Physical activity and metabolic risk factors in relation to lifestyle behaviour among employees in the Vhembe District municipality of Limpopo Province

TC Muluvhu

Orcid.org 0000-0002-5407-377X

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Promoter: Prof MA Monyeki

Co-promoter: Prof GL Strydom

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Student number: 24710806

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DEDICATION

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DECLARATION

Prof M.A. Monyeki (Promoter and co-author), Prof G.L. Strydom (Co-promoter and co-author) and Prof A.L. Toriola (Co-author) of the three articles which form part of this thesis, hereby give permission to the candidate Mr TC Muluvhu to include articles as part of a doctoral thesis. The contribution of each co-author, both supervisory and supportive, was kept within reasonable limits and included:

Mr T.C. Muluvhu: Developing the proposal, interpretation of the results, writing of the manuscript.

Prof M.A. Monyeki: Guiding the development of the study proposal and protocol; advising and analysing on statistical analysis and statistical analyses and interpretation thereof; structure of the manuscripts; write-up and comments on the thesis.

Prof G.L. Strydom: Contributing to the write-up of articles.

Prof A.L. Toriola: Contributing to the write-up of the articles.

This thesis therefore, serves the fulfilment of the requirements for the PhD degree in Human Movement Science within Physical, Activity, Sport and Recreation (PhASRec) in the faculty of Health Sciences at the North-West University, Potchefstroom Campus.

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Prof Dr MA Monyeki

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Prof Dr GL Strydom

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Prof Dr AL Toriola

ABSTRACT

Physical inactivity and sedentary behaviour as daily habits are considered major causes of metabolic syndrome (MetS); hence, MetS is a highly prevalent health problem among employees. Therefore, increasing physical activity in daily life is considered important for the prevention of metabolic syndrome. The objectives of the study were as follows/the following:

1. To determine the relationship between selected metabolic risk factors and waist-to-height ratio among employees in the Vhembe District municipality of Limpopo Province, South Africa.
2. To investigate the relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa.
3. To examine the relationship between physical activity, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa.

A cross-sectional study was conducted among 535 participants (men = 249; women = 286) employees (aged 24–65 years). Physical activity (PA) levels were assessed using the International Physical Activity Questionnaire (IPAQ). Participants' lifestyle habits (smoking and alcohol consumption), and anthropometric, blood pressure, fasting glucose and total cholesterol measurements were undertaken using standardised protocols. Data was analysed using the statistical package for social sciences (SPSS) version 25. The results of the first objective showed that fasting glucose was positively associated with the body mass index (BMI), waist circumference (WC) and waist-to-height ratio (WHtR). Furthermore, the results showed that 25 per cent of the total participants had elevated levels of fasting glucose; women (3.8%) were more affected than males (3.2%). The results of the second objective showed that participants were classified as overweight (27%) and obese (34%), with women being more overweight (29%) and obese (48%) compared to men (24% and 17% respectively). Twenty-five percent of the participants were hypertensive with women (27%) showing a higher prevalence compared to men (22%). Based on BMI categories the obese group (35%) had a higher prevalence of hypertension in contrast to groups that were of normal weight (18%) and overweight (22%). The results also showed that all measures of body composition correlated

positively ($p \leq 0.05$) with systolic blood pressure (SBP) in the normal weight group and overweight group. Waist circumference (WC) correlated significantly with SBP (r=0.23) and WHtR correlated positively with both SBP (r=0.26) and diastolic blood pressure (DBP) (r=0.19). The results of the third objective showed that 55% employees had metabolic syndrome (MetS) according to the National Cholesterol Education Program (NCEP-ATPIII) and International Diabetes Federation (IDF) diagnostic criteria, with males having a higher percentage (87%) of MetS compared to females (26%). The results also showed that the total group of employees who participated in low physical activity (PA) had a propensity to develop MetS (odd ratio {OR} 1.17) in contrast to those who engage in moderate to high physical activity. Men classified as having a low physical activity index (PAI) showed a significantly higher risk of MetS than those with a moderate to high PAI after adjusting for age, smoking, alcohol consumption, PA and BMI (OR 5.20; 95% confidence interval {CI}:1.77–15.28). Among participants without MetS, alcohol consumption was positively correlated with DBP, SBP, BMI and WC (r =0.200; p=0,004). Smoking was positively associated with DBP in participants with MetS (r=0.158; p=0.01). The results further indicated non-significant inverse correlations between PA and MetS risk factors (all MetS riks factors). Based on the results of this study, an urgent need to develop culturally sensitive health promotion and lifestyle education programmes addressing the risk factors of MetS among municipality employees in Vhembe District.

