white academic staff members (University of Witwatersrand, 2020).

The two campuses selected for this study were Main (Solomon Mahlangu House) and Education (Bohlaneng Concourse) campuses. These sites were used as the screening sites as they are easily

accessible to staff and students and also carry a lot of foot traffic. The screening program was conducted on six different days from April to September 2019. The sites were set up to include 13 point of care stations with 25 fourth year students per session who were supervised by two pharmacists and four academic interns. Each station was equipped with a glucometer, tape measure, validated sphygmomanometer, cholesterol test kits, automated BP machine, safety lancets, bins, cotton wool and gloves. A scale and a standiometer was shared amongst the different stations.

3.3 Scope

The study involved capturing and analyzing data collected using the 2019 STEPPS questionnaire (Appendix A). The questionnaire that was used as a data collection tool consisted of 5 sections, namely; demographics, medical history, wellness test selected, results and action taken section. The demographics section, which focused on demographics such as designation, age, gender and ethnicity was used to determine whether there were any correlations between demographics and disease occurrence. The medical history section focused on self-reported diagnosed conditions and this was used to determine prevalence of diagnosed chronic conditions within the study population. The wellness test selected section indicated the tests participants chose to be screened for. The results section comprised of the results obtained from the screening program which were used to determine level of control of diagnosed conditions and occurrence of potentially undiagnosed conditions.

3.4 Study population

The results from the screening tests for all participants were captured by the researcher using Redcap Software for record keeping. The inclusion and exclusion criteria were used to determine the records that would be analysed to determine disease occurrence within the University of the Witwatersrand.

Inclusion criteria:

- Wits registered students and staff members as the study was meant to determine occurrence within an academic institution.

- Participants aged 18 years or older at the time of screening as there would be need for additional consent to analyse results from younger participants.

Exclusion criteria

- Incomplete records that missed information crucial for data analysis such as screening test results, incomplete demographics were excluded.
- Results from pregnant participants were excluded as pregnancy can lead to weight gain, development of gestational diabetes or hypertension as a result of metabolic changes (Catalano, 2010; Hedderson *et al.,* 2010).

3.5 Description of variables

This section describes the variables used in this study. Table 3.1 describes the variables used in the analysis. The table describes the type of variable, generation of variables and unit of measurement. The types of variables were defined as either continuous and categorical variables; categorical variables contain a finite number of categories such as gender whereas continuous variables are numeric variables with an infinite number of values between any two values such as weight (Institute for Digital Research and Education, 2021).

Table 3.1: Description of variables used in the analysis

Variable	Type	Description
Demographic Data		
Designation	Categorical	Staff or Student
Age	Continuous	Calculated from self-reported year of birth and screening year. Range 18 - 67
Gender	Categorical	Male or Female or Other
Ethnicity	Categorical	Ethnicity was self-reported. 7 categories existed: African or Arab or East Asian or Mixed or Other or South Asian or White
Medical History		
History of hypertension	Categorical	Self-reported hypertension by participant. Two level variable: yes or no

Variable	Type	Description
Use of blood pressure lowering treatment	Categorical	Self-reported use of prescribed blood pressure lowering treatment by participant. Two level variable: yes or no
History of Diabetes	Categorical	Self-reported Diabetes by participant. Two level variable: yes or no
Smoking status	Categorical	Self-reported tobacco use by participant. Two level variable: yes or no
Alcohol consumption	Categorical	Self-reported alcohol use by participant.
History of Dyslipidaemia	Categorical	Self-reported dyslipidaemia by participant
Results		
Weight (kg)	Continuous	Measured using an electronic scale.
Height (m)	Continuous	Measured using a standiometer.
Body Mass Index (kg/m)	Continuous	Calculated using the equation [BMI= weight (kg) / height(m)^2] (Kushner, 2012).
Waist Circumference (cm)	Continuous	Measured using a tape measure.
Systolic Blood Pressure (SBP)	Continuous	Average of two readings taken using a sphygmomanometer.
Diastolic Blood Pressure (DBP)	Continuous	Average of two readings taken using a sphygmomanometer.
Blood Glucose (mmol/l)	Continuous	Biochemical measurement of glucose level in blood.
Total Cholesterol (mmol/l)	Continuous	Biochemical measurement of total cholesterol level in blood.
High-density lipoprotein cholesterol (mmol/l)	Continuous	Biochemical measurement of high-density lipoprotein cholesterol level in blood.
Low density lipoprotein cholesterol (mmol/l)	Continuous	Biochemical measurement of Low-density lipoprotein cholesterol level in blood.
Triglycerides (mmol/l)	Continuous	Biochemical measurement of triglycerides level in blood.
Glycated haemoglobin (%)	Continuous	Biochemical measurement of glycemic control over the preceding 2-3 months.

3.6 Data collection and management

The data used in this study was collected using results that were obtained following the screening procedures explained in Appendix B. Data collected from all the six STEPPS sessions in 2019 was captured using Redcap Software. The data was entered as it appears on the questionnaire (Appendix A) that was used as the STEPPS data collection tool in 2019. The records that met the inclusion criteria were then exported to Stata for data analysis. The occurrence of cardiovascular related NCDs (hypertension, dyslipidaemia, diabetes and obesity) was determined using designation as the main classifying proxy; hence results for staff and students were analysed separately. Prevalence of diagnosed conditions (hypertension, diabetes and dyslipidaemia) was determined based on self-reported history of diagnosis and was stratified by gender as evidence points to appreciable differences in disease occurrence within different genders. (Christiani *et al.,* 2016; Liu *et al.,* 2017). The level of control amongst diagnosed participants was then determined using the participant's results at the time of screening.

The occurrence of potentially undiagnosed conditions was determined for participants who had reported to not having the specific condition diagnosed. This analysis was stratified by gender, ethnicity and age as evidence points to appreciable differences in disease occurrence within the different demographics (Katzmarzyk *et al.,* 2011; Christiani *et al.,* 2016; Liu *et al.,* 2017; Stanford *et al.,* 2019). The occurrence and interpretation of results for the different conditions was determined as explained below.

3.6.1 Hypertension

Prevalence of Hypertension was based on the number of self-reported cases. The level of control amongst diagnosed participants was interpreted using the parameters described in table 3.2 (National Department of Health, 2019; Seedat *et al.,* 2014).

Table 3.2: Level of hypertension control *

Level of control	Systolic bp (mmHg)	Diastolic bp (mmHg)
Good	≤ 139	≤ 89
Sub-optimal	140 - 159	90 - 99
Poor	≥ 160	≥ 100

*(National Department of Health, 2019; Seedat *et al.,* 2014)

Occurrence of potentially undiagnosed hypertension was interpreted using the parameters described in table 3.3 (Seedat *et al.,* 2014; National Department of Health, 2019).

Table 3.3: Determination of potentially undiagnosed hypertension*

Stage	Systolic bp (mmHg)	Diastolic bp (mmHg)
Normal	< 120	< 80
Optimal	120 - 129	80 - 84
High-normal	130 - 139	85 - 89
Hypertension	≥ 140	≥ 90

*(Seedat *et al.,* 2014; National Department of Health, 2019)

3.6.2 Diabetes mellitus

Prevalence of diabetes mellitus was based on the number of self-reported cases. The results obtained from those who reported having diabetes mellitus was used as a proxy to determine the level of control of diabetes amongst diabetic patients. The level of control was interpreted using the parameters described in table 3.4 (National Department of Health, 2019b).

Table 3.4: Level of diabetes control as described by diabetes reading*

Level of control	HbA_1C %	Fasting plasma glucose (mmol/L)	2 hour-post load glucose (mmol/L)	Random plasma glucose (mmol/L)
Good	< 5.7	< 5.6	< 7.8	< 5.6
Sub-optimal	5.7 - 6.4	6.0 - 6.9	7.8 – 10.0	5.6 - 10.0
Poor	≥ 6.5	≥ 7.0	≥ 10	≥ 10

*(National Department of Health, 2019b)

The occurrence of potentially undiagnosed diabetes mellitus was interpreted using the parameters described in table 3.5 (National Department of Health, 2019b).

Table 3.5: Determination of potentially undiagnosed diabetes*

Blood glucose test	**Result Interpretation**		
Fasting plasma glucose (mmol/L)	< 5.6 Diabetes excluded	6.0 - 6.9 Impaired fasting glucose	≥ 7.0 Diabetes
2 hour-post load glucose (mmol/L)	< 7.8 Normal glucose tolerance	7.8 - 11.0 Impaired glucose Tolerance	≥ 11.1 Diabetes
HbA_1C (%)	< 6.5 Inconclusive		≥ 6.5 Diabetes
Random plasma glucose (mmol/L)	< 5.6 Diabetes excluded	5.6 - 11.0 Inconclusive	≥ 11.1 Diabetes

*(National Department of Health, 2019b)

3.6.3 Dyslipidaemia

Prevalence of dyslipidaemia was based on the number of self-reported cases. Occurrence of potentially undiagnosed dyslipidaemia and level of control was determined using the parameters described in table 3.6 (Hofman, 2014).

Table 3.6: Blood lipids results interpretation*

Lipid	**Desirable lipid profile (good control) (mmol/l)**	**Undesirable lipid profile (poor control) (mmol/l)**
Total Cholesterol	≤ 5.0	> 5.0
LDL- cholesterol	≤ 3.0	> 3.0
HDL - cholesterol	≥ 1.2	< 1.2
Triglycerides	≤ 1.5	> 1.5

*(Hofman, 2014)

3.6.4 Obesity

Body mass index was calculated using the equation [BMI=weight (kg) / height$(m)^2$] (Kushner, 2012). Occurrence of potentially undiagnosed obesity and obesity classes were determined using the parameters described in table 3.7 (WHO, 2000; Kushner, 2012; SEMDSA, 2017).

Table 3.7: Body mass index interpretation*

Classification	BMI (kg/m^2)	BMI for Asians (kg/m^2)
Underweight	< 18.5	< 18.5
Normal	18.5 - 24.9	18.5 - 22.9
Overweight	25.0 - 29.9	23.0 - 24.9
Obesity	≥ 30	≥ 25

*(WHO, 2000; Kushner, 2012; SEMDSA, 2017)

3.6.5 Waist circumference

Waist Circumference was used to determine the occurrence of abdominal and the results obtained were used to determine occurrence of abdominal obesity, considering gender and ethnicity, using the parameters described in table 3.8 (SEMDSA, 2017).

Table 3.8: Determination of abdominal obesity by gender and ethnicity*

Ethnicity	Men (cm)	Women (cm)
Sub-Saharan Africa	≥ 94	≥ 80
Europid	≥ 94	≥ 80
Asian	≥ 90	≥ 80
Chinese	≥ 85	≥ 80

*(SEMDSA, 2017)

3.6.6 Co-occurrence of screened conditions

Results obtained from participants with diagnosed and potentially undiagnosed conditions were analysed to determine the occurrence of more than one diagnosed or potentially undiagnosed condition and to determine which of the screened conditions had a greater chance of existing together.

3.7 Data analysis

The data recorded using redcap was coded and exported to excel spreadsheets for data cleaning. The records that met the inclusion criteria were then exported to Stata/IC 15.1 (StataCorp, USA) for analysis. Descriptive statistics were used to describe the sample in terms of *designation, age*, *gender, ethnicity, smoking status* and *alcohol consumption*. As recommended, age was categorized

into five-year age bands in order to promote comparison of studies (Reijneveld, 2003). Continuous data was presented as means (standard deviations) or median (inter-quartile range). Categorical data was presented as tables of frequencies or illustrated using graphs. Statistical significance was calculated at 95.00% confidence level.

The following statistical tests were used in the analysis:

• Continuous variables: Student T-test (T-test) /Wilcoxon – Mann Whitney test were used as they are both useful in analyzing continuous data. The T-test was used for data with normal distribution while the Mann–Whitney test was used for data that was not normally distributed. These tests were employed as they provided evidence of a difference in diseases occurrence between groups (Bhalerao and Parab, 2010).

• Categorical variables: Chi-square test was used for categorical variables as it allows two or more groups to be compared, which was relevant for determining disease occurrence within different groups (Bhalerao and Parab, 2010).

• The association among the variables were measured using the Spearman test for correlation as it determines the presence of a monotonous relationship between two continuous variables. This was useful in determining associations between BMI and the other variables (blood glucose, total cholesterol and blood pressure) which were then quantified by linear regression (Bhalerao and Parab, 2010).

3.8 Study validity and reliability

Reliability means the consistency of measure whereas validity is the extent to which a certain measurement is accurate in a quantitative study (Heale and Twycross, 2015). Prior to the commencement of STEPPS, the fourth-year pharmacy students were given rigorous training on screening techniques and then assessed to see if they were competent enough to take part in the program. Competence pass mark was 80.00% and students had access to online tutorials as well as clinical skills videos, increasing the reliability on the results they produced. At each of the STEPPS sessions there were at least four academic interns and two lecturers from the Department of Pharmacy and Pharmacology who assisted the fourth-year students with the screening process to ensure accuracy. To ensure high quality data and improve validity of the study, the real-time data validation feature in Redcap was used for record capturing.

3.9 Ethical considerations

Permission to access the STEPPS data was obtained from the STEPPS coordinator (Appendix C). The ethics application was approved by the Human Research Ethics Committee (Medical) at the University of the Witwatersrand (Clearance certificate number M190921) (Appendix D) on 08/11/2019 and was amended on 04/09/2020 (Appendix E) when study was changed from a prospective analysis to a retrospective analysis due to covid-19. The study was conducted in accordance with ethical requirements and information obtained was treated with strict confidence. Patients' names and identifications were excluded while capturing and reporting data and separate IDs were generated for each participant. The data records captured are password protected and are only accessible to the researcher and the supervisors.

CHAPTER 4: RESULTS

This chapter describes the main results obtained from data analysis. Demographic characteristics of the study population are outlined, followed by the individual cardiovascular related risk factors and their association with demographics. Co-occurrence of these conditions is briefly outlined and the occurrence of the four conditions with relation to risk factors (smoking and alcohol consumption) is briefly discussed. Finally, the association between BMI and the occurrence of diabetes, hypertension and dyslipidaemia is explored.

4.1 Demographic profile

The study comprised of 722 participants: 411 students (56.90%) and 311 staff members (43.10%). The age for students ranged from 18 to 65 years and the median age was 22 (IQR 20-24). The age distribution for students was right skewed and leptokurtic (heavy tails on either side indicating large outliers). The age for staff members ranged from 19 to 67 years and the median age was 41 (IQR 34-51). The assumption is that the staff members older than 65 years (retirement age), are participants kept on a contract basis for their experience. The age distribution for staff members was approximately symmetric and platykurtic (flat tails indicating small outliers). The demographic characteristics of the study population are set out in Table 4.1.

Table 4.1: Demographic characteristics of the study population (n=722)

	Students n = 411 (%)	**Staff n = 311 (%)**	**P-value**
Gender			
Female, n (%)	278 (67.64)	188 (60.45)	0.133
Male, n (%)	107 (26.03)	100 (32.15)	
Other	26 (6.33)	23 (7.40)	
Total	**411 (100.00)**	**311 (100.00)**	
Ethnicity			
African	324 (78.83)	212 (68.17)	0.001*
Other	37 (9.00)	41 (13.18)	
White	14 (3.41)	32 (10.29)	
South Asian	17 (4.14)	8 (2.57)	
Mixed	10 (2.43)	12 (3.86)	
East Asian	7 (1.70)	6 (1.93)	

	Students n = 411 (%)	Staff n = 311 (%)	P-value
Arab	2 (0.49)	0 (0.00)	
Total	**411 (100.00)**	**311 (100.00)**	
Age			
< 20	93 (22.63)	2 (0.64)	0.000*
20-24	219 (53.28)	6 (1.93)	
25-29	59 (14.36)	15 (4.82)	
30-34	17 (4.14)	59 (18.97)	
35-39	11 (2.68)	59 (18.97)	
40-44	2 (0.49)	43 (13.83)	
45-49	4 (0.97)	37 (11.90)	
50-54	2 (0.49)	40 (12.86)	
55-59	1 (0.24)	26 (8.36)	
60-64	2 (0.49)	20 (6.493)	
≥ 65	1 (0.24)	4 (1.29)	
Total	**411 (100.00)**	**311 (100.00)**	
Smoker			
No	357 (86.86)	277 (89.07)	0.370
Yes	54 (13.14)	34 (10.93)	
Total	**411 (100.00)**	**311 (100.00)**	
Alcohol consumption			
Never or rarely	278 (67.64)	206 (66.24)	0.063
Less than once a week	96 (23.36)	59 (18.97)	
Regularly	34 (8.27)	44 (14.15)	
Unknown	3 (0.73)	2 (0.64)	
Total	**411 (100.00)**	**311 (100.00)**	

***** statistically significant

4.2 Cardiovascular related non-communicable diseases profile

In this section, the occurrence of the four cardiovascular-related non-communicable diseases within the study population namely hypertension, diabetes, dyslipidemia and obesity are described.