Keywords: Physical activity, physical inactivity, metabolic risk factors, sedentary behaviours, metabolic syndrome, employees.

OPSOMMING

Fisieke onaktiwiteit en sedentêre gedrag as daaglikse gebruike, word beskou as betekenisvolle oorsake van metaboliese sindroom, wat ’n algemene gesondheidsprobleem is onder werknemers. Daarom word verhoogde fisieke aktiwiteit in die daaglikse lewe as ’n noodsaaklikheid beskou vir die voorkoming van metaboliese sindroom. Die doelstellings vir hierdie studie was drieledig nl. (i) om die verwantskap tussen geselekteerde metaboliese risikofaktore en middel-tot-lengte ratio by werknemers van die Vhembe Distriks Munisipaliteit in die Limpopo provinsie, te bepaal; (ii) om die verwantskap tussen obesiteit en bloeddruk by werknemers van die Vhembe Distriks Munisipaliteit in die Limpopo provinsie te ondersoek, en (iii) om die verwantskap tussen fisieke aktiwiteit, leefstylgedrag en metaboliese siekte risiko’s by werknemers van die Vhembe Distriks Munisipaliteit in die Limpopo provinsie, Suid Afrika, te bepaal. ’n Dwarsdeursnitstudie is onderneem met 535 (mans = 249; vroue = 286) werknemers (ouderdomme 24 – 65 jaar). Fisieke aktiwiteitsvlakke (FA) is bepaal deur van die ‘*International Physical Activity Questionnaire’* (IPAQ) gebruik te maak. Deelnemers se leefstylgebruike (rook en alkoholverbruik), antropometriese, bloeddruk, vastende bloedglukose en totale cholesterol metings is gedoen deur gestandaardiseerde protokolle te gebruik. Statistiese ontleding van die data is gedoen deur middel van die SPSS statistika program (uitgawe 25). Die resultate van die eerste doelstelling toon aan dat die vastende glukose-konsentrasie ’n positiewe assosiasie met liggaamsmassa-indeks (LMI) middelomtrek (MO) en middel-tot-lengte ratio (MrLR) vertoon. Die resultate toon ook verder dat 25% van die totale werknemers ’n verhoogde bloedglukose-konsentrasie vertoon, in vrouens (3.8%) meer as by mans (3.2%). Die resultate van die tweede doelstelling toon dat 27% van die deelnemers as oorgewig geklassifiseer kan word en 34% as obees, by dames (29%:48%) meer so as by mans (24%:17%). Vyf- en- twintig persent (25%) van die deelnemers was hipertensief met dames wat ’n hoër voorkoms as mans toon (27% vs 22%). Met betrekking tot die LMI kategorië toon die obese groep (35%) ’n hoër voorkoms van hipertensie in teenstelling met diegene met normale gewig (18%) en oorgewig (22%). Die resultate toon ook aan dat alle metings van liggaamsamestelling positief gekorreleer ($p \leq 0.05$) het met sistoliese bloeddruk (SBD) in die groep met normale liggaamsgewig, terwyl in die