4.2.1 Hypertension

This section outlines the prevalence of self-reported hypertension and determine the level of control among the patients with self-reported hypertension. The occurrence of potentially undiagnosed hypertension was determined and stratified by gender, ethnicity and age within each designation.

4.2.1.1 Prevalence of self-reported hypertension

A total of 18/411 (4.38%) students and 56/311 (18.00%) staff members reported *yes* to having hypertension. The prevalence of self-reported hypertension was stratified by gender within each designation as illustrated in table 4.2. The prevalence of hypertension was high for females within both designations, however, there was no statistically significant relationship between gender and prevalence for both students (p=0.979) and staff (p=0.952).

Table 4.2: Prevalence of hypertension by gender

Gender	**Students n = 18 (%)**	**Staff n = 56 (%)**
Female	12 (66.67)	33 (58.93)
Male	5 (27.78)	19 (33.92))
Other	1 (5.55)	4 (7.17)
Total	**18 (100.00)**	**56 (100)**

4.2.1.2 Control of blood pressure amongst participants with diagnosed hypertension

Blood pressure control among hypertensive participants was determined using the South African Treatment guidelines for the diagnosis of hypertension as a proxy for control (as described in Chapter 3: Table 3.2). A total of 10/18 (55.56%) students with self-reported hypertension recorded good control of systolic blood pressure and only one male student recorded poor control. The proportion of staff members who recorded poor control was 6/56 (10.71%), with 5 of them being females. The level of control of systolic blood pressure in this study is presented in figure 4.1.

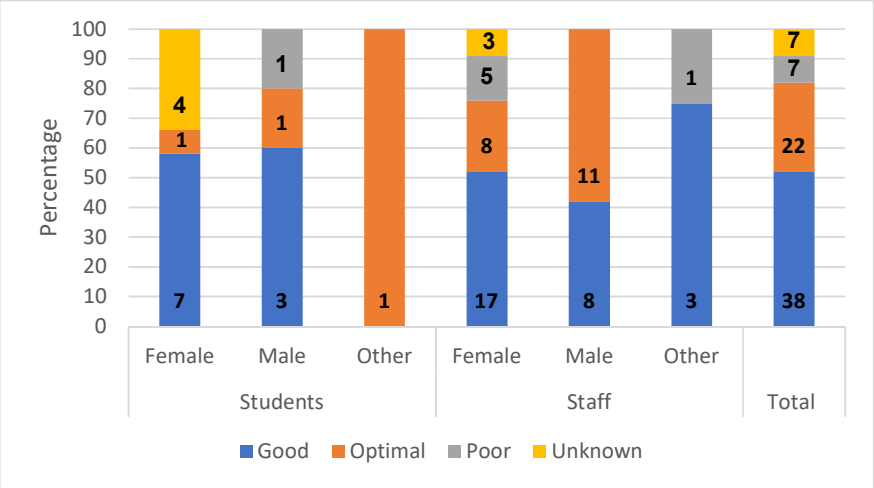

Figure 4.1: Level of systolic blood pressure control among participants with diagnosed hypertension

The level of control of diastolic blood pressure was similar to that of systolic blood pressure amongst students, with only 1 male recording poor control. There were more cases of poor diastolic blood pressure control (15/56, 26.79%) than systolic control (6/56, 10.71%) amongst staff members. The 15/56 poor diastolic control cases among staff members were recorded among 7/33 (21.21%) females, 7/19 (36.84%) males and 1/4 (25.00%) other. Figure 4.2 depicts the level of control of systolic blood in this study.

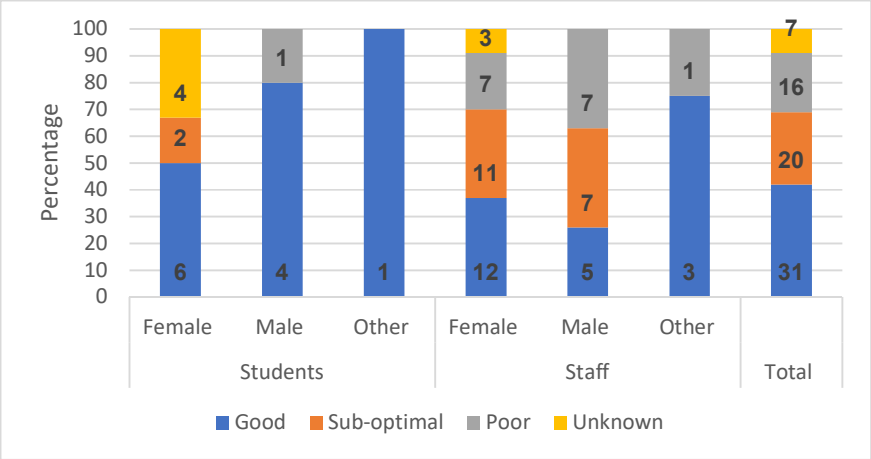

Figure 4.2: Level of diastolic blood pressure control among diagnosed hypertension participants

4.2.1.3 Occurrence of potentially undiagnosed hypertension

Occurrence of potentially undiagnosed hypertension was analysed for participants who reported *no* to having diagnosed hypertension [(393/411 95.62% students) and (255/311, 81.99% staff members)]. The occurrence of potentially undiagnosed hypertension was classified using an average of three combined blood pressure readings and participants with potentially undiagnosed hypertension were referred for further evaluations. A total of 54/393 (13.74%) students had potentially undiagnosed hypertension, with the greatest occurrence being recorded amongst females 31/54 (57.41%). For staff members, 69/255 (27.06%) had potentially undiagnosed hypertension, with the greatest occurrence being recorded amongst females 39/69 (56.52%). The complete combined blood pressure profile is attached as Appendix F (Table E1 and E2). Table 4.3 summarises the occurrence of potentially undiagnosed hypertension (combined) amongst students and staff members.

Table 4.3: Occurrence of potentially undiagnosed hypertension combined

Gender	**Students**		**Staff**	
	Hypertensive n =54 (%)	**P-value**	**Hypertensive n = 69 (%)**	**P-value**
Female	31 (57.41)	0.040*	39 (56.52)	0.030*
Male	15 (27.28)		27 (39.13)	
Other	8 (14.81)		3 (4.35)	
Total	**54 (100.00)**		**69 (100.00)**	

* statistically significant

4.2.1.4 Occurrence of potentially undiagnosed hypertension using the individual blood pressure components (Systolic and Diastolic)

The occurrence of potentially undiagnosed hypertension was analysed using the separate blood pressure components as evidence in literature points to differences in occurrence of the different components with respect to demographics such as gender, age and ethnicity (Pinto, 2007; Vishram *et al.,* 2012; Ford *et al.,* 2016; Still *et al.,* 2018).

Students: A total of 46/393 (11.70%) students had potentially undiagnosed diastolic hypertension whereas 21/393 (5.34%) students had potentially undiagnosed systolic hypertension. Results from

the gender stratification show a greater occurrence of diastolic hypertension among females and a greater occurrence of systolic hypertension among males. Occurrence of both diastolic and systolic hypertension was greatest amongst the African ethnicity, however, the relationship between ethnicity and occurrence of potentially undiagnosed hypertension was not statistically significant (p=0.605). Occurrence of both systolic and diastolic BP was high within the 20-24-year age band, as it was the most common age band within the student population. As age increased, there was a greater occurrence of diastolic than systolic blood pressure within each age band. A full profile on occurrence of diastolic and systolic blood pressure is outlined in Appendix F (Table E3 and E4). Table 4.4 summarises the occurrence of potentially undiagnosed diastolic and systolic hypertension amongst students.

Table 4.4: Occurrence of potentially undiagnosed hypertension amongst students

	Diastolic		**Systolic**	
	Hypertensive n = 46 (%)	**P-value**	**Hypertensive n = 21 (%)**	**P-value**
Gender				
Female	28 (60.87)	0.043*	8 (38.10)	0.010*
Male	11 (23.91)		9 (42.86)	
Other	7 (15.22)		4 (19.05)	
Total	**46 (100.00)**		**21 (100.00)**	
Ethnicity				
African	35 (76.09)	0.605	15 (71.43)	0.711
Other	6 (13.04)		0 (0.00)	
South Asian	1 (2.17)		0 (0.00)	
White	3 (6.52)		0 (0.00)	
Mixed	0 (0.00)		1 (4.76)	
East Asian	1 (2.17)		1 (4.76)	
Arab	0 (0.00)		4 (19.05)	
Total	**46 (100.00)**		**21 (100.00)**	
Age				
< 20	9 (19.57)	0.001*	5 (23.21)	0.001*
20-24	22 (47.83)		12 (57.14)	

	Diastolic		Systolic	
	Hypertensive n = 46 (%)	**P-value**	**Hypertensive n = 21 (%)**	**P-value**
25-29	5 (10.87)		2 (9.52)	
30-34	5 (10.87)		0 (0.00)	
35-39	2 (4.35)		0 (0.00)	
40-44	2 (4.35)		1 (4.76)	
45-49	1 (2.17)		0 (0.00)	
50-54	0 (0.00)		0 (0.00)	
60-64	0 (0.00)		1 (4.76)	
Total	**46 (100.00)**		**21 (100.00)**	

* statistically significant

Staff: A total of 63/255 (24.71%) staff members had potentially undiagnosed diastolic hypertension, whereas 39/255 (15.29%) had potentially undiagnosed systolic hypertension. Results from the gender stratification show a greater occurrence of diastolic hypertension amongst females (38/63, 60.32%), while there was an equal occurrence of systolic hypertension among females and males (19/39, 48.72%). Occurrence of both diastolic and systolic hypertension was greatest amongst Africans as they made the greater part of the study population, however, the relationship between ethnicity and occurrence of potentially undiagnosed hypertension was not statistically significant (p= 0.286). Occurrence of diastolic hypertension was reported from as early as less than 20 years while that of systolic hypertension was only reported from 30-34 years. A full profile on occurrence of diastolic and systolic blood pressure is outlined in Appendix F (Table E5 and E6). Table 4.5 summarises the occurrence of diastolic and systolic hypertension amongst staff members.

Table 4.5: Occurrence of potentially undiagnosed hypertension amongst staff members

	Diastolic		Systolic	
	Hypertensive n = 63 (%)	**P-value**	**Hypertensive n = 39 (%)**	**P-value**
Gender				
Female	38 (60.32)	0.015*	19 (48.72)	0.001*
Male	22 (34.92)		19 (48.72)	
Other	3 (15.79)		1 (2.56)	
Total	**63 (100.00)**		**39 (100.00)**	

	Diastolic		Systolic	
	Hypertensive n = 63 (%)	**P-value**	**Hypertensive n = 39 (%)**	**P-value**
Ethnicity				
African	46 (73.02)	0.161	30 (76.92)	0.286
Other	5 (7.94)		0 (0.00)	
White	10 (15.87)		0 (0.00)	
Mixed	2 (3.17)		0 (0.00)	
South Asian	0 (0.00)		5 (12.82)	
East Asian	0 (0.00)		4 (10.26)	
Totals	**63 (100.00)**		**39 (100.00)**	
Age				
< 20	1 (1.59)	0.298	0 (0.00)	0.001*
20-24	0 (0.00)		0 (0.00)	
25-29	2 (3.17)		0 (0.00)	
30-34	10 (15.87)		6 (15.38)	
35-39	12 (19.05)		6 (15.38)	
40-44	11 (17.46)		6 (15.38)	
45-49	10 (15.87)		4 (10.26)	
50-54	5 (7.94)		2 (5.13)	
55-59	6 (9.52)		9 (23.08)	
60-64	5 (7.94)		4 (10.26)	
≥ 65	1 (1.59)		2 (5.13)	
Total	**63 (100.00)**		**39 (100.00)**	

* statistically significant

4.2.2 Diabetes mellitus

4.2.2.1 Prevalence of self-reported diabetes mellitus

From the participants, 2/411 (0.49%) students and 15/311 (4.82%) staff members reported *yes* to having diabetes. The findings were then stratified by gender within each designation as illustrated in table 4.6. The self-reported rates of diabetes in the study population were higher among females for staff members 9/15, (60.00%) while the 2 cases within the student population were males.

There was no statistically significant relationship between gender and prevalence of diabetes for both students (p=0.186) and staff members (p= 0.710).

Table 4.6: Prevalence of diabetes by gender

Gender	Students n =2 (%)	Staff n=15 (%)
Female	0 (0.00)	9 (60.00)
Male	2 (100.00)	5 (33.33)
Other	0 (0.00)	1 (6.67)
Total	**2 (100.00)**	**15 (100.00)**

4.2.2.2 Control of diagnosed diabetes mellitus

Glycemic control among diabetics was determined using the South African guidelines for the diagnosis of diabetes as a proxy for control (as described in Chapter 3: Table 3.4). Figure 4.3 describes the glycemic control among those who reported *yes* to having diabetes. Particularly concerning is the poor level of control amongst most staff members (11/15, 73.33%), with most cases being recorded amongst females (7/11, 63.64%).

Figure 4.3: Level of control of blood glucose among patients with diagnosed DM

4.2.2.3 Occurrence of potentially undiagnosed diabetes mellitus

Students: Occurrence of potentially undiagnosed diabetes was low (1/ 409, 0.24%) and 8/409 (1.96%) being reported as prediabetic. The occurrence of prediabetes was similar in males and

females, with all cases being reported amongst Africans. Both potentially undiagnosed diabetes and impaired glucose tolerance (IGT) and were present in participants as young as 20-24years.

Staff: Occurrence of potentially undiagnosed diabetes was low (2/296, 0.68%) and 16/296 (5.41%) were reported as prediabetic. Occurrence of diabetes was frequent among females while the proportion of prediabetes was similar in males and females. Occurrence of both diabetes and prediabetes was greater among Africans as they made the greater part of the study population, however, the relationship between ethnicity and occurrence of potentially undiagnosed diabetes was not statistically significant (p= 0.934). Occurrence of potentially undiagnosed diabetes presented at a later age (45-49 years) whilst that of prediabetes presented at (30-34 years).
Table 4.7 summarizes the occurrence of potentially undiagnosed DM by gender, ethnicity and age within the two designations with the full profile being presented in Appendix F (Table E7 and E8). None of the stratifications yielded a statistically significant relationship.

Table 4.7: Occurrence of potentially undiagnosed diabetes

	Students			**Staff**		
	Prediabetes n = 8 (%)	**Diabetic n = 1 (%)**	**P value**	**Prediabetes n = 16 (%)**	**Diabetes n = 2 (%)**	**P-value**
Gender						
Female	4 (50.00)	1(0.39)	0.419	7 (43.75)	2 (100.00)	0.328
Male	4 (50.00)	0 (0.00)		8 (50.00)	0 (0.00)	
Other	0 (0.00)	0 (0.00)		1 (6.25)	0 (0.00)	
Total	**8 (100.00)**	**1 (100.00)**		**16 (100.00)**	**2 (100.00)**	
Ethnicity						
African	8 (100.00)	1 (100.00)	0.937	11 (68.75)	2 (100.00)	0.934
Arab	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	
East Asian	0 (0.00)	0 (0.00)		1 (16.67)	0 (0.00)	
Mixed	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	
South Asian	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	
White	0 (0.00)	0 (0.00)		1 (6.25)	0 (0.00)	
Other	0 (0.00)	0 (0.00)		3 (18.75)	0 (0.00)	
Total	**8 (100.00)**	**1 (100.00)**		**16 (100.00)**	**2 (100.00)**	
Age						
< 20	0 (0.00)	0 (0.00)	0.390	0 (0.00)	0 (0.00)	0.234
20-24	4 (50.00)	1 (100.00)		0 (0.00)	0 (0.00)	
25-29	1 (12.50)	0 (0.00)		0 (0.00)	0 (0.00)	
30-34	1 (12.50)	0 (0.00)		2 (12.50)	0 (0.00)	

	Students			Staff		
	Prediabetes n = 8 (%)	**Diabetic n = 1 (%)**	**P value**	**Prediabetes n = 16 (%)**	**Diabetes n = 2 (%)**	**P-value**
35-39	1 (12.50)	0 (0.00)		1 (6.25)	0 (0.00)	
40-44	0 (0.00)	0 (0.00)		1 (6.25)	0 (0.00)	
45-49	1 (12.50)	0 (0.00)		2 (12.50)	1 (50.00)	
50-54	0 (0.00)	0 (0.00)		4 (25.00)	1 (50.00)	
55-59	0 (0.00)	0 (0.00)		5 (31.25)	0 (0.00)	
60-64	0 (0.00)	0 (0.00)		0 (0.00)	0 (0.00)	
≥ 65	0 (0.00)	0 (0.00)		1 (6.25)	0 (0.00)	
Total	**8 (100.00)**	**1 (0.24)**		**16 (100.00)**	**2 (100.00)**	

4.2.3 Dyslipidaemia

4.2.3.1 Diagnosed dyslipidaemia

Table 4.8 describes the prevalence of self-reported dyslipidaemia. 10/411 (2.43%) students and 29/311 (9.32%) staff members reported *yes* to having diagnosed dyslipidaemia, With the highest prevalence being reported amongst females in both groups. The was no statistically significant relationship between the prevalence of dyslipidaemia and gender for both students (p=0.699) and staff (p=0.081).