oorgewig groep, MO ’n betekenisvolle korrelasie met SBD getoon het (r=0.23). Die MtLR het ook ’n positiewe korrelasie met beide SBD (r=0.26) en DBD (r=0.19) getoon. Die resultate van die derde doelstelling toon dat 55% van die werknemers metaboliese sindroom vertoon soos beskryf deur die NCEP-ATPIII en die IDF diagnostiese kriteria, met mans wat ’n hoër voorkoms van metaboliese sindroom vertoon (87%) in vergelyking met vrouens (26%). Die resultate vir die totale groep met ’n lae fisieke aktiwiteitsvlak, toon dat die moontlikheid om metaboliese sindroom te ontwikkel, ’n OR van 1.17 toon in vergelyking met diegene wat matige tot hoë fisieke aktiwiteitsvlakke handhaaf. By mans met lae fisieke aktiwiteitsvlakke was die risiko vir metaboliese sindroom betekenisvol hoër as by diegene met matige tot hoë aktiwiteitsvlakke, nadat vir ouderdom, rook, alkoholinname, fisieke aktiwiteit en LMI gekorrigeer is (OR 5.20;95% CI:1.77-15.28). By deelnemers sonder metaboliese sindroom het alkoholinname verbruik positief gekorreleer met DBD, SBD, LMI en MO (r=0.200;p=0.004). Rook het ook ’n positiewe verband getoon met DBD by diegene met metaboliese sindroom (r=0.158;p=0.01). Die resultate toon verder nie-betekenisvolle omgekeerde korrelasies tussen fisieke aktiwiteit en metaboliese risikofaktore. Op grond van die resultate word daar aanbeveel dat dringende aandag gegee moet word om ’n kultuur-sensitiewe gesondheidsbevordering- asook leefstyl-opvoedingsprogramme te ontwikkel wat die risikofaktore vir die ontwikkeling van metaboliese sindroon by die werknemers van die Vhembe Distriks Munisipaliteit sal aanspreek.

Sleutelterme: Fisieke aktiwiteit, fisieke onaktiwiteit, metaboliese risikofaktore, sedentêre gedrag, metaboliese sindroom, werknemers.

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LIST OF ABBREVIATIONS

ACSM	American College of Sports Medicine
BMI	Body mass index
BP	Blood pressure
CHD	Coronary heart disease
CRIBSA	Cardiovascular risk among black South Africans
CVD	Cardiovascular diseases
DBP	Diastolic blood pressure
EGIR	European group for the study of insulin resistance
FG	Fasting glucose
HDL	High-density lipoprotein
IDF	International Diabetes Federation
IPAQ	International Physical Activity Questionnaire
$Kg.m^2$	Kilogram per metre squared
LCAT	Lecithin cholesterol acyltransferase
LDL-C	Low-density lipoprotein-cholesterol
MET	Metabolic equivalent
MetS	Metabolic syndrome
MmHg	Millimetre of mercury

NCDs	Non-communicable diseases
NCEP-ATPIII	National Cholesterol Education Program Adult Treatment Plan III
PA	Physical activity
PAI	Physical activity index
SBP	Systolic blood pressure
SD	Standard deviation
TC	Total cholesterol
TG	Triglycerides
WC	Waist circumference
WHO	World Health Organization
WHtR	Waist-to-height ratio

LIST OF SYMBOLS

%	Percentage
>	Greater
≤	Smaller or equal
±	Plus minus
=	Equals

CHAPTER 1:

Introduction

1.1 INTRODUCTION

Physical inactivity is the fourth leading cause of death due to non-communicable diseases (NCDs) worldwide and each year contribute to over forty one million preventable deaths (WHO, 2018). Physical inactivity accounts for 6% of global deaths, with overweight and obesity accounting for 5%, hypertension 13%, tobacco use 9%, and high blood glucose 6% (WHO, 2011). These risk factors contribute to mortality and low quality of life (CDC, 1996; Jiang *et al*., 2004: 1337), while participation in physical activity was linked with reduction and management of NCDs (Booth *et al*., 2000:774; WHO, 2016). Physical activity is defined as any bodily movement produced by skeletal muscles that require energy expenditure (Caspersen *et al.*, 1985: 126).

1.2 PROBLEM STATEMENT

Various countries worldwide are undergoing major epidemiological, demographic, nutrition and economic transitions that have a widespread effect throughout the population (Bender & Dufor, 2012: 372; Popkin, 2006:289; Popkin, 1993:138), with an increase in NCDs (Misra & Khurana, 2008: S9). Part of the proliferation in NCDS is caused by the rise in the clustering of metabolic risk factors within an individual (Moller & Kaufman, 2005:45), which may or may not, have a single underlying cause. When three or more cardio-metabolic risk factors cluster together in an individual, it is referred to as metabolic syndrome (MetS) (Grundy *et al*., 2005:2735). Metabolic syndrome is a clustering of various metabolic disorders or risk factors, which include high fasting blood sugar, abdominal obesity, hypertension and high cholesterol (Gami *et al*., 2007:403; Grundy, 2007:399).

The prevalence of metabolic risk factors has increased rapidly due to an increasingly westernised lifestyle, characterised by over-consumption of calories, smoking, excessive alcohol intake and physical inactivity (Nestel *et al*., 2007:362; Rakugi & Ogihara, 2005:103). The factors associated with an increased risk for the development of cardiovascular diseases (CVD) tend to cluster in MetS (Johnson & Weinstock, 2006:1617). The prevalence of metabolic risks has been estimated at approximately 22% in the United States, which corresponds to approximately 47 million adults (ACSM, 2018). In a study by Meigs *et al*. (2006:63), it was also indicated that participants with MetS or insulin resistance were at higher risk for diabetes regardless of BMI status, whereas obese participants

without insulin resistance were at a threefold higher risk for diabetes relative to normal weight participants without insulin resistance (Arnlov *et al*., 2011:63).

The relationship between BMI and blood pressure has long been the subject of epidemiological research (Tesfaye *et al*., 2007:28). Body fat distribution is an important contributor to the association between obesity and high blood pressure (De Menezes *et al*., 2014:1741). Abdominal obesity is a major public health problem associated with insulin resistance, type 2 diabetes, hypertension, dyslipidemia, disability and increased mortality among adults (Jura & Kozak, 2016: 23; Nam *et al.,* 2012: 40). These concur with findings of the study in Ecudor, which found that there was strong correlation between abdominal adiposity and cardiometabolic risk factors (Orces *et al.,* 2017: 727). Waist circumference (WC) serves as an inexpensive method for determining body fat distribution in the abdominal area and could therefore be used as a proxy marker of abdominal fatness (Pouliot *et al*., 1994:460). In middle-aged men and women, a central distribution of body fat is associated with increased blood pressure independently of BMI, and insulin resistance, thus suggesting a key role of central adiposity in the full expression of MetS (Siani *et al*., 2002:783).

Research has shown that high BMI have been associated with abnormal levels of lipids, insulin, blood pressure, and all components of metabolic syndrome (Liu *et al*., 2010:42; Kaur, 2014; Roberts *et al.,* 2013:1). The metabolic syndrome becomes more prevalent with each decade of life and is parallel with age-related increases in obesity, particularly central obesity, and these trends suggest an interaction between age and sex on the screening of metabolic syndrome (Cornier *et al*., 2008:820).

The overall prevalence of metabolic syndrome is approximately 34% in the general population of the United States and Europe (Alegria *et al*., 2005:797; Dallongeville *et al*., 2005:409; Gill *et al.,* 2017:1; Salsberry *et al*., 2007:114). In a national survey conducted among the general Malaysian population, 40.2% of men and 43.7% of women were reported to have metabolic syndrome (Wan Nazaimoon *et al*., 2011:239). In Botswana 34% of the hospital workers had metabolic syndrome, while a further 34% were at risk of developing metabolic syndrome, 28.7% were obese, and 27.3% were overweight (Garrido *et al*., 2009:331). Similarly, 31% of corporate executives in South Africa fulfilled the criteria for the diagnosis of metabolic syndrome (Ker *et al*., 2007:30). Studies in African populations reported a prevalence of metabolic syndrome ranging from 0% to as high as around 50% or

more, depending on population settings (Lakka *et al*., 2002:2709; Okafor, 2012:56-66). However, data is limited to some countries, since there is a scarcity of data for the majority of African countries (Makuyana *et al*., 2004:24; Kengne *et al*., 2012:22).