Table 4.8: Prevalence of self-reported dyslipidaemia

Gender	**Students n = 10 (%)**	**Staff n = 29 (%)**
Female	7 (70.00)	14 (48.28)
Male	3 (30.00)	10 (34.48)
Other	0 (0.00)	5 (17.24)
Total	**10 (100.00)**	**29 (100.00)**

4.2.3.2 Control of dyslipidaemia

Blood lipid control among participants who reported yes to having dyslipidaemia was determined using the South African guidelines for the diagnosis of dyslipidaemia as a proxy for control (as described in Chapter 3: Table 3.6). Only 1/10 (10%) female students reported poor control while 10/29 (34.48%) staff members had poor control, with the highest being recorded among females Figure 4.4 describes the level of lipid control among the participants.

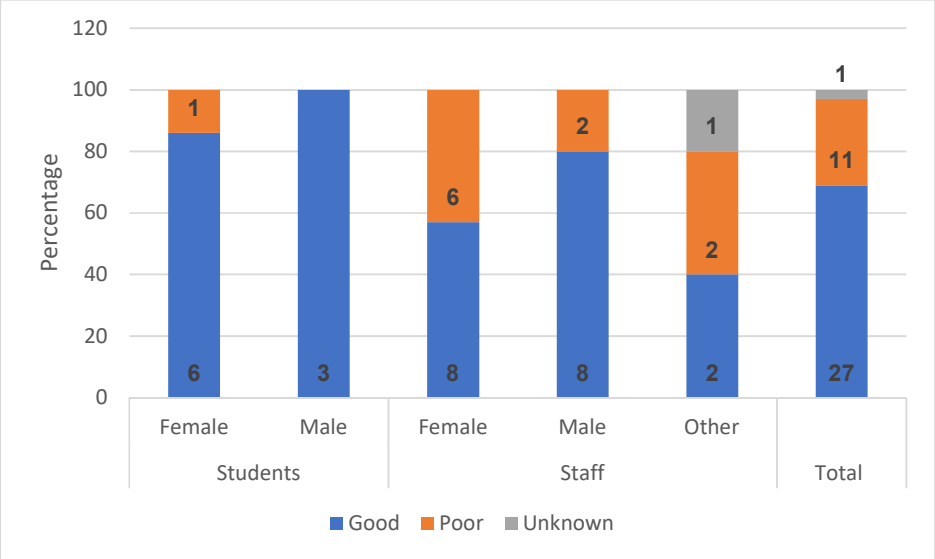

Figure 4.4: Level of control of blood lipids amongst diagnosed participants

4.2.3.3 Occurrence of potentially undiagnosed dyslipidaemia

Students: A total of 32/401 (7.98%) students had potentially undiagnosed dyslipidaemia, with the greatest occurrence being reported among females. Occurrence of dyslipidaemia was highest among Africans (18/32, 56.25%). Particularly concerning is the occurrence of dyslipidaemia from as early as less than 20 years.

Staff: A total of 52/282 (18.44%) staff members had potentially undiagnosed dyslipidaemia, with the greatest occurrence being reported among females. The Ethnicity stratification showed greater occurrence amongst Africans. The greatest occurrence of potentially undiagnosed dyslipidaemia was reported among participants within the 50-54 age band.

The full profile on occurrence of dyslipidaemia is presented in Appendix F (Table E9 and E10). Table 4.9 summarizes the occurrence of potentially dyslipidaemia amongst the two designations.

Table 4.9: Occurrence of potentially undiagnosed dyslipidaemia

	Students		Staff	
	Undesirable n = 32 (%)	**P value**	**Undesirable n = 52 (%)**	**P value**
Gender				
Female	22 (68.75)	0.010*	32 (61.54)	0.228
Male	9 (28.13)		15 (28.85)	

	Students		Staff	
	Undesirable n = 32 (%)	**P value**	**Undesirable n = 52 (%)**	**P value**
Other	1 (3.13)		5 (9.62)	
Total	**32 (100.00)**		**52 (100.00)**	
Ethnicity				
African	18 (56.25)	0.000*	27 (51.92)	0.003*
Arab	0 (0.00)		0 (0.00)	
East Asian	2 (6.25)		3 (5.77)	
Mixed	2 (6.25)		2 (3.85)	
South Asian	1 (3.13)		5 (9.62)	
White	5 (15.63)		7 (13.46)	
Other	4 (12.50)		8 (15.38)	
Total	**32 (100.00)**		**52 (100.00)**	
Age				
< 20	4 (12.50)	0.001*	0 (0.00)	0.756
20-24	16 (50.00)		1 (1.92)	
25-29	4 (12.50)		3 (5.77)	
30-34	1 (3.13)		9 (17.31)	
35-39	4 (12.50)		8 (15.38)	
40-44	0 (0.00)		9 (17.31)	
45-49	1 (3.13)		5 (9.62)	
50-54	1 (3.13)		10 (19.23)	
55-59	0 (0.00)		3 (5.77)	
60-64	1 (3.13)		4 (7.69)	
≥ 65	0 (0.00)		0 (0.00)	
Total	**32 (100.00)**		**52 (100.00)**	

* statistically significant

4.2.4 Obesity

4.2.4.1 Occurrence of potentially undiagnosed obesity

Students: A total of 48/411 (11.68%) students were classified as obese while 84/411 (20.44%) were overweight with the greatest occurrence being amongst females. Particularly concerning is the level of obesity among Africans 74/84 (88.10%) and the occurrence of obesity at a very young age (less than 20) amongst the student population.

Staff: A total of 79/311 (25.40%) staff members were classified as being obese, with 81.01% of these cases being females. The ethnicity stratification showed greater occurrence amongst Africans (62/79, 78.48%) as they made the greater part of the study population, however, the relationship between ethnicity and occurrence of potentially undiagnosed obesity was not statistically significant (p= 0.129). Occurrence of obesity was highest amongst participants within the 45-49

age band. The full profile on occurrence of obesity is presented in Appendix F (Table E11 and E12). Table 4.10 summarizes the occurrence of obesity amongst the two designations.

Table 4.10: Occurrence of obesity

	Students			Staff		
	Overweight n = 84 (%)	**Obese n = 48 (%)**	**P-value**	**Overweight n = 76 (%)**	**Obese n = 79 (%)**	**P-value**
Gender						
Female	57 (67.86)	37 (77.08)	0.237	40 (52.63)	64 (81.01)	0.001*
Male	25 (29.76)	7 (14.58)		29 (39.73)	11 (13.92)	
Other	2 (2.38)	4 (8.33)		6 (46.15)	4 (5.06)	
Total	**84 (100.00)**	**48 (100.00)**		**76 (100.00)**	**79 (100.00)**	
Ethnicity						
African	74 (88.10)	39 (81.25)	0.288	54 (71.05)	62 (78.48)	0.129
Arab	1 (1.19)	0 (0.00)		0 (0.00)	0 (0.00)	
East Asian	0 (0.00)	0 (0.00)		0 (0.00)	4 (80.00)	
Mixed	0 (0.00)	3 (6.25)		1 (20.00)	1 (20.00)	
South Asian	3 (3.57)	1 (2.08)		0 (0.00)	4 (80.00)	
White	1 (1.19)	2 (4.17)		6 (25.00)	5 (20.83)	
Other	5 (5.95)	3 (6.25)		11 (44.00)	7 (28.00)	
Total	**84 (100.00)**	**48 (100.00)**		**76 (100.00)**	**79 (100.00)**	
Age						
> 20	15 (17.86)	8 (16.67)	0.007*	0 (0.00)	1 (1.27)	0.159
20-24	44 (52.38)	21 (43.75)		1 (1.32)	1 (1.27)	
25-29	16 (19.05)	7 (14.58)		5 (6.58)	2 (2.53)	
30-34	3 (3.57)	7 (14.58)		9 (11.84)	15 (18.99)	
35-39	3 (3.57)	3 (6.25)		9 (11.84)	23 (29.11)	
40-44	2 (2.38)	0 (0.00)		9 (11.84)	14 (17.72)	
45-49	0 (0.00)	1 (2.08)		11 (14.47)	10 (12.66)	
50-54	0 (0.00)	1 (2.08)		13 (17.11)	4 (5.06)	
55-59	1 (1.19)	0 (0.00)		10 (13.16)	5 (6.33)	
60-64	1 (1.19)	0 (0.00)		7 (9.21)	4 (5.06)	
≥ 65	0 (0.00)	0 (0.00)		1 (1.32)	0 (0.00)	
Total	**84 (100.00)**	**48 (100.00)**		**76 (100.00)**	**79 (100.00)**	

* statistically significant

4.2.4.2 Prevalence of abdominal obesity

Waist circumference was used to determine the occurrence of abdominal obesity, which is greatly associated with the development of cardiovascular diseases. Particularly concerning is the level of abdominal obesity among females for both designations reaching 77/91 (84.61%) for students and

71/91 (78.02%) for staff members. Participants within the gender identified as other were not included in the waist circumference analysis as the determination of abdominal obesity only has cut off points for males and females (Macek *et al.,* 2020).

Table 4.11: Occurrence of abdominal obesity

Designation	Gender	Abdominal obesity		P-value
		No (%)	Yes (%)	
Students	Female	116 (72.50)	77 (84.61)	0.025*
	Male	44 (27.50)	14 (15.38)	
	Total	**160 (100.00)**	**91(100.00)**	
Staff	Female	35 (58.33)	71 (78.02)	0.030*
	Male	25 (41.67)	20 (21.98)	
	Total	**60 (100.00)**	**91 (100.00)**	

4.3 Effect of risk factors on the occurrence of potentially undiagnosed conditions statistics

Interestingly, there were more cases of potentially undiagnosed hypertension, diabetes mellitus dyslipidaemia and obesity among non-smokers (Table 4.12). However, chi-square test showed no significant differences between the two groups and the occurrence of diabetes, hypertension, dyslipidaemia.

Table 4.12: Effect of smoking on the occurrence of potentially undiagnosed conditions

Potentially undiagnosed condition	Designation	Smoker		Total (%)	P-value (%)
		Yes (%)	No (%)		
Hypertension	**Students**	6 (13.04)	40 (86.96)	46 (100.00)	0.944
	Staff	5 (7.94)	58 (92.06)	63 (100.00)	0.328
Diabetes	**Students**	0 (0.00)	1 (100.00)	1 (100.00)	0.461
	Staff	2 (100.00)	0 (0.00)	2 (100.00)	0.867
Dyslipidaemia	**Students**	5 (15.63)	27 (10.27)	32 (100.00)	0.668
	Staff	7 (13.46)	45 (86.54)	52 (100.00)	0.691
Obesity	**Students**	10 (20.83)	38 (79.17)	48 (100.00)	0.138
	Staff	6 (23.08)	73 (35.96)	79 (100.00)	0.045*

* statistically significant

None or rare alcohol drinkers were more in numbers across the four potentially undiagnosed cardiovascular related NCDs than alcohol drinkers (Table 4.13). However, chi-square test showed

no significant relationship between alcohol consumption and the occurrence of diabetes, hypertension and obesity.

Table 4.13: Effect of alcohol consumption on the occurrence of potentially undiagnosed conditions

Potentially undiagnosed condition	Designation	Alcohol consumption			Total (%)	P-value
		Never or Rarely (%)	Less than once a week (%)	Regularly (%)		
Hypertension	**Students**	29 (63.04)	14 (30.43)	3 (6.52)	46 (100.00)	0.348
	Staff	38 (61.29)	11 (17.74)	13 (20.97)	62 (100.00)	0.247
Diabetes	**Students**	1 (100.00)	0 (0.00)	0 (0.00)	1 (100.00)	0.958
	Staff	2 (100.00)	0 (0.00)	0 (0.00)	2 (100.00)	0.517
Dyslipidaemia	**Students**	18 (56.25)	7 (21.88)	7 (21.88)	32 (100.00)	0.006*
	Staff	35 (68.63)	12 (23.53)	4 (7.84)	51 (100.00)	0.292
Obesity	**Students**	32 (13.73)	8 (17.02)	7 (14.89)	47 (100.00)	0.625
	Staff	58 (74.36)	15 (19.23)	5 (15.15)	78 (100.00)	0.067

* statistically significant

4.4 Occurrence of multimorbidity

4.4.1 Co-occurrence of diagnosed conditions

Co-occurrence of diagnosed conditions was analysed among the 110 participants with at least 1 diagnosed condition. The greatest occurrence was recorded for participants with diagnosed hypertension and diabetes (12/110, 10.90%). Table 4.14 summarises the co-occurrence of diagnosed conditions amongst participants.

Table 4.14: Co-occurrence of diagnosed conditions

Designation	Hypertension and Diabetes	Hypertension and Dyslipidaemia	Dyslipidaemia and Diabetes	Dyslipidaemia, Diabetes and Hypertension
Students	0	0	0	0
Staff	12	7	5	4
Total	12	7	5	4

4.4.2 Occurrence of potentially undiagnosed conditions in diagnosed patients

The analysis was further stratified to determine the occurrence of potentially undiagnosed conditions among participants with at least one diagnosed condition (Table 4.15). There were more cases of potentially undiagnosed obesity among participants with diagnosed hypertension for both staff members and students.

Table 4.15: Occurrence of potentially undiagnosed conditions in diagnosed patients

Diagnosed condition	Designation	Potentially undiagnosed condition		
		Hypertension	Obesity	Dyslipidaemia
Hypertension	**Students**		6	3
	Staff		12	7
Diabetes	**Students**	1	0	1
	Staff	2	6	2
Dyslipidaemia	**Students**	1	2	
	Staff	9	4	

4.4.3 Co-occurrence of potentially undiagnosed conditions

Out of the 612 participants with 0 diagnosed conditions, co-occurrence of potentially undiagnosed conditions was highest for hypertension and obesity for staff members while for students it was highest for hypertension and dyslipidaemia. Table 4.16 summarises the co-occurrence of potentially undiagnosed conditions.

Table 4.16: Co-occurrence of potentially undiagnosed conditions

Conditions	Students	Staff	Total
HT and DM	0	2	2
HT and OB	8	18	26
HT and DY	10	13	23
DM and OB	0	2	2
DM and DY	0	0	0
DY and OB	3	15	18
HT, DM and OB	0	2	2
HT, DY and OB	1	3	4

HT- Hypertension**, DY –** Dyslipidaemia**, DM-** Diabetes mellitus**, OB-** Obesity

4.5 Association between bmi and other risk factors

The course of communicable diseases can be deduced by using coefficients of determination (*r*-squared), however, NCDs have a multi-faceted course, hence most of the associations in this study recorded a low *r*-squared value.

4.5.1 SBP vs BMI

Body mass index and systolic blood pressure are correlated ($r = 0.259$, $p = 0.009$). The association shows a linear and significant relationship (Figure 4.5). The *r*-squared value only elucidates approximately 7.00% of the variation in SBP by BMI ($r^2 = 0.07$). The linear prediction shows a weak positive relationship between SBP and BMI.