The workplace environment has gradually become a focus for intervention aimed at the reduction of the risk of chronic diseases, because the majority of adults employed spend a substantial amount of their time at work (Department of Statistics Malaysia, 2013). Therefore, interventions in the workplace can be a successful approach to address risk factors for chronic diseases (Freak-Poli *et al*., 2010:1132), however it is believed that employed adults are healthier than the general population (Li & Sung, 1999:225). According to various researchers occupations have progressively become more sedentary (Feak-Poli *et al*., 2010:1132; Puig-Ribera *et al*., 2008:11; Straker *et al.,* 2009:1215). Worksites have been identified as strategic locations for the delivery of interventions in order to decrease the prevalence of chronic diseases of lifestyle among adult populations (Emmons *et al*., 1999:545). Therefore, importance of determining the prevalence of modifiable health risk behaviours among specific populations for effective preventive and therapeutic measures has been emphasised (Mion *et al*., 2004:329). Health promotion at the worksite has increased over the last decades (Schult *et al*., 2006:541; Terry, 2016:563; Wellsteps, 2018), and some researchers have attributed this increase to an increased awareness of the benefits and advantages of having quality health promotion programmes available for employees (Hahn & Truman; 2015:657; Schult *et al*., 2006:541; Tabrizi *et al.,* 2011:1). In addition, soaring healthcare costs have further encouraged employers to take a more proactive approach in keeping their employees healthy (Carter *et al*., 2011:761; WHO, 2016).

Health promotion and health screening at the workplace can have both a beneficial influence on employees' health behaviour, as well as raise awareness of the risks of a sedentary lifestyle (Alkhatib, 2013:218). In addition, changing from a sedentary lifestyle to a more active one can lead to a significant reduction in the cardiovascular risk of employees (Alkhatib, 2013:218; Burke & McCarthy, 2011:230; Carter *et al*., 2011:761). Some researchers have also indicated that physical activity (PA) promises to be one of the most effective intervention strategies for reducing the risks of virtually all chronic diseases simultaneously (Booth *et al*., 2000:774). Current epidemiological studies have indicated that moderate-to-vigorous PA is associated with decreased risk of developing metabolic syndrome (Brien & Katzmarzyk, 2006:40). It has been revealed that the associated health

benefits of PA and early adaptations in the transition from sedentary living to becoming moderately active, seem to have the greatest effect on the reduction of chronic diseases of lifestyle in both men and women (Bouchard, 2001:347-350; Haskell, 2001:454; Warburton & Bredin, 2016:495). The presence of lifestyle-related chronic diseases and their associated risk factors may contribute to a decline in workplace productivity and hence economic loss, which may lead to a decline in quality of life of employees. Therefore, employers should be mindful of the health status of their employees (Gallo, 2004:408; IHPM, 2016; WEF, 2011).

It is thus against this background that the following research questions are posed:

- What is the relationship between selected metabolic risk factors and waist-to-height ratio among employees in Vhembe District municipality of Limpopo Province, South Africa?
- What is the relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa.?
- What is the relationship between PA, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa?

Answers to these questions will provide health professionals with more information to assist in implementing health and wellness promotion programmes among employees in municipalities in South Africa, and to devise strategies to teach employees about the importance and benefits of living a healthy lifestyle in order to improve their productivity and quality of life. Additionally, the findings of this research will provide the Vhembe local municipality government and employees with valuable information regarding the PA and health status, as well as recommendations on how to improve their lifestyle so that production at the workplace can be improved.

1.3 RESEARCH OBJECTIVES

The objectives of this research are to determine the following:

- The relationship between selected metabolic risk factors and waist-to-height ratio among employees in Vhembe District municipality of Limpopo Province, South Africa.

- The relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa.

- The relationship between PA, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa**.**

1.4 RESEARCH HYPOTHESES

There will be a:

- Significant positive relationship between selected metabolic risk factors and waist-to-height ratio among Employees in Vhembe District municipality of Limpopo Province, South Africa will be found.

- Significant positive relationship between obesity and elevated blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa will be found.

- Significant relationship between PA, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa will be found.

1.5 STRUCTURE OF THE THESIS

The structure of the thesis will be presented in article format as approved by the senate of the North-West University (Potchefstroom campus) and will be as follows:

Chapter One: Introduction.

This chapter describes the problem, purpose and hypothesis of the study. A complete bibliography of Chapter one will be presented at the end of the chapter. The referencing of Chapter one will be according to the NWU-Harvard style.

Chapter Two: Literature review: physical activity and metabolic risk factors in relation to lifestyle behaviour among employees.

Chapter two will present the literature review on physical activity and some selected metabolic risks in relation to lifestyle behaviour. A complete bibliography of Chapter

Two will be presented at the end of the chapter. Referencing will be according to NWU-Harvard style.

Chapter Three – Article One: Relationship between selected risk factors of metabolic disease and waist-to-height ratio among local government employees in Vhembe District municipality, Limpopo Province of South Africa A manuscript was published in the *Asian Scientific Research [Volume 11, December 15, 2017, pp. 42-50; DOI: 10.3923/ajsr.2017]*. The references are prepared in accordance with the guidelines proposed by *Asian Scientific research.*

Chapter Four –Article Two: Relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa. A manuscript was submitted for publication in the *African Journal of Primary Health Care & Family Medicine (Afr. J. Prim. Health Care Fam. Med)*. The references will be prepared in accordance with the guidelines proposed by the *African Journal of Primary Health Care & Family Medicine.*

Chapter Five – Article Three: Relationship between physical activity, lifestyle behaviour and metabolic disease risk among municipality employees in South Africa.

A manuscript was submitted for publication in the *International Journal of Environmental Research and Public Health (Int. J. Environ. Res. Publ. Health)*. The references will be prepared in accordance with the guidelines proposed by the *International Journal of Environmental Research and Public Health (Int. J. Environ. Res. Publ. Health).*

Chapter Six: Summary, conclusion, limitations and recommendations

In Chapter Six a summary of the research are presented, together with the main conclusions of the research based on the hypotheses that are set out in Chapter One. Limitations of the study are presented with recommendations for future research. The references of Chapters One, Two and Six will be presented according to the Harvard style as prescribed by the North-West University (Potchefstroom Campus).

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CHAPTER 2:

Physical activity and metabolic risk factors in relation to lifestyle behaviour among employees: A literature review

2.1 INTRODUCTION

Metabolic syndrome (MetS) refers to a cluster of known disorders that increases the risk for morbidity and mortality from cardiovascular diseases (CVD) and type 2 diabetes (Rodrigues *et al*., 2010:134). Metabolic syndrome could be defined as the occurrence of three (3) of any of the following five (5) factors: central obesity, elevated triglycerides (TG), low-density lipoprotein-cholesterol (LDL-C), elevated blood pressure (BP) and elevated fasting glucose (FG) levels (Grundy *et al*., 2005:2954). Lifestyle factors such as alcohol consumption, cigarette smoking and physical inactivity have also been reported to negatively affect an individual's metabolic profile (Freiberg *et al*., 2004: 2954; Klatsky, 2004:805). Low cardiorespiratory fitness (CRF) has been associated with the presence of metabolic risk factor clustering and MetS in numerous published studies in both men employees and women employees (Baur *et al.,* 2012:2331; Earnest *et al.,* 2013:259; Ekblom *et al.,* 2015:131). A sedentary lifestyle, and especially poor fitness, is not only associated with MetS among employees, but also could be considered features of the syndrome (Sharkey & Gaskill, 2013:29). Studies have also reported an inverse relationship between PA and certain components of MetS such as waist circumference (WC) (Rennie *et al*., 2003:600; Waller *et al*., 2008: 353), HDL-C (Fung *et al*., 2008:1171), and blood pressure (El Belbeisi *et al*., 2017: 273, Paffenbarger *et al*., 1983:245; Paffenbarger Jnr *et al*., 1991:319).