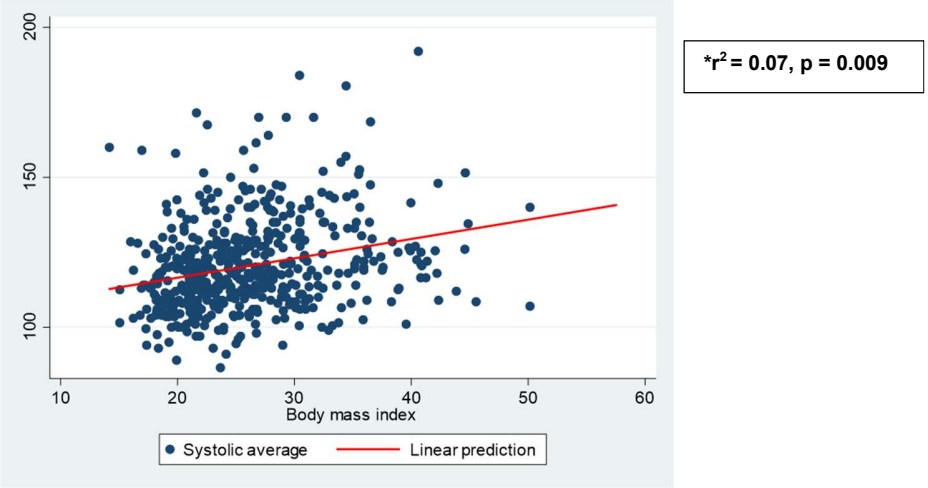

Figure 4.5: Scatter plot of SBP vs. BMI

4.5.2 DBP vs BMI

Body mass index and diastolic blood pressure are correlated ($r = 0.38$, $p < 0.001$). The association shows a linear and significant relationship (Figure 4.6). The *r*-squared value only elucidates approximately 15.00% of the variation in DBP by BMI ($r^2 = 0.15$). The linear prediction shows a weak positive relationship between DBP and BMI.

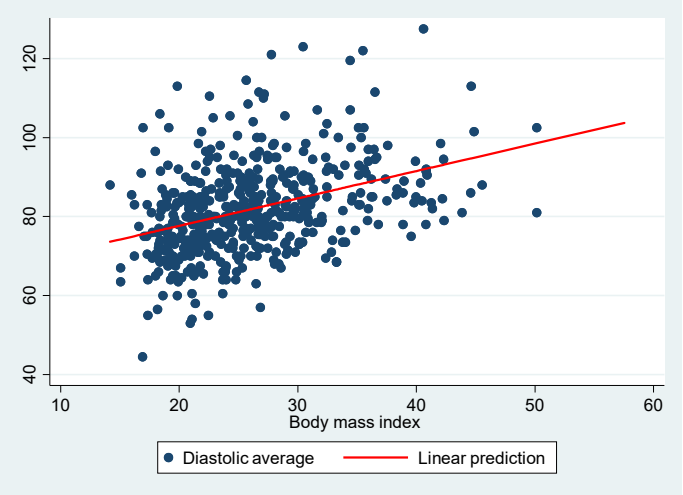

Figure 4.6: Scatter plot of DBP vs. BMI

4.5.3 Total cholesterol vs BMI

Body mass index and total cholesterol are correlated ($r = 0.10$, $p < 0.001$). The association shows a linear and significant relationship (Figure 4.7). The *r*-squared value only elucidates approximately 1.00% of the variation in total cholesterol by BMI ($r^2 = 0.01$). The linear prediction shows a weak positive relationship between TC and BMI.

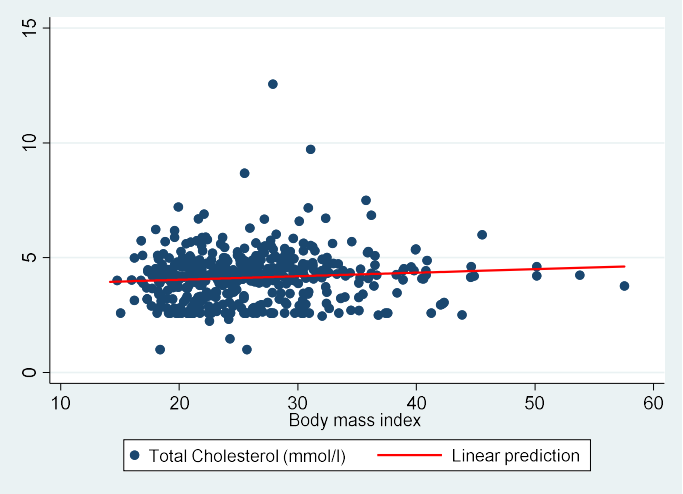

Figure 4.7: Scatter plot of TC vs. BMI

4.5.4 Blood glucose vs BMI

Blood glucose level and BMI are correlated ($r = 0.173$, $p < 0.001$). The association shows a linear and significant relationship (Figure 4.8). The *r*-squared value only elucidates approximately 3.00% of the variation in blood glucose by BMI ($r^2 = 0.03$). The linear prediction shows a weak positive relationship between blood glucose and BMI.

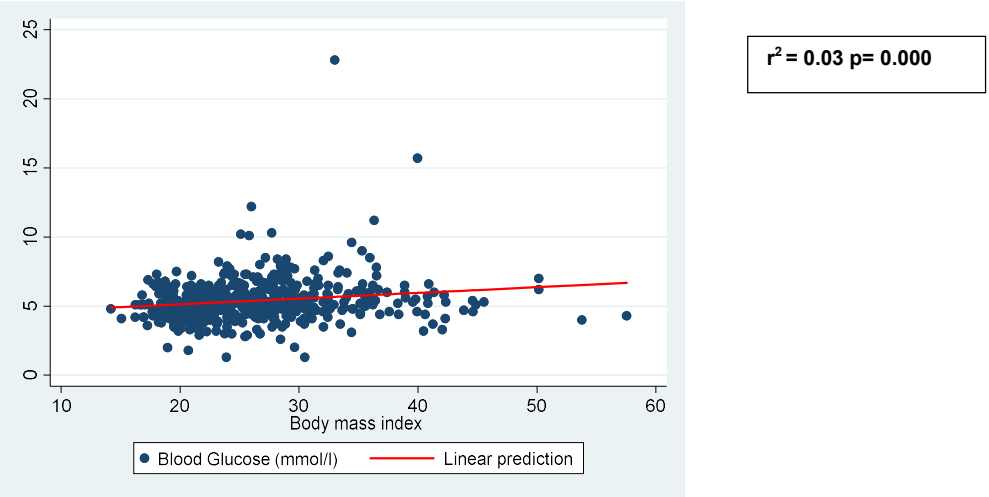

Figure 4.8: Scatter plot of Blood glucose vs. BMI

4.6 Summary of findings in relation to objectives

Objective 1: To determine the occurrence of diagnosed and uncontrolled hypertension, dyslipidaemia and diabetes amongst students/ staff at Wits University.

- The prevalence of hypertension was 4.38% for students and 18.00% for staff members. Of these, 5.56% of students and 10.71% of staff members had uncontrolled hypertension.
- The prevalence of diabetes mellitus was 0.49% for students and 4.82% for staff members. Of these, 50.00% of students and 73.77% of staff members had uncontrolled diabetes.
- The prevalence of dyslipidaemia was 2.43% for students and 9.32% for staff members. Of these, 10.00% of students and 34.48% of staff members had uncontrolled dyslipidaemia.

Objective 2: To determine the occurrence of potentially undiagnosed hypertension, dyslipidaemia, diabetes and obesity amongst students/ staff at Wits University.

- The occurrence of potentially undiagnosed hypertension was 13.74% for students and 27.06% for staff members.
- The occurrence of potentially undiagnosed diabetes was 0.24% for students and 0.68% for staff members.
- The occurrence of potentially undiagnosed dyslipidaemia was 7.98% for students and 18.44% for staff members.
- The occurrence of potentially undiagnosed obesity was 11.68% for students and 25.40% for staff members based on BMI interpretations.
- Prevalence of abdominal obesity was 22.14% for students and 29.26% for staff members.

Objective 3: To determine disease co-occurrence of screened conditions in individuals with chronic conditions and in individuals with potentially undiagnosed conditions.

- The co-occurrence of diagnosed hypertension and diabetes was more common.
- Most participants with diagnosed hypertension had potentially undiagnosed obesity.
- Obesity had the greatest co-occurrence frequency amongst participants with diagnosed hypertension, diabetes and dyslipidaemia.
- The occurrence of potentially undiagnosed hypertension and obesity was more common among participants who reported that they had zero diagnosed conditions.

Objective 4: To determine correlations between BMI and occurrence of hypertension, dyslipidaemia and diabetes.

- Increasing values of SBP, DBP, TC and blood glucose were associated with an increase in BMI.
- Obesity had a high co-existence frequency with hypertension dyslipidaemia and diabetes.

CHAPTER 5: DISCUSSION

This chapter describes the results outlined in the previous chapter and justifies the findings with other published studies.

5.1 Introduction

The retrospective study aimed to determine the occurrence of selected cardiovascular related non-communicable diseases (NCDs) (hypertension, diabetes, dyslipidaemia, and obesity) amongst students and staff members at the University of Witwatersrand. The focus of the study was on a) prevalence of cardiovascular related NCDS and their management; b) occurrence of potentially undiagnosed cardiovascular related NCDS in relation to demographics; c) co-occurrence of cardiovascular related NCDS (Both diagnosed and potentially undiagnosed); and d) effect of BMI on occurrence of the other 3 cardiovascular related NCDs (hypertension, diabetes and dyslipidaemia). This data will hopefully contribute awareness on the need to reduce the burden of cardiovascular related NCDs through disease management and prevention programs and promote the implementation of screening programs to improve management and minimize the occurrence of disease complications.

5.2 Hypertension

5.2.1 Prevalence of hypertension

In sub-Saharan Africa, the prevalence of hypertension is highest in South Africa, and this has been attributed to urbanization, unhealthy diets, sedentary lifestyle and increased alcohol consumption (Peer *et al.,* 2013). According to the 2017 World Health Organization report, prevalence of hypertension in South Africa is estimated at 27.40% for men and 26.10% for women (World Health Organization, 2017b). The data from the present study shows that the self-reported prevalence of hypertension was 4.38% for students and 18.00% for staff members. These results were slightly lower than those reported for studies conducted at universities in Kuwait and Uganda which reported that about 7.00% of students (Al-Majed and Sadek, 2012) and 34.40% of staff members had hypertension (Rampal *et al.,* 2011). A possible explanation for the slight difference in prevalence may be the fact that our study separated diagnosed cases from potentially undiagnosed cases, whereas the above-mentioned studies combined the two groups.

It was observed from the current study, that the self-reported prevalence of hypertension was higher amongst female participants within both designations (66.67% for students and 58.93% for staff members). This is consistent with the findings of Choi *et al.,* (2017) that reported a higher number of self-reported hypertension cases amongst females. Everett and Zajacova (2015) report that women are more likely to report their hypertensive status than men. Contrary to our findings, Tadesse and Alemu (2014) reported a higher prevalence of hypertension amongst male university students. However, our study did not find any significant relationship between gender and prevalence of self-reported hypertension.

5.2.1.1 Management of hypertension

There were more cases of poor diastolic control (26.79%) than those of systolic blood pressure control (10.71%) among staff members, whereas only one case was recorded for both systolic and diastolic blood pressure among students. These findings are incongruent with Banegas *et al.,* (2002), who reported more cases of systolic than those of diastolic. This difference could be attributed to the difference in population age groups studied as Banegas *et al.,* (2002)'s study population ranged from 35 to 65 years. Moreover, an elevation in SBP is more common among those aged 50 or over as a result of structural changes in the arteries such as artery stiffness (Zhang and Moran, 2017; Tee *et al.,* 2020).

On the other hand, the number of poor control cases were higher in males than in females and these results were consistent with results from Tee *et al.,* (2020) who recorded a higher proportion of poor control in males than in female university staff members. The assumption is that the high anti-inflammatory immune profile in hypertensive females acts as a compensatory mechanism to limit blood pressure increase compared to males who do not have this compensatory mechanism as they have a pro-inflammatory immune profile (Gillis and Sullivan, 2016; Sylvester and Brooks, 2019). It is important to address poor control cases as studies have shown that a mean blood pressure reduction as small as 2 mm/Hg decreases the risk of CVDs by 10.00% (Chockalingam, 2000).

5.2.2 Identifying undiagnosed hypertension

Measuring blood pressure in this study identifies 54/393 (13.74%) students and 69/255 (27.06%) staff members with potentially undiagnosed hypertension. The prevalence of potentially undiagnosed hypertension is comparable to the 29.10% recorded in USA and 30.00% recorded in England (Joffres *et al.,* 2013). Despite the fact that our figures do not include diagnosed cases, this finding adds to accumulating evidence that the prevalence of hypertension in developing countries is approaching that of developed countries (Kearney *et al.,* 2005; Joffres *et al.,* 2013; Kotwani *et al.,* 2013). The greatest occurrence was recorded amongst females within both designations (57.41% for students and 56.52% for staff members). Our findings are consistent with findings from Sharma *et al.,* (2021) that reported a higher prevalence of hypertension among females than males. Contrary to our findings, Simão *et al.,* (2008) reported greater occurrence of hypertension among amongst male undergraduate university students. Our study showed a significant relationship between gender and occurrence of potentially undiagnosed hypertension. However, the impact of gender on the occurrence of hypertension has not been clearly reported as there are contradictory results with regards to the association between gender and prevalence of hypertension.

An analysis of the separate blood pressure components showed more cases of potentially undiagnosed diastolic blood pressure (DBP) (11.70% students and 24.71% staff members) than those of systolic blood pressure (SBP) (5.34% students and 15.29% staff members) amongst both designations. Diastolic blood pressure (DBP) was greater amongst females (60.87% for students and 60.32% for staff), whereas the distribution of systolic blood pressure was similar amongst females and males. Despite the fact that SBP has been identified as a better indicator of cardiovascular risk (Basile, 2002), DBP cannot be ignored as it also influences the risk of CVDs (Flint *et al.,* 2019).

The ethnicity stratification for both diastolic (76.09% students and 73.02% staff members) and systolic blood pressure (71.43% students and 76.92% staff members) showed greater occurrence amongst the African ethnic group. However, the majority of the study population were African (78.83% students and 68.17% staff members) and no statistical significance was established in our study, which makes it difficult to conclude that occurrence of hypertension is greater amongst

Africans because of their ethnicity. Hypertension has been identified as the most common CVD risk factor amongst the African population in South Africa as urbanization predisposes them to developing hypertension (Peer *et al.,* 2013).

A key predictor of blood pressure in most populations is age, in our study, the mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) increased with age in both designations. Numerous other studies have reported an association between age and occurrence of hypertension, with greater occurrence being recorded among older people (Tee *et al.,* 2020; Sharma *et al.,* 2021). The age stratification showed a similar distribution in occurrence of diastolic blood pressure for ages 29 years and below, whereas most age bands from 30 years and above had more cases of diastolic blood pressure than systolic blood pressure for students. Staff members showed a similar distribution in occurrence of diastolic and systolic blood pressure within most age bands, however, showed a greater occurrence of systolic blood pressure for participants aged 50 and above. The rise in systolic blood pressure with advancing age have been attributed to increased peripheral vascular resistance (Sharma *et al.,* 2021). Moreover, it has been suggested that an increase in vascular resistance and most chronic diseases occur in the elderly population, due to loss of physiological function (Tee *et al.,* 2020).

5.3 Diabetes mellitus

5.3.1 Prevalence of diabetes mellitus

The present study shows that 0.49% of students and 4.28% of staff members had self-reported hypertension, with 60.00% of the staff cases being women and all student cases being males. This is in line with the prevalence rates from a study by Rao *et al.,* (2017) which reported a 2.36% prevalence rate of diabetes amongst medical college students. Our findings, are much lower than the 12.80% prevalence rate of Diabetes in South Africa (The International Diabetes Federation, 2020). This could be attributed to low reporting, as our findings were based on self-reporting.

5.3.1.1 Management of diabetes mellitus

Few of the study participants had their blood glucose controlled. Particularly concerning is the poor level of control amongst most staff members (73.33%), with most cases being recorded amongst females (63.64%) while 1 out of the 2 male students recorded poor control. Level of

control in our study was similar to finding from Rao *et al.,* (2017) that recorded 66.70% cases of poor control amongst medical college students.

5.3.2 Occurrence of potentially undiagnosed diabetes mellitus

This study identifies 1 (0.24%) student and 2 (0.68%) staff members with potentially undiagnosed diabetes mellitus. A similar study by Abou-Gamel *et al.,* (2014) recorded one case (1.01%) of potentially undiagnosed diabetes amongst university staff members and Delouky *et al.,* (2014) reported three (2.50%) cases of diabetes amongst female university students. An issue of concern with regards to differences in prevalence of diabetes, is the use of different methods to determine occurrence. Random blood glucose test is not the preferred method to determine if the patient is diabetic or not, whereas the HbA1C and fasting plasma glucose level tests are more acceptable. However, it was difficult to apply these in our study due to the random sampling method and limited resources (HbA1C kits).

A smaller proportion of the present study had prediabetes (1.96% students and 5.41% staff members), however, the number of participants with inconclusive results (25.92% students and 43.12% staff members) is concerning as this can result in underestimation of the disease burden. Although all these participants were referred for further treatment, no follow up was done to confirm if they received further help. Current data suggests that more than 50.00% of women and 75.00% of men in need hypertension and diabetes mellitus intervention in South Africa are unaware of their condition, reiterating the need for early diagnosis. Furthermore, pre-diabetes has a 25.00% - 50.00% lifetime risk of developing into diabetes and this group should be targeted for preventative strategies (Tabák *et al.,* 2012; Khan *et al.,* 2019; Van Herpt *et al.,* 2020). All potentially undiagnosed diabetes cases recorded in the present study were amongst females. Diabetes has been reported to be a stronger CVD risk factor in females than in males (Nilsson *et al.,* 2007).

Most prediabetes cases and all the potentially undiagnosed cases of diabetes were identified within the African ethnic group. However, our study did not show any significant association between ethnicity and occurrence of potentially undiagnosed diabetes. Epidemiological information have reported a growing prevalence of diabetes and other chronic conditions within the African ethnicity

in Southern Africa due to urbanization (Mbanya and Ramiaya, 2006; Azevedo and Alla, 2008). The results of this study revealed that cases of potentially undiagnosed diabetes and prediabetes from as early as 20-24 years. The early onset of diabetes may be attributed to the increasing occurrence of obesity in children (Jura and Kozak, 2016; Kinlen *et al.,* 2018).

5.4 Dyslipidaemia

5.4.1 Prevalence of dyslipidaemia

The burden of dyslipidaemia in Africa is inadequately characterized due to lack of epidemiological data (Noubiap *et al.,* 2018). A total of 2.43% students and 9.32% of staff members reported *yes* to having diagnosed dyslipidaemia. Similarly, a study in Kuwait recorded a 10.50% prevalence of dyslipidaemia among university students (AlMajed *et al.,* 2011). A longitudinal study of a community in South Africa reported that 30.00% of participants who met the criteria for dyslipidaemia had diagnosed hypertension (Reiger *et al.,* 2017a; Opoku *et al.,* 2019). We assume that our results were low as results were based on self-reported cases that are subject to bias. Our results highlighted that the prevalence of dyslipidaemia was highest among females and this is in line with a study by Reiger *et al.,* (2017a) that reported a higher prevalence of dyslipidemia amongst women. This may be attributed to the fact that women undergo several hormonal changes that have a significant effect on lipoprotein metabolism (Phan and Toth, 2014).

5.4.1.1 Management of dyslipidaemia

A total of 10.00% of students and 34.48% of staff members showed poor control of blood lipids. Similar to our findings, results from a longitudinal study of a community in South Africa reported a relatively small subset of the population had poor lipid control. Unfortunately, there is limited data in the available literature about control of dyslipidemia in South Africa. However, control of dyslipidaemia should be targeted to decrease the burden of cardiovascular related NCDs in South Africa as uncontrolled dyslipidaemia has serious cardiovascular implications which increase disability adjusted life years (DALYs) (Canadian Cardiovascular Society, 2016).

5.4.2 Occurrence of potentially undiagnosed dyslipidaemia

The occurrence of potentially undiagnosed dyslipidemia was 7.98% for students and 18.44% for staff members. A 2012 South African survey recorded that 28.00% of women and 19.00% of men

above 18 years of age had elevated total cholesterol (Reiger *et al.,* 2017). The slight difference in frequencies could be attributed to the separation of diagnosed cases from potentially undiagnosed cases. In the present study, greater occurrence was reported amongst Africans. African ethnicity has been associated with an increased occurrence of dyslipidaemia, particularly high levels of HDL-C. However, most of the participants in our study did not opt for the full lipid panel, hence only total cholesterol results were available. The greatest occurrence of potentially undiagnosed dyslipidaemia among staff members was reported among participants within the 50-54 age band and students showed an early onset of dyslipidaemia, with reports of occurrence from participants less than 20 years of age. Our findings are in line with reports from AlMajed *et al.,* (2011) who proposes the need to implement screening and nutrition programs at an early age following findings from his study on prevalence of dyslipidaemia among college students.

5.5 Obesity

5.5.1 Occurrence of potentially undiagnosed obesity

A total of 11.68% students and 25.40% staff members were classified as obese while 20.44% students and 24.44 % of staff members were classified as overweight. Our findings are congruent to those from a study conducted in Botswana that reported an overall prevalence of obesity and overweight of 36.80% amongst university students (Tapera *et al.,* 2017). Similarly, a study by Moretti *et al.,* (2014) reported a prevalence of overweight and obesity to be 35.60% among university students. Andrew *et al.,* (2016) reported that prevalence of obesity and overweight among teaching staff was 4.10% and 10.20% respectively. The high figures in our study can be attributed to the fact that our study comprised of both teaching and non-teaching staff. These results have highlighted that, despite the sensitivity surrounding the issue of obesity, the pandemic needs to be addressed.

The data from the present study suggests that obesity and overweight are more prevalent among women than in men within both designations. This data correlates with previous data reported by Steyn *et al.,* (2000) which recorded that seven out of ten women and four out of ten men in South Africa have more body fat than what is deemed to be health. Moreover, high levels of obesity among females is a recurring theme in the literature (Jean-Luc Gradidge and Crowther, 2017; Mittal, 2019; Nauli and Matin, 2019). This can be attributed to sex hormones, as body weight and

body mass index are inversely linked to sex hormone binding globulin concentration in both pre- and post-menopausal women (Hajian-Tilaki and Heidari, 2007).

The ethnicity stratifications showed greater occurrence of obesity amongst the African ethnic group (more than 70.00%). The change in diet to more sugars and saturated fats is responsible for the increasing obesity trend characterizing the emergence of cardiovascular related NCDs in South Africa, particularly in African women (Jean-Luc Gradidge and Crowther, 2017). For this study, the difference in the prevalence of obesity and overweight between the ethnic groups was insignificant; the apparently higher values for Africans could be confounded by a greater number of African participants as compared to other ethnic groups.

Distribution of obesity and overweight among students was more in the 20 to 24-year age band and showed a significant association between age and occurrence of obesity. This was different for staff, as the greatest occurrence was within the 35-39 age bands and there was no statistically significant association between age and occurrence of obesity. However, studies have documented a significant association between increasing age and occurrence of obesity and overweight (Suleiman *et al.,* 2009; Peltzer *et al.,* 2014; Andrew *et al.,* 2016).

5.5.2 Occurrence of potentially undiagnosed abdominal obesity

Occurrence of potentially undiagnosed abdominal obesity was significantly associated with gender, within both designations. The present study showed that 36.25% of students and 60.26% of staff members had potentially undiagnosed abdominal obesity. Particularly concerning is the level of abdominal obesity among females for both designations reaching 84.61% for students and 78.02% for staff members. This is in conformity with the previously stated literature findings, which highlight a dramatic increase in occurrence of obesity in South Africa due to the perils of urbanization and technological advancements (Heart and Stroke Foundation South Africa, 2017b). Our findings are in line with findings from Aljamed *et al.,* (2011) and Lubell (2012) that documented a higher prevalence of abdominal obesity in female students than in male university students. The present study also highlighted that a greater proportion of participants preferred BMI to Waist circumference as the measure for obesity.

5.6 Effect of risk factors on occurrence of potentially undiagnosed conditions

Smoking and alcohol consumption are modifiable risk factors that contribute to the occurrence of cardiovascular related NCDs. Findings from this study show that non-smokers and non or rare alcohol consumers were mostly affected by the selected cardiovascular related NCDs. This might be attributed to under-reporting or other confounding variables or low prevalence of these factors in the community studied. However, Puoane *et al.,* (2008) proposed that successful NCD control requires strong effective service approach, health promotion and prevention, particularly for modifiable risk factors such as alcohol consumption and smoking.

5.7 Occurrence of multimorbidity

This study found a high co-occurrence of diagnosed hypertension and diabetes (10.90%) amongst staff members. Several studies have reported that raised blood pressure is more common among people with diabetes than in the general population (Adler *et al.,* 2000; Balogun and Salako, 2011). Both diseases are independent risk factors for cardiovascular disease (CVD), however when they co-exist they increase the risk of CVD related morbidity and mortality (Balogun and Salako, 2011; Okpara *et al.,* 2015). The study went on to determine co-occurrence by looking at occurrence of potentially undiagnosed conditions amongst participants with diagnosed conditions, this revealed a greater occurrence of obesity amongst participants with diagnosed hypertension. Obesity had been identified as an independent risk factor of hypertension as it causes accumulation of fat that causes blockage of arteries, resulting in obstruction of blood flow (Pi-Sunyer, 2009; Dagan *et al.,* 2013; Bray *et al.,* 2018). Particularly concerning is the co-occurrence of potentially undiagnosed conditions, with the highest incidence being recorded for hypertension and obesity followed by hypertension and dyslipidaemia. These findings indicate the need for integrated chronic care wellness programs as the conditions in the present study have a greater chance of occurring together.

5.8 Association between BMI and other risk factors

Non-communicable diseases have a multi-factorial aetiology (Bigna and Noubiap, 2019), which explains why many of the associations discussed have a low r-squared value. The presence of outliers in the scatter plots which resulted in weaker positive relationships can also be attributed to the multi-factorial aetiology of cardiovascular related NCDS. Despite the multi-factorial

aetiology of NCDs, the evidence from the present study suggests that increasing levels of DBP, SBP, TC and blood glucose can be expected as the BMI increases. Similar to our findings, many studies have identified obesity as an important independent modifiable predictor of diabetes, hypertension and dyslipidaemia (Pi-Sunyer, 2009; Dagan *et al.,* 2013; Bray *et al.,* 2018).

CHAPTER 6: CONCLUSION

The limitations of the study are outlined and recommendations for further studies that are derived from the limitations are made. This chapter concludes the research report.

6.1 Limitations of the study

The following limitations were encountered during the study period:

a) The main limitation of our study were the self-reported assessments that were used to determine prevalence of the diagnosed conditions. Self-reported data may be a source of bias because individuals may not be free to disclose their health status and this could result in disease underestimation.

b) Not all blood samples drawn for the blood glucose test were fasting samples. Moreover, different types of tests were used to determine blood glucose level and were not repeated in participants with inconclusive results, which could result in underestimating the burden of disease within the university.

c) In most of the participants, lipid concentrations were measured using the total cholesterol test which does not show the ratio of individual blood lipids, which is sometimes necessary to define dyslipidaemia. For instance, triglyceride concentrations give pertinent details as a predictor of cardiovascular risk mostly when combined with elevated low density lipoprotein cholesterol concentrations and low high density lipoprotein cholesterol.

d) A limitation that might have been associated with this study was mainly with the instrument used in data collection. The questionnaire did not request information about other chronic conditions and medications participants were taking; therefore, the effect of other diseases and medications on blood pressure, blood glucose, obesity and lipids level was not considered.

e) The study sites were not setup on all campuses and for that reason, the sample might not be representative of the university hence resulting in underestimating the disease burden.

f) The was limited information to rule out if poor control was due to ineffective therapy or patient related factors such as compliance.

6.2 Recommendations

This study has found a significant burden of cardiovascular related NCDs within the academic environment. Cardiovascular related NCDS have become a global health problem, and this has been worsened by their early onset and silent profile. Therefore, we recommend intervention programs for university students and staff at an earlier age through screening, health education, and counseling. There is a need to improve on participation, we suggest getting the university more involved, through showcasing the STEPPS program so it becomes part of the university calendar.

Considering that the private sector is already a step ahead in implementation measures to reduce the burden of NCDS, we recommend that medical aid schemes collaborate with Wits University to take further measures to help potentially undiagnosed and uncontrolled participants. This collaboration can look at establishing traceable follow-up patterns and expanding the screening program to incorporate more prevalent NCDs. The translation of screening outcomes into clinical interventions motivates the clinical students to collect data as they are assured of traceable interventions. Females and the African Ethnic group need to be targeted for future interventions, as the data suggests that these groups have a higher risk of developing cardiovascular related NCDs.

Our results provide a foundation for further studies to reduce cardiovascular related NCDs prevalence and their complications. Literature has shown that inter-professional collaborations result in better health outcomes (Janson *et al.,* 2009), we therefore recommend that the screening program be extended to other departments within the School of Therapeutic Sciences. In doing so, health interventions beyond the scope of practice of pharmacists can be implemented. The use of point of care testing by students to determine disease occurrence can be implemented in more universities, while identifying strengths and weaknesses of implementation and acting on these accordingly. This will allow for comparison between universities and provinces, however, there is a need to improve screening and surveillance strategies by using a standardized tool. We recommend the expansion of the STEPPS questionnaire (Appendix G), to allow incorporation of sections that could strengthen the surveillance system and pave way for further research.

6.3 Future research

The following research areas are important as the findings will improve screening, management, and surveillance of cardiovascular related NCDs in academic institutions in South Africa:

a) Identify common behaviors within the academic environment that contribute to development of the selected cardiovascular related NCDs.
b) Determine the impact of student lead health programs such as STEPPS, on students' professional ethic.
c) To conduct similar studies in all universities in South Africa, using a standardized tool.
d) To conduct a follow up study on referred participants, to ascertain if they seek further investigation from health care facilities.
e) To determine the effectiveness of point of care tests by determining the number of potentially undiagnosed cases that are classified as diagnosed after seeking further investigation from health care facilities.
f) To investigate the level of awareness on the selected cardiovascular related NCDs, within an academic environment.
g) A pre-implementation and post-implementation study on impact of targeted wellness program on occurrence of cardiovascular related NCDs within academic environments.
h) To compare occurrence of cardiovascular related NCDs among medical students and staff and non-medical students and staff.
i) To investigate the reason for the shift of hypertension prevalence not being gender specific.

6.4 Summary of the study

The findings of this study show that the extent of the burden of selected cardiovascular related NCDs; this will be useful in determining how the academic environment can be tailored to meet the health needs of the community. The growing prevalence of cardiovascular related NCDs continue to pressurize an already overburdened health system, to such an extent that their impact cannot be ignored. A multi-sectorial approach has been identified as a possible solution in fighting the growing burden of cardiovascular related NCDs, hence there is a need to promote use of point of tests in pharmacies as they are embedded in communities.

Use of results from this screening program has shown the effectiveness of using point of care testing for screening purposes to determine disease occurrence within a selected population. This has highlighted how promotion of screening programs in public areas such as universities and pharmacies can lead to early diagnosis, and improved disease management, thus reducing complications associated with late diagnosis. Moreover, it has shown that point of care testing is effective in determining occurrence of more than one condition which is useful in determining multimorbidity. The academic environment has been identified as a possible arena to address the burden of NCDs as the population is less likely to be aware of their potentially undiagnosed conditions. The current research provides valuable data that could be used by responsible authorities to plan strategies aiming at improving the health of future generations at the University of Witwatersrand.

Countering the burden of cardiovascular related NCDS involves the identification and targeting of females and Africans as high-risk priority groups and screening participants from as early as 20 years. This study calls for implementation of educational and awareness programs on NCDs risk factors to the University of Witwatersrand students and staff members. Orientation measures to promote participation in long-term cohort studies that aim to define the epidemiology of cardiovascular related NCDs within the University of Witwatersrand is vital. Integrated prevention, detection and control programs targeting major risk factors for cardiovascular related diseases can potentially help to decrease the observed trends.