Excess central or abdominal fat, as indicated by WC is a predictor of metabolic syndrome, therefore high levels of visceral abdominal fat are also associated with measures of inflammation which predict several chronic diseases, including coronary heart diseases and NCDs (Despres *et al*., 2008:1039). This chapter will discuss the history of metabolic syndrome; its prevalence; the metabolic risk factors among employees, PA and comorbidities that cluster into risk factors of metabolic syndrome; modifiable risk factors, and the lifestyle behaviours that contributes to the development of metabolic syndrome.

2.2 HISTORY OF METABOLIC SYNDROME

Metabolic syndrome was first recognised in 1920 and then given a description in 1936 by H.P. Himsworth, who recognised the defects of insulin and the harmful effects on the body system (Rountree, 2010:391). However, it was not named until Gerald Reaven referred to it as 'syndrome X' in 1988 (Rountree, 2010:319). Other terms used to describe the cluster of risk

factors included; the 'the insulin resistance syndrome' and the 'deadly quartet' (Eckel *et al*., 2005:1415). In 1998 the WHO recommended the development of a universal definition and changed the name from syndrome X to metabolic syndrome (Alberti *et al*., 2006:1464).

There are several working definitions for MetS proposed by the WHO, the 2001 National Cholesterol Education Program Adult Treatment Panel III (NCEP-ATPIII), the European Group for the study of Insulin Resistance (EGIR) and the International Diabetes Federation (IDF) (Isomaa, 2003:2395). The existence of different definitions makes it difficult to compare data from around the world and between different populations (Broderstad & Melhus, 2016:6). However, the NCEP description of MetS is considered the most applicable tool for clinical and epidemiological practice (Isomaa, 2003:2395).

2.2.1 Definitions of metabolic syndrome

The definition of MetS according to the NCEP (Adult Treatment Panel III) report (NCEP, 2002:3143) stated that a person is considered to have MetS if he/she has any three of the following:

1. Abdominal obesity: waist circumference: > 102 cm in men and > 88cm women.
2. Hypertriglyceridemia: Triglyceride (TG) level: ≥ 150 mg/dl (1.69 mmol/l).
3. High-density lipoprotein-cholesterol (HDL-C) level: < 40 mg/dl (1.04 mmol/l) in men and < 50 mg/dl (1.29 mmol/l) in women.
4. High BP: ≥ 130/85 mmHg or use of anti-hypertensive medication.
5. High FG: ≥110 mg/dl (6.1 mmol/l) or use of hyperglycaemic medication.

According to the new definition by the IDF (Alberti *et al*., 2006:469), MetS is diagnosed if central obesity (waist measurement >90 cm for men or > 80 cm for women) is accompanied by any two of the following factors:

1. TG levels of 1.7 mmol/l or greater.
2. An HDL cholesterol value lower than 1.03 mmol/l for men or lower than 1.29 mmol/l for women.

3. A BP of 130/85mmHg or greater, or treatment of previously diagnosed hypertension.
4. A fasting blood glucose (FBG) of 5.6 mmol/l or greater, or previously diagnosed type 2 diabetes.

According to WHO criteria (Albert *et al*., 2005:1059) the presence of DM, impaired glucose tolerance or insulin resistance and any two of the following is required:

1. Body mass index (BMI) ≥ 30 kg/m² and/or waist-to-hip ratio (WHR) > 0.90 (men), > 0.85 (women).
2. Blood pressure ≥ 140/90 mmHg or on medication.
3. Diabetes ≥ 6.1 mmol/l or on medication for diabetes, impaired glucose tolerance or insulin resistance.
4. Triglycerides ≥ 1.7 mmol/l and/or HDL-C < 0.91 mmol/l (male), < 1.01 mmol/l (women).