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APPENDICES

APPENDIX A: STEPPS QUESTIONNAIRE

School of Therapeutic Sciences
Department of Pharmacy and Pharmacology
STEPPS (Screening and TEsting Programme by Pharmacist Students)

Faculty of Health Sciences · Private Bag 3, Wits, 2050, South Africa
Tel: +27 11 717 2042· Fax : +27 11 643 5415 · E-mail: ane.orchard@wits.ac.za · www.wits.ac.za

MANUAL ENTRY FORM FOR STEPPS WELLNESS DAY 2019			
PERSONAL and DEMOGRAPHIC DATA			
Name:	Designation: Staff/Student/Member of Public		
Please confirm that you understand and give permission for the Wellness Screenings to be performed on you and for your data to be recorded	☐ Yes ☐ No		
Date:	Site: Main Campus/Education Campus		
Please enter your month and year of birth	/ (MM / YYYY)		
What is your sex?	☐ Male ☐ Female		
Ethnicity (Self-Declared)	☐ African ☐ Mixed ☐ Other	☐ White ☐ East Asian	☐ South Asian ☐ Arab
MEDICAL HISTORY			
Have you ever been diagnosed with Hypertension?	☐ Yes ☐ No		
Are you currently on prescribed blood pressure lowering treatment?	☐ Yes ☐ No		
Have you ever been diagnosed with diabetes?	☐ Yes ☐ No		
Do you smoke?	☐ Yes ☐ No		
When was your blood pressure (BP) last measured?	/ (MM/YYYY) ☐ Don't know		
Have you had a heart attack in the past?	☐ Yes ☐ No		
Have you had a stroke in the past?	☐ Yes ☐ No		
To your best knowledge, are you pregnant?	☐ Yes ☐ No		
Have you ever been diagnosed with High Cholesterol?	☐ Yes ☐ No		
How often do you consume alcohol?	☐ Never or rarely ☐ Less than once a week ☐ Regularly (More than one a week)		
WELLNESS TEST SELECTED (SELECT MOST APT BASED ON HISTORY)			
☐ BMI ☐ BP ☐ Blood Glucose ☐ Total Cholesterol ☐ Waist Circumference ☐ HBA1c ☐ Lipid Panel ☐ Diabetic Foot Examination			
RESULTS			
Weight: _____kg	Height: _____m		Waist Circumference: _____cm
BP (mm/Hg) (INSERT FIGURES)	1. / p =		2. / p =

Blood Glucose: _____mmol/l	Total Cholesterol: _____mmol/l	HbA1c:_____%

Lipid Panel:	TC: _____mmol/l HDL-C: _____mmol/l Trig _____mmol/l LDL-C _____mmol/l TC/HDL Ratio: _____	BMI: _____kg/m^2

ACTIONS TAKEN	
Given appropriate lifestyle advice	□ Yes □ No
Referred for follow-up testing	□ Yes □ No
Referred for better management of Chronic Condition	□ Yes □ No

STEPPS VOLUNTEER INFORMATION	
Name	Date:
Signature:	

APPENDIX B: SCREENING INSTRUCTIONS

Section A: Blood Pressure Measurement

The Omron M6 (version HEM-7001-E, Omron, Kyoto, Japan)

Two measurements should be taken with the participant in the seated position, after resting for at least 3 minutes.

- Participant should be seated with their back supported, feet firmly on the ground and arm supported at the level of the heart.
- The length of the automated device bladder should be 80% of the circumference of the upper arm.
- Position the cuff's lower edge about an inch (2.5cm) above the elbow bend and close the cuff then secure with the Velcro fastening.
- Press the START/ON button. Let the cuff inflate and deflate and record the (1) Systolic BP, (2) Diastolic BP and (3) Pulse.
- Then Repeat (1 minute apart) and record average of the 32 readings.
- If the results are not within the normal or desired range the participant's consent is sought for this information to be indicated on the referral letter and register.

Manual Machine procedure

- An appropriate size cuff should be used. Must enclose 80% of length of upper arm and two-thirds of circumference.
- Check to see if equipment is functioning correctly. Check bulb, valve, tubing, and zero and ensure that the bladder is free of folds.
- Room should be noise free with a temperature about 21°C.
- The sphygmomanometer should be on a horizontal surface, not more than one meter away, and at eye level.
- The patient's arm should be supported on a flat surface. The arm should be horizontal at the level of the heart. The arm should be bare.
- Palpate radial and brachial pulses. Determine the middle of the bladder and place over the brachial artery with the lower end 2.5cm above the antecubital fossa. The cuff should be applied smoothly, not too tight or too loose.

- The radial pulse should be palpated with one hand while the bladder is inflated until the pulse disappears. It should be inflated an extra 30mmHg, and then deflated slowly. Remember the reading that the pulse reappears at, as the possible systolic reading.
- The air is expelled from the bladder. The stethoscope is placed lightly over the brachial artery but held firmly in place without pressure and free from interference.
- Inflate the bladder to 30mm Hg above estimated systolic reading. Deflate slowly at rate of 2-3mm Hg per second.
- Listen for Korotkoff sounds. One or two clear tapping sounds which increase in intensity until the sounds disappear. The first sound appears at the systolic pressure and the diastolic pressure is where the sounds disappear.
- Record the readings.

Section B: Diabetes Measurement

The CareSens glucose meters (I-sense Inc, Seoul, South Korea), Accucheck active (Roche Diagnostics GmbH, Mannheim, Germany) and Cardiocheck PA (PTS Diagnostics, Whitestown, USA)

- Wash hands before putting on non-sterile examination gloves.
- Take the test strip out of the vial and close the container immediately.
- The site of puncture for sample extraction from the participant's finger is wiped clean using a sterile alcohol swab. Allow time for the alcohol to evaporate.
- Set finger-pricking device at a suitable depth for thickness of skin.
- Place the finger-pricking device on the cleaned puncture site and release lancet.
- Allow time for a large enough droplet of blood to develop.
- Care is exercised when taking the blood sample and not to spill or drop blood.
- The participant's droplet sample is guided to the sample plate or capillary.
- The sample area should be saturated with blood to ensure an accurate reading.
- Equipment is cleaned with alcohol swab and sharp and test strip disposed of in a waste container and sharps bin.
- Record result on the questionnaire.

- The result is interpreted, and counselling and/or advice provided.
- If the results are not within the normal or desired range the participant's consent is sought for this information to be indicated on the referral letter and register.

HBA_1C

The A1cNow monitor is a disposable, 4-channel reflectance photometer immunoassay device integrated with dry reagent chemistry strips and contained within a sealed plastic case. Each A1cNow test kit consists of a monitor; a sample dilution kit (a vial of sample dilution buffer, a capillary pipette, a transfer pipette, and a tube holder); and a package insert.

- Wash hands before putting on non-sterile examination gloves.
- The site of puncture for sample extraction from the participant's finger is wiped clean using a sterile alcohol swab. Allow time for the alcohol to evaporate.
- Place the finger-pricking device on the cleaned puncture site and release lancet.
- Use the provided lancet device to draw blood.
- Gently touch the tip of the blood collector to the blood drop to fill.
- Fully insert Blood Collector into Sampler Body.
- Push firmly until fully inserted.
- Shake well 6-8 times (vertically). This will mix the blood with the solution.
- Stand Sampler on table while preparing the Test Cartridge.
- Open the Test Cartridge pouch.
- Insert the Test Cartridge into the Monitor until the Cartridge is "CLICKED" into position.
- Monitor and Test Cartridge codes must match.
- Wait for SMPL to display on the Monitor.
- Remove the base of the Sampler exposing the plunger.
- Ensure that the Monitor is on a level surface.
- Place the tip of the plunger into the corresponding hole in the Test Cartridge.
- Push the sampler down completely to dispense diluted sample.
- Remove quickly after the sampler is dispensed.
- Do not handle Monitor again until test is complete.
- Equipment is cleaned with alcohol swab and sharp and test strip disposed of in a waste

container and sharps bin.

- Record result on the questionnaire.
- The result is interpreted, and counselling and/or advice provided.
- If the results are not within the normal or desired range the participant's consent is sought for their information to be indicated on the referral letter and register.

Section C: Total Cholesterol test

Reagent Strip/ Accutrend plus (Roche Diagnostics GmbH, Mannheim, Germany), Cardiocheck PA (PTS Diagnostics, Whitestown, USA): The instrument is checked for correct code and re-code if necessary.

- Wash hands before putting on non-sterile examination gloves.
- Take the test strip out of the vial and close the container immediately.
- The site of puncture for sample extraction from the participant's finger is wiped clean using a sterile alcohol swab. Allow time for the alcohol to evaporate.
- Set finger-pricking device at a suitable depth for thickness of skin.
- Place the finger-pricking device on the cleaned puncture site and release lancet.
- Wipe the first drop away with cotton wool.
- Allow time for a large enough droplet of blood to develop. Care is exercised when taking the blood sample and not to spill or drop blood.
- The participant's droplet sample is guided to the strip.
- The sample area should be saturated with blood to ensure an accurate reading.
- The test field must be completely covered with blood. If too little blood is applied, do not rub it in or apply a second drop, but repeat the measurement with a fresh test strip.
- Give the participant a cotton ball to press on the puncture.
- Equipment is cleaned with alcohol swab and sharp and test strip disposed of in a waste container and sharps bin.
- Record result on the questionnaire.
- The result is interpreted, and counselling and/or advice provided.

- If the results are not within the normal or desired range the participant's consent is sought for their information to be indicated on the referral letter and register.

Lipid Panel

The CardioChek Plus (Polymer Technology Systems Inc, Indianapolis, Indiana) device is used to determine lipid profile (total cholesterol (TC), high-density lipoprotein (HDL) cholesterol, and triglycerides (TG))

- Switch the machine on using the circle button and wait for the number of the coding chip to be displayed on the screen. Compare this to the number on the vial of the strips that you are using, and check expiry date.
- Take out a strip from the vial and close the vial immediately.
- Insert the strip into the machine and ensure that it goes under the groves and fits snugly.
- The flat side should be facing downwards.
- The machine will display a sign to tell you to place the sample onto the testing area.
- Wash your hands and put on a pair of gloves.
- The site of puncture for sample extraction from the participant's finger is wiped clean using a sterile alcohol swab. Allow time for the alcohol to evaporate.
- If you are using a single use lancet, simply remove the cover using a twist and pull action and then place the lancing end of the device up to the participant's finger. Ensure that it fits snugly against the participant's finger and then press the trigger to activate it.
- Wipe away the first droplet of blood using sterile gauze/ cotton wool.
- Form a large droplet of blood, trying not to milk the finger.
- Collect the blood droplet using the BLACK pipette. The pipette has negative pressure so there is no need to press the end. Ensure that the blood fills the pipette up to indicated line (usually a black line) and that are no air bubbles in the blood sample.
- Dispense the sample of blood from the pipette onto the testing area of strip. Ensure that you do not allow the bottom of the pipette to touch the testing area of the strip.
- The machine will now indicate that it is testing.
- The results will be displayed on the screen after a beep.

- When complete, the device will show the results and you can cycle through all the results using the right-hand arrow button on the device.
- Equipment is cleaned with alcohol swab and sharp and test strip disposed of in a waste container and sharps bin.
- Record results on the questionnaire.
- The result is interpreted, and counselling and/or advice provided.

If the results are not within the normal or desired range the participant's consent is sought for their information to be indicated on the referral letter and register.

Section D: Obesity Determination

BMI calculation

Total body weight (kg) will be measured to the nearest 0.1 kg using a mechanical weighing scale and standing height will be measured to the nearest mm using a standiometer (Seca 213, Hamburg, Germany).

Height:

- Ask the participant to remove their: footwear (shoes, slippers, sandals, etc), head gear (hat, cap, hair bows, comb, ribbons, etc) and any fancy or high hairdos may have to be pressed.
- Ask the participant to stand on the board facing you.
- Ask the participant to stand with: feet together, heels against the back board and knees straight.
- Ask the participant to look straight ahead and not tilt their head up.
- Make sure eyes are the same level as the ears.
- Move the measure arm gently down onto the head of the participant and ask the participant to:

  Breathe in and stand tall.

  Read the height in centimeters at the exact point to the nearest cm and convert to meters.

  Record the height in m.

. **Weight:**

- Make sure the scales are placed on a firm, flat surface.

- Ask the participant to remove their footwear.
- They should also remove any heavy objects (e.g. keys, wallets, coins etc).
- Ask the participant to step onto scale with one foot on each side of the scale.
- Ask the participant to stand still, face forward, place arms on the side and wait until asked to step off.
- Record the weight in kg.

Calculate BMI and record the value on the questionnaire (BMI, $kg.m^{-2}$).

- Record results on the questionnaire.
- The result is interpreted, and counselling and/or advice provided.
- If the results are not within the normal or desired range the participant's consent is sought for their information to be indicated on the referral letter and register.

Waist circumference:

Waist circumference will be measured using a flexible, but inelastic measuring tape.

- The measurement may be taken over light clothing.
- This measurement should be taken at the end of a normal expiration; with the arms relaxed at the sides.
- Ask the participant to stand with their feet together with weight evenly distributed across both feet; hold the arms in a relaxed position at the sides; breathe normally for a few breaths, then make a normal expiration.
- Standing to the side of the participant, locate the last palpable rib and the top of the hip bone.
- Ask the participant to wrap the tension tape around themselves and then position the tape at the midpoint of the last palpable rib and the top of the hip bone, making sure to wrap the tape over the same spot on the opposite side.
- Ensure constant tension in the TAPE and the tape remains horizontal to the hip bone
- Record results (in cm) on the questionnaire.
- The result is interpreted, and counselling and/or advice provided.
- If the results are not within the normal or desired range the participant's consent is sought for their information to be indicated on the referral letter and register.

APPENDIX C: PERMISSION TO ACCESS STEPPS DATA

Department of Pharmacy and Pharmacology, Clinical Pharmacy Lecturer
Faculty of Health Sciences I 7 York Road Parktown, 2193 I Johannesburg I South Africa I ane.orchard@wits.ac.za

28 May 2020

To whom it may concern,

RE: CONFIRMATION OF USE OF 2019 STEPPS DATA

This letter serves to grant Ms Pauline Tendai Maniki permission, with conditions, to use the 2019 STEPPS data for her Masters dissertation titled "*A quantitative assessment of cardiovascular related non-communicable disease occurrence at a South African academic environment: a pharmacy students' health promotion initiative*", Supervised by Mrs Neelaveni Padayachee (40%), Dr Ané Orchard (40%), Mrs Razeeya Khan (10%) and Ms Stephanie Leigh de Rapper (10%).

The design of STEPPS, and the process of collecting this data, is due to a teamwork of Dr Ané Orchard with Mr Muhammed Vally and Mr David Bayever. Thus, the first condition for using this data is that any output, whether publication or conference proceeding, includes all three team members as authors, and that any data analysis and output be shared and approved by each of these three STEPPS team members.

The second condition is that this data may be used by no one, other than by Ms Pauline Tendai Maniki's for her dissertation or by Dr Ané Orchard.

Yours Sincerely,

Dr Ané Orchard I Clinical Pharmacy Lecturer
STEPPS co-ordinator
Undergraduate Special project co-ordinator
University of the Witwatersrand I Faculty of Health Sciences
7 York Road, Parktown, 2193 Johannesburg, South Africa
E: ane.orchard@wits.ac.za

APPENDIX D: ETHICS APPROVAL

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

R14/49 «Tit init name»

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M190921 MED19-07-037

NAME: (Principal Investigator)	Miss Pauline Tendai Manjiki
DEPARTMENT:	Pharmacy and Pharmacology
PROJECT TITLE:	A quatitative assessment of cardiovascular related non-communicable diseases occurrence at a South African academic environment: a pharmacy students' health promotion initiative
DATE CONSIDERED:	27/09/2019 (Initial approval: 06/11/2019)
DECISION:	Approved unconditionally
CONDITIONS:	Title Change
SUPERVISOR:	Mrs N Padayachee, Dr A Orchard, Mrs R Khan and Miss S De Rapper
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	03/02/2020

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the Third Floor, Faculty of Health Sciences, Phillip Tobias Building, 29 Princess of Wales Terrace, Parktown, 2193, University of the Witwatersrand. I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report.** The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. In this case, the study was initially reviewed in **September** and will therefore be due in the month of **September** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

Date 03/03/2020

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX E: ETHICS APPROVAL – AMENDED STUDY

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG	HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

2020/09/04

Ms PT Maniki
School of Therapeutic Sciences
Department of Pharmacy and Pharmacology
Medical School
University

Sent by e-mail to: tendymaniki@gmail.com

Dear Ms Maniki

Re: **Protocol Ref No: M190921**
Protocol Title: *A quantitative assessment of cardiovascular related non-communicable diseases occurence in a South African academic environment: a pharmacy students' health promotion initiative*
Principal Investigator: Ms PT Maniki

Thank you for your letter of 2020/08/24.