2.3 PREVALENCE OF METABOLIC SYNDROME

The prevalence of MetS within individual cohorts varies according to the definition used, however, within each definition the prevalence of MetS increases with age and ethnicity (Day, 2007:32). Kaur (2014: 21) reported that the worldwide prevalence of MetS to be between 10% and 84% depending on the ethnicity, age, gender and race of the population, whereas the IDF estimates that one-quarter of the world's population has MetS. Metabolic syndrome affects 44% of the US population over the age of 20, and a greater percentage of women older than 50 years have MetS than men (Falkaner & Cossrow, 2014:449). Studies from Europe, North America, and Australia report the prevalence of MetS to be between 20% to 30% (Nematy *et al.,* 2014:12**)**) respectively, while studies in Asia have mostly found a lower prevalence of 5% (Song *et al.,* 2014:75).

Using the 2005 version of NCEP-ATPIII the prevalence of MetS in China, Taiwan, Hong Kong and Thailand ranged from 10–15% but was much lower in southern rural China (Feng *et al*., 2006:2089; Lohsoonthorn *et al.,* 2006:339). A study conducted in Sub- Saharan Africa using IDF criteria to diagnose MetS found an absence of MetS prevalence in rural men and a low prevalence in both rural (0.3%) and urban (1.5%) women with urban men at 1.2% (Okafor,

2012:56). Equally, by using ATPIII definition of MetS, there was an absence of MetS in rural men and women, with a very low prevalence in urban men and women (Motala *et al*., 2011: 1032). The high prevalence rates were however found when the WHO criteria was used, being 1.8% (rural) and 5.9% (urban) women, and 1.9% (rural) and 7.3% (urban) men; by using these criteria, urban rates were higher in both women and men compared to rural levels of prevalence (Motala *et al.*, 2011:1032). Therefore, the lower prevalence rate was understood to be due to a high level of physical activity (Motala *et al*., 2009:s2). Analysing the prevalence of individual risk factors for the MetS in sub-Saharan Africa indicated that serum triglyceride was the risk factor in both women and men with the lowest prevalence. In men, the most prevalent risk factor was elevated BP and central obesity, which is known to be frequent in rural (58.6%) and urban areas (49.5%) (Motala *et al*., 2009:s2).

Studies from countries such as Cameroon (Fezeu *et al*., 2007:70), Benin (Ntandou *et al*., 2009:180) and Nigeria (Motala *et al*., 2011:1032; Oladapo *et al*., 2010:26) with regards to the prevalence of MetS reported a low prevalence (0–4%) in rural communities. Although the prevalence was higher in semi- urban (6.4%) and urban samples (11%) when compared with the findings from rural communities in Benin (Ntandou *et al*., 2009:180). Motala *et al*. (2011:1032) reported that the prevalence of MetS was higher in women (25%) than in men (10.5%) in the rural South African black community. A study conducted among Zimbabwean type 2 diabetic patients to determine the prevalence of MetS showed that 43% of the participants had MetS (Makuyana *et al*., 2004:24). In addition, MetS was also seen in 25.2% of type 2 diabetic patients in Nigeria; however, systemic hypertension was found to be the most common component (38%) of MetS (Alebiosu & Odusun, 2004:817). In the Temeke municipality, Dar es Salaam, Tanzania, risk factors of MetS such as: central obesity, LDL-cholesterol and high FG were found to be more prevalent in women; this means that women have a threefold greater chance of MetS compared to men (Njelekela *et al*., 2002:58).

2.4 METABOLIC RISK FACTORS AMONG EMPLOYEES

MetS is becoming a common problem among employees and the early detection, treatment and prevention of this condition is a major challenge for health care professionals (Garrido *et al*., 2009:331). There is strong agreement that workers who comprise