I confirm that your proposal to amend your study to be a review of retrospective data from the *REDCAP* database has been noted and approved.

Thank you for keeping us informed.

Yours Sincerely

J. Burns

.....

Mr I Burns
For the Human Research Ethics Committee (Medical)

CB Penny

.....

Dr CB Penny, Chairperson, Human Research Ethics Committee (Medical)

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APPENDIX F: RESULTS FULL TABLES

Section A - Hypertension

Table E1 Combined blood pressure profile for undiagnosed students

Designation	Gender	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
Students	Female	208 (68.42)	31 (57.41)	27 (77.14)	0.040*
	Male	79 (25.99)	15 (27.28)	8 (22.86)	
	Other	17 (5.59)	8 (14.81)	0 (0.00)	
	Total	**304 (100.00)**	**54 (100.00)**	**35 (100.00)**	

Table E2 Combined blood pressure profile for undiagnosed staff members

Designation	Gender	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
Staff	Female	103 (63.58)	39 (56.52)	13 (54.17)	0.030*
	Male	49 (30.25)	27 (39.13)	5 (20.83)	
	Other	10 (6.17)	3 (4.35)	6 (25.00)	
	Total	**162 (100.00)**	**69 (100.00)**	**24 (100.00)**	

Table E3 Occurrence of potentially undiagnosed diastolic blood pressure - Students

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
Gender				
Female	212 (67.73)	28 (60.87)	26 (76.47)	**0.043***
Male	83 (26.52)	11 (23.91)	8 (7.84)	
Other	18 (5.75)	7 (15.22)	0 (0.00)	
Total	**313 (100.00)**	**46 (100.00)**	**34 (100.00)**	
Ethnicity				
African	252 (80.51)	35 (76.09)	23 (67.65	**0.605**
Other	23 (7.53)	6 (13.04)	6 (17.65)	
South Asian	14 (4.47)	1 (2.17)	1 (2.94)	
White	9 (2.88)	3 (6.52)	2 (5.88)	

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
Mixed	8 (2.56)	0 (0.00)	1 (2.94)	
East Asian	5 (1.60)	1 (2.17)	1 (2.94)	
Arab	2 (0.64))	0 (0.00)	0 (0.00)	
Total	**313 (100.00)**	**46 (100.00)**	**34 (100.00)**	
Age				
< 20	76 (24.28)	9 (19.57)	7 (20.59)	0.001*
20-24	175 (55.91)	22 (47.83)	15 (44.12)	
25-29	45 (14.38)	5 (10.87)	6 (17.65)	
30-34	9 (2.88)	5 (10.87)	3 (8.82)	
35-39	5 (1.60)	2 (4.35)	2 (5.88)	
40-44	0 (0.00)	2 (4.35)	0 (0.00)	
45-49	2 (0.64)	1 (2.17)	0 (0.00)	
50-54	0 (0.00)	0 (0.00)	1 (2.94)	
60-64	1 (0.32)	0 (0.00)	0 (0.00)	
Total	**313 (100.00)**	**46 (100.00)**	**34 (100.00)**	

Table E4 Occurrence of potentially undiagnosed diastolic blood pressure - Students

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P value
Female	231 (68.55)	8 (38.10)	26 (76.47)	
Male	85 (25.22)	9 (42.86)	8 (23.53)	
Other	21 (6.23)	4 (19.05)	0 (0.00)	0.010*
Total	**337 (100.00)**	**21 (100.000**	**34 (100.00)**	
Ethnicity				
African	271 (80.42)	15 (71.43)	24 (70.59)	
Arab	2 (0.59)	0 (0.00)	0 (0.000	
East Asian	6 (1.78)	0 (0.00)	1 (2.94)	0.711
Mixed	8 (2.37)	0 (0.00)	1 (2.94)	
South Asian	14 (4.15)	1 (4.76)	1 (2.94)	
White	11 (3.26)	1 (4.76)	2 (5.88)	
Other	25 (7.42)	4 (19.05)	6 (17.65)	
Total	**337 (100.00)**	**21 (100.00)**	**34 (100.00)**	

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P value
Age				
< 20	80 (23.74)	5 (23.21)	6 (17.65)	0.001*
20-24	184 (54.60)	12 (57.14)	16 (47.06)	
25-29	48 (14.24)	2 (9.52)	6 (17.65)	
30-34	14 (4.15)	0 (0.00)	3 (8.82)	
35-39	7 (2.08)	0 (0.00)	2 (5.88)	
40-44	1 (0.30)	1 (4.76)	0 (0.00)	
45-49	3 (0.89)	0 (0.00)	0 (0.00)	
50-54	0 (0.00)	0 (0.00)	1 (2.94)	
60-64	0 (0.00)	1 (4.76)	0 (0.00)	
Total	**337 (100.00)**	**21 (100.00)**	**34 (100.00)**	

Table E5 Occurrence of potentially undiagnosed diastolic blood pressure - Staff

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
Gender				
Female	104 (61.90)	38 (60.32)	13 (54.17)	0.015*
Male	54 (32.14)	22 (34.92)	5 (20.83)	
Other	10 (5.95)	3 (15.79)	6 (25.00)	
Total	**168 (100.00)**	**63 (100.00)**	**24 (100.00)**	
Ethnicity				
African	113 (67.26)	46 (73.02)	13 (54.17)	0.161
Other	22 (13.10)	5 (7.94)	5 (20.83)	
White	17 (10.12)	10 (15.87)	1 (4.17)	
Mixed	6 (3.57)	2 (3.17)	3 (12.50)	
South Asian	6 (3.57)	0 (0.00)	1 (4.17)	
East Asian	4 (2.38)	0 (0.00)	1 (4.17)	
Total	**168 (100.00)**	**63 (100.00)**	**24 (100.00)**	
Age				
< 20	1 (0.60)	1 (1.59)	0 (0.00)	
20-24	5 (2.98)	0 (0.00)	1 (4.17)	
25-29	10 (5.85)	2 (3.17)	1 (4.17)	
30-34	41 (24.41)	10 (15.87)	3 (12.50)	

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P-value
35-39	37 (22.02)	12 (19.05)	6 (25.00)	0.298
40-44	21 (12.50)	11 (17.46)	1 (4.17)	
45-49	15 (8.93)	10 (15.87)	4 (16.67)	
50-54	20 (11.90)	5 (7.94)	7 (29.17)	
55-59	9 (5.36)	6 (9.52)	0 (0.00)	
60-64	7 (4.17)	5 (7.94)	1 (4.17)	
≥ 65	2 (1.19)	1 (1.59)	0 (0.00)	
Total	**168 (100.00)**	**63 (100.00)**	**24 (100.00)**	

Table E6 Occurrence of potentially undiagnosed diastolic blood pressure - Staff

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P value
Gender				
Female	123 (64.06)	19 (48.72)	13 (54.17)	0.001*
Male	57 (29.69)	19 (48.72)	5 (20.83)	
Other	12 (6.25)	1 (2.56)	6 (25.00)	
Total	**192 (100.00)**	**39 (100.00)**	**24 (100.00)**	
Ethnicity				
African	129 (67.19)	30 (76.92)	13 (54.17)	0.286
East Asian	4 (2.08)	0 (0.00)	1 (4.17)	
Mixed	8 (4.17)	0 (0.00)	3 (12.50)	
South Asian	6 (3.13)	0 (0.00)	1 (4.17)	
White	22 (11.46)	5 (12.82)	1 (4.17)	
Other	23 (11.98)	4 (10.26)	5 (20.83)	
Total	**192 (100.00)**	**39 (100.00)**	**24 (100.00)**	
Age				
< 20	2 (1.04)	0 (0.00)	0 (0.00)	0.001*
20-24	5 (2.60)	0 (0.00)	1 (4.17)	
25-29	12 (6.25)	0 (0.00)	1 (4.17)	
30-34	45 (23.44)	6 (15.38)	3 (12.50)	
35-39	43 (22.40)	6 (15.38)	6 (25.00)	
40-44	26 (13.54)	6 (15.38)	1 (4.17)	
45-49	21 (10.94)	4 (10.26)	4 (16.67)	
50-54	23 (11.98)	2 (5.13)	7 (29.17)	

	Normotensive (%)	Hypertensive (%)	Unknown (%)	P value
55-59	6 (3.13)	9 (23.08)	0 (0.00)	
60-64	8 (4.17)	4 (10.26)	1 (4.17)	
≥ 65	1 (0.52)	2 (5.13)	0 (0.00)	
Total	**192 (100.00)**	**39 (100.00)**	**24 (100.00)**	

Section B: Diabetes Mellitus

Table E7 – Occurrence of potentially undiagnosed diabetes among Students

	Diabetes excluded (%)	Inconclusive (%)	Prediabetes (%)	Diabetic (%)	Unknown (%)	P value
Gender						
Female	185 (71.71)	67 (63.21)	4 (50.00)	1(0.39)	20 (57.14)	
Male	59 (22.87)	30 (28.30)	4 (50.00)	0 (0.00)	12 (34.29)	0.419
Other	14 (5.43)	9 (8.49)	0 (0.00)	0 (0.00)	3 (8.57)	
Total	**258 (100.00)**	**106 (100.00)**	**8 (100.00)**	**1 (100.00)**	**35 (100.00)**	
Ethnicity						
African	206 (79.84)	79 (74.53)	8 (100.00)	1 (100.00)	27 (77.14)	
Arab	2 (0.78)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
East Asian	3 (1.16)	4 (3.77)	0 (0.00)	0 (0.00)	0 (0.00)	
Mixed	6 (2.33)	4 (3.77)	0 (0.00)	0 (0.00)	0 (0.00)	0.937
South Asian	12 (4.65)	3 (2.83)	0 (0.00)	0 (0.00)	2 (5.71)	
White	10 (3.88)	2 (1.89)	0 (0.00)	0 (0.00)	2 (5.71)	
Other	19 (7.36)	14 (13.21)	0 (0.00)	0 (0.00)	4 (11.43)	
Total	**258 (100.00)**	**106 (100.00)**	**8 (100.00)**	**1 (100.00)**	**35 (100.00)**	
Age						
< 20	63 (24.42)	22 (20.75)	0 (0.00)	0 (0.00)	8 (22.86)	
20-24	141 (54.65)	55 (51.89)	4 (50.00)	1 (100.00)	17 (48.57)	

	Diabetes excluded (%)	Inconclusive (%)	Prediabetes (%)	Diabetic (%)	Unknown (%)	P value
25-29	35 (13.57)	15 (14.15)	1 (12.50)	0 (0.00)	7 (20.00)	
30-34	13 (5.04)	1 (0.94)	1 (12.50)	0 (0.00)	2 (5.71)	
35-39	3 (1.16)	6 (5.66)	1 (12.50)	0 (0.00)	1 (2.86)	
40-44	1 (0.39)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0.390
45-49	1 (0.39)	2 (1.89)	1 (12.50)	0 (0.00)	0 (0.00)	
50-54	1 (0.39)	1 (0.94)	0 (0.00)	0 (0.00)	0 (0.00)	
55-59	0 (0.00)	1 (0.94)	0 (0.00)	0 (0.00)	0 (0.00)	
60-64	0 (0.00)	2 (1.89)	0 (0.00)	0 (0.00)	0 (0.00)	
≥ 65	0 (0.00)	1 (0.94)	0 (0.00)	0 (0.00)	0 (0.00)	
Total	**259 (63.02)**	**106 (100.00)**	**8 (100.00)**	**1 (0.24)**	**35 (100.00)**	

Table E8: Occurrence of Potentially undiagnosed Diabetes amongst Staff members

	Diabetes excluded (%)	Inconclusive (%)	Prediabetes (%)	Diabetic (%)	Unknown (%)	P value
Gender						
Female	88 (64.71)	68 (58.62)	7 (43.75)	2 (100.00)	14 (56.00)	
Male	39 (28.68)	36 (31.03)	8 (50.00)	0 (0.00)	11 (44.00)	
Other	9 (6.62)	12 (10.34)	1 (6.25)	0 (0.00)	0 (0.00)	0.328
Total	136 (100.00)	116 (100.000	16 (100.00)	2 (100.00)	25 (100.00)	
Ethnicity						
African	95 (69.85)	73 (62.93)	11 (68.75)	2 (100.00)	18 (72.00)	
East Asian	1 (0.74)	4 (3.45)	1 (16.67)	0 (0.00)	0 (0.00)	
Mixed	6 (4.41)	5 (4.31)	0 (0.00)	0 (0.00)	1 (4.00)	

	Diabetes excluded (%)	Inconclusive (%)	Prediabetes (%)	Diabetic (%)	Unknown (%)	P value
South Asian	5 (3.68)	3 (2.59)	0 (0.00)	0 (0.00)	0 (0.00)	
White	14 (10.29)	13 (11.21)	1 (6.25)	0 (0.00)	4 (16.00)	0.934
Other	15 (11.03)	18 (15.52)	3 (18.75)	0 (0.00)	2 (8.00)	
Total	**136 (100.000**	**116 (100.00)**	**16 (100.00)**	**2 (100.00)**	**25 (100.00)**	
Age						
< 20	1 (0.74)	1 (0.86)	0 (0.00)	0 (0.00)	0 (0.00)	
20-24	4 (2.94)	2 (1.72)	0 (0.00)	0 (0.00)	0 (0.00)	
25-29	9 (6.62)	5 (4.31)	0 (0.00)	0 (0.00)	1 (4.00)	
30-34	30 (22.06)	22 (18.97)	2 (12.50)	0 (0.00)	4 (16.00)	
35-39	25 (18.38)	28 (24.14)	1 (6.25)	0 (0.00)	5 (20.00)	
40-44	21 (15.44)	13 (11.21)	1 (6.25)	0 (0.00)	5 (20.00)	0.234
45-49	18 (13.24)	10 (8.62)	2 (12.50)	1 (50.00)	6 (24.00)	
50-54	14 (10.29)	17 (14.66)	4 (25.00)	1 (50.00)	2 (8.00)	
55-59	5 (3.68)	7 (6.03)	5 (31.25)	0 (0.00)	2 (8.00)	
60-64	8 (5.88)	9 (7.76)	0 (0.00)	0 (0.00)	0 (0.00)	
≥ 65	1 (0.74)	2 (1.72)	1 (6.25)	0 (0.00)	0 (0.00)	
Total	**138 (44.37)**	**120 (38.59)**	**20 (6.43)**	**6 (1.93)**	**25 (100.00)**	

Section C: Dyslipidaemia

Table E9: Occurrence of potentially undiagnosed dyslipidaemia amongst Students

	Desirable (%)	Undesirable (%)	Unknown (%)	P value
Gender				
Female	190 (70.11)	22 (68.75)	59 (60.20)	
Male	70 (25.83)	9 (28.13)	25 (25.51)	
Other	11 (4.06)	1 (3.13)	14 (14.29)	0.010*

	Desirable (%)	Undesirable (%)	Unknown (%)	P value
Total	**271 (100.00)**	**32 (100.00)**	**98 (100.00)**	
Ethnicity				
African	228 (84.13)	18 (56.25)	72 (73.47)	0.000*
Arab	0 (0.00)	0 (0.00)	1 (1.02)	
East Asian	3 (1.11)	2 (6.25)	2 (2.04)	
Mixed	6 (2.21)	2 (6.25)	1 (1.02)	
South Asian	11 (4.06)	1 (3.13)	4 (4.08)	
White	7 (2.58)	5 (15.63)	2 (2.04)	
Other	16 (5.90)	4 (12.50)	16 (16.33)	
Total	**271 (100.00)**	**32 (100.00)**	**98 (100.00)**	
Age				
< 20	63 (23.25)	4 (12.50)	25 (25.51)	0.001*
20-24	149 (54.98)	16 (50.00)	49 (50.00)	
25-29	37 (13.65)	4 (12.50)	16 (16.33)	
30-34	11(4.06)	1 (3.13)	4 (4.08)	
35-39	5 (1.85)	4 (12.50)	1 (1.02)	
40-44	2 (0.74)	0 (0.00)	0 (0.00)	
45-49	1 (0.37)	1 (3.13)	2 (2.04)	
50-54	1 (0.37)	1 (3.13)	0 (0.00)	
55-59	1 (0.37)	0 (0.00)	0 (0.00)	
60-64	0 (0.00)	1 (3.13)	1 (1.02)	
≥ 65	1 (0.37)	0 (0.00)	0 (0.00)	
Total	**271 (100.00)**	**32 (100.00)**	**98 (100.00)**	

Table E10: Occurrence of potentially undiagnosed dyslipidaemia amongst Staff members

	Desirable (%)	Undesirable (%)	Unknown (%)	P value
Gender				
Female	113 (64.57)	32 (61.54)	29 (52.73)	0.228
Male	55 (31.53)	15 (28.85)	20 (36.36	
Other	7 (4.00)	5 (9.62)	6 (10.91)	

	Desirable (%)	Undesirable (%)	Unknown (%)	P value
Total	**175 (100.00)**	**52 (100.00)**	**55 (100.00)**	
Ethnicity				
African	137 (78.29)	27 (51.92)	39 (70.91)	0.003*
East Asian	3 (1.71)	3 (5.77)	0 (0.00)	
Mixed	4 (2.29)	2 (3.85)	3 (5.45)	
South Asian	2 (1.14)	5 (9.62)	0 (0.00)	
White	14 (8.00)	7 (13.46)	4 (7.24)	
Other	15 (8.57)	8 (15.38)	9 (16.36)	
Total	**175 (100.00)**	**52 (100.00)**	**55 (100.00)**	
Age				
< 20	1 (0.57)	0 (0.00)	1 (1.82)	0.756
20-24	4 (2.29)	1 (1.92)	1 (1.82)	
25-29	11 (6.29)	3 (5.77)	1 (1.82)	
30-34	38 (21.71)	9 (17.31)	9 (16.36)	
35-39	41 (23.43)	8 (15.38)	9 (16.36)	
40-44	20 (11.43)	9 (17.31)	11 (20.00)	
45-49	20 (11.43)	5 (9.62)	8 (14.55)	
50-54	20 (11.43)	10 (19.23)	7 (12.73)	
55-59	9 (5.14)	3 (5.77)	6 (10.91)	
60-64	8 (4.57)	4 (7.69)	1 (1.82)	
≥ 65	3 (1.71)	0 (0.00)	1 (1.82)	
Total	**175 (100.00)**	**52 (100.00)**	**55 (100,00)**	

Table E11: Occurrence of Obesity amongst Students

	Underweight (%)	Normal (%)	Overweight (%)	Obese (%)	Unknown (%)	P value
Gender						
Female	26 (74.29)	119 (67.61)	57 (67.86)	37 (77.08)	39 (57.35)	

	Underweight (%)	Normal (%)	Overweight (%)	Obese (%)	Unknown (%)	P value
Male	7 (20.00)	46 (26.14)	25 (29.76)	7 (14.58)	22 (32.35)	
Other	2 (5.71)	11 (6.25)	2 (2.38)	4 (8.33)	7 (10.29)	0.237
Total	**35 (100.00)**	**176 (100.00)**	**84 (100.00)**	**48 (100.00)**	**68 (100.00)**	
Ethnicity						
African	28 (80.00)	136 (77.27)	74 (88.10)	39 (81.25)	47 (69.12)	
Arab	0 (0.00)	1 (0.57)	1 (1.19)	0 (0.00)	0 (0.00)	
East Asian	2 (5.71)	3 (1.70)	0 (0.00)	0 (0.00)	2 (2.94)	
Mixed	1 (2.86)	5 (2.84)	0 (0.00)	3 (6.25)	1 (1.47)	
South Asian	1 (2.86)	8 (4.55)	3 (3.57)	1 (2.08)	4 (5.88)	0.288
White	0 (0.00)	9 (5.11)	1 (1.19)	2 (4.17)	2 (2.94)	
Other	3 (8.57)	14 (7.95)	5 (5.95)	3 (6.25)	12 (17.65)	
Total	**35 (100.00)**	**176 (100.00)**	**84 (100.00)**	**48 (100.00)**	**68 (100.00)**	
Age						
< 20	9 (25.71)	47 (26.70)	15 (17.86)	8 (16.67)	14 (20.59	
20-24	22 (62.86)	103 (58.52)	44 (52.38)	21 (43.75)	29 (42.65)	
25-29	3 (8.57)	18 (10.23)	16 (19.05)	7 (14.58)	15 (22.06)	
30-34	0 (0.00)	6 (3.41)	3 (3.57)	7 (14.58)	1 (1.47)	0.007*
35-39	0 (0.00)	2 (1.14)	3 (3.57)	3 (6.25)	3 (4.41)	
40-44	0 (0)	0 (0)	2 (2.38)	0 (0.00)	0 (0.00)	
45-49	1 (2.86)	0 (0.00)	0 (0.00)	1 (2.08)	1 (1.47)	
50-54	0 (0.00)	0 (0.00)	0 (0.00)	1 (2.08)	1 (1.47)	
55-59	0 (0.00)	0 (0.00)	1 (1.19)	0 (0.00)	0 (0.00)	
60-64	0 (0.00)	0 (0.00)	1 (1.19)	0 (0.00)	0 (0.00)	
≥ 65	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (1.47)	

	Underweight (%)	Normal (%)	Overweight (%)	Obese (%)	Unknown (%)	P value
Total	**35 (100.00)**	**176 (100.00)**	**84 (100.00)**	**48 (100.00)**	**68 (100.00)**	

Table E12: Occurrence of obesity amongst Staff members

	Underweight (%)	Normal (%)	Overweight (%)	Obese (%)	Unknown (%)	P value
Gender						
Female	3 (42.86)	36 (53.73)	40 (52.63)	64 (81.01)	45 (54.88)	
Male	3 (42.86)	29 (43.28)	29 (39.73)	11 (13.92)	27 (32.93)	0.001*
Other	1 (14.29)	2 (2.99)	6 (46.15)	4 (5.06)	10 (12.20)	
Total	**7 (100)**	**67 (100.00)**	**76 (100.00)**	**79 (100.00)**	**82 (100.00)**	
Ethnicity						
African	6 (85.71)	43 (64.18)	54 (71.05)	62 (78.48)	47 (57.32)	
East Asian	0 (0.00)	1 (20.00)	0 (0.00)	4 (80.00)	1 (1.22)	
Mixed	0 (0.00)	3 (60.00)	1 (20.00)	1 (20.00)	7 (8.54)	
South Asian	0 (0.00)	1 (20.00)	0 (0.00)	4 (80.00)	8 (2.57)	0.129
White	0 (0.00)	13 (54.17)	6 (25.00)	5 (20.83)	32 (10.29)	
Other	1 (14.29)	6 (24.00)	11 (44.00)	7 (28.00)	41 (13.18)	
Total	**7 (100.00)**	**67 (100.00)**	**76 (100.00)**	**79 (100.00)**	**82 (100.00)**	
Age						
< 20	0 (0.00)	1 (1.49)	0 (0.00)	1 (1.27)	0 (0.00)	
20-24	1 (14.29)	2 (2.99)	1 (1.32)	1 (1.27)	1 (1.22)	
25-29	1 (14.29)	3 (4.48)	5 (6.58)	2 (2.53)	4 (4.88)	
30-34	0 (0.00)	21 (31.34)	9 (11.84)	15 (18.99)	14 (17.07)	0.159

	Underweight (%)	**Normal (%)**	**Overweight (%)**	**Obese (%)**	**Unknown (%)**	**P value**
35-39	2 (28.57)	15 (22.39)	9 (11.84)	23 (29.11)	10 (12.20)	
40-44	2 (28.57)	6 (8.96)	9 (11.84)	14 (17.72)	12 (14.63)	
45-49	1 (14.29)	5 (7.46)	11 (14.47)	10 (12.66)	10 (12.20)	
50-54	0 (0.00)	7 (10.45)	13 (17.11)	4 (5.06)	16 (19.51)	
55-59	0 (0.00)	3 (4.48)	10 (13.16)	5 (6.33)	8 (9.76)	
60-64	0 (0.00)	3 (4.48)	7 (9.21)	4 (5.06)	6 (7.32)	
≥ 65	0 (0.00)	1 (1.49)	1 (1.32)	0 (0.00)	1 (1.22)	
Total	**7 (100.00)**	**67 (100.00)**	**76 (100.00)**	**79 (100.00)**	**82 (100.00)**	

APPENDIX G: RECOMMENDED STEPPS QUESTIONNAIRE

MANUAL ENTRY QUESTIONNAIRE FOR STEPPS WELLNESS DAY	
PERSONAL & DEMOGRAPHIC DATA	
Date:	Designation: ☐ Staff ☐ Student ☐ Other
Please confirm that you understand and give permission for the Wellness Screenings to be performed on you and for your data to be recorded	☐ Yes ☐ No
Site	☐ Main Campus ☐ Education Campus
Please indicate your age range	☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 55-64 ☐ 65 and above
What is your sex?	☐ Male ☐ Female ☐ Other
Ethnicity (Self-declared)	☐ Black ☐ White ☐ Indian ☐ Mixed ☐ Asian ☐ Other
Level of education	☐ Primary School ☐ Secondary School ☐ Matric Certificate ☐ Certificate ☐ Diploma ☐ Bachelors/Honours ☐ Masters degree ☐ PHD
What is your Occupation	
Are you on medical aid	☐ Yes ☐ No
If on medical aid, are you on any medical aid specific diabetes/hypertension/dyslipidaemia program?	☐ Yes ☐ No
MEDICAL HISTORY	
Have you ever been diagnosed with Hypertension? (except in pregnancy)	☐ Yes ☐ No
Do you have a family history of Hypertension?	☐ Yes ☐ No
When was your blood pressure (BP) last measured?	☐ Never ☐ Over 12 Months ago ☐ Within the last 12 months
Are you currently on prescribed blood pressure lowering treatment? If yes, please specify the medication? For how long have you been taking the medication?	☐ Yes ☐ No ☐ Less than 1 year ☐ 1-5years ☐ >5years
Have you ever been diagnosed with diabetes? (except in pregnancy) If yes specify	☐ Yes ☐ No ☐ Type 1 ☐ Type 2 ☐ Other
Do you have a family history of diabetes?	☐ Yes ☐ No
When was your blood glucose level last measured	☐ Never ☐ Over 12 Months ago ☐ Within the last 12 months
Are you currently on prescribed diabetes medication? If yes specify the medication For how long have you been taking the medication?	☐ Yes ☐ No ☐ Less than 1 year ☐ 1-5years ☐ >5years
Have you ever been diagnosed with High Cholesterol?	☐ Yes ☐ No
Do you have a family history of high cholesterol	☐ Yes ☐ No
When was your Cholesterol level last measured?	☐ Never ☐ Over 12 Months ago ☐ Within the last 12 months

Are you on any cholesterol lowering medication? If yes specify the medication For how long have you been taking the medication?	☐ Yes ☐ No ☐ Less than 1 year ☐ 1-5years ☐ >5years
Have you ever been classified as overweight or obese by a health professional?	☐ Yes ☐ No
Are you on any prescribed weight loss medication? If yes specify the medication For how long have you been taking the medication?	☐ Yes ☐ No ☐ Less than 1 year ☐ 1-5years ☐ >5years
To your best knowledge, are you pregnant?	☐ Yes ☐ No
How often do you consume alcohol?	☐ Never or rarely ☐ Less than once a week ☐ Regularly (More than one a week)
Do you smoke?	☐ Yes ☐ No
Are you currently fasting?	☐ Yes ☐ No
Do you have any other chronic condition besides the ones indicated above? If yes specify	☐ Yes ☐ No
Are you currently taking any other chronic or natural medication? If yes specify	☐ Yes ☐ No
Are you currently on other medication that is not chronic? If yes specify	☐ Yes ☐ No

WELLNESS TEST SELECTED (SELECT MOST APT BASED ON HISTORY)

☐ BMI ☐ BP ☐ Blood Glucose ☐ Total Cholesterol ☐ Waist Circumference ☐ HBA1c
☐ Lipid Panel

RESULTS

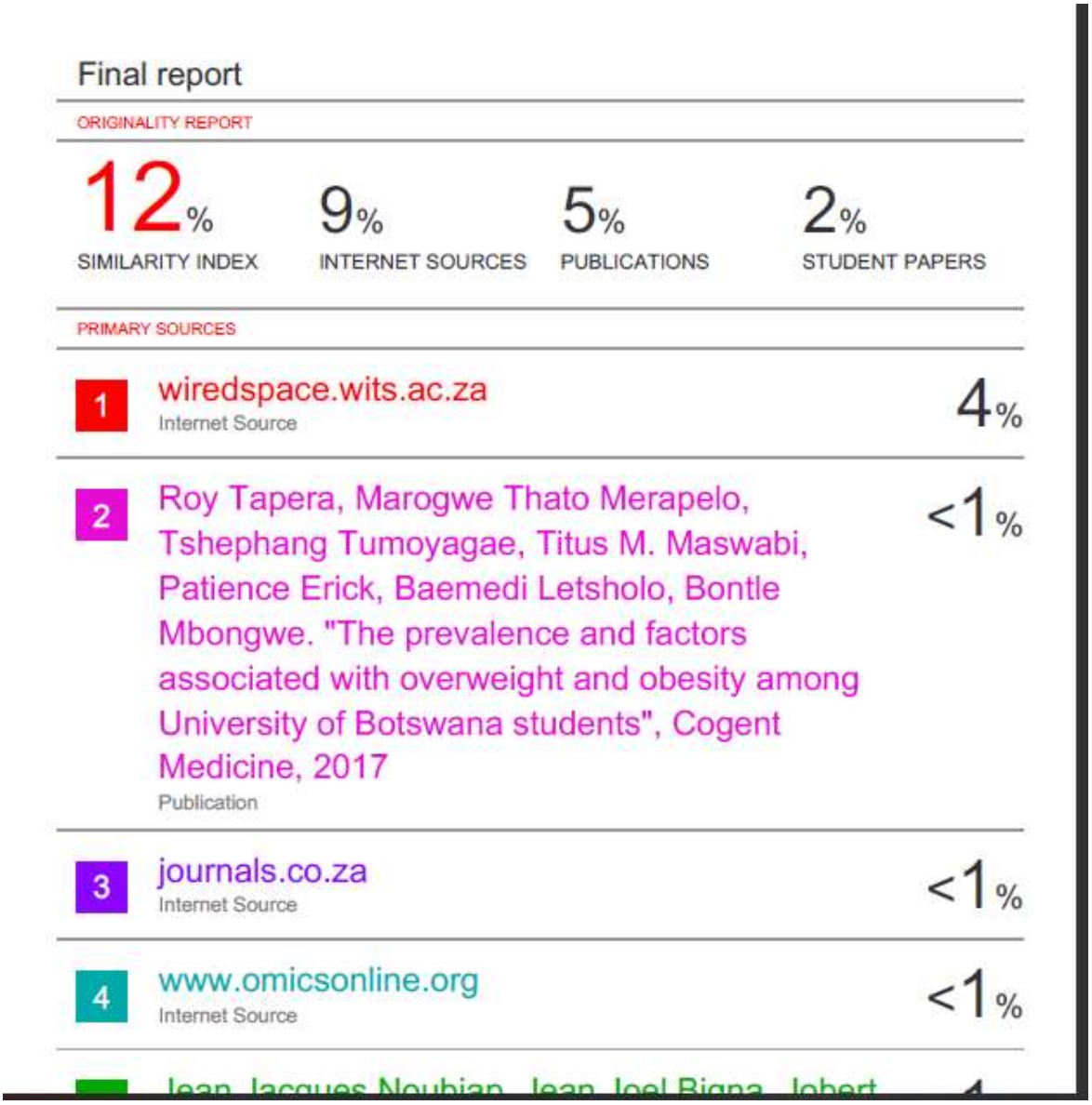
Weight: _____kg	Height: _____m	Waist Circumference: _____cm
BP (mm/Hg) (INSERT FIGURES) **1.** / p =	Device used: **2.** / p =	**3.** / p =
Blood Glucose: _____mmol/l Device: Test:	Total Cholesterol: _____mmol/l Device:	HbA1c:_____%
Lipid Panel: (CardioChek PA)	TC: _____mmol/l HDL-C: _____mmol/l Trig _____mmol/l LDL-C _____mmol/l TC/HDL Ratio: _____	BMI: _____kg/m^2

ACTIONS TAKEN

Given appropriate lifestyle advice Specify type of advice given	☐ Yes ☐ No ☐ Smoking ☐ Salt restriction ☐ Exercise ☐ Diet ☐ Weight reduction

	□ Alcohol consumption
Referred for follow-up testing	□ Yes □ No
Referred for better management of Chronic Condition	□ Yes □ No
STEPPS VOLUNTEER INFORMATION	
Name	Date:
Signature:	

APPENDIX H: TURNIT-IT-IN REPORT



Final report

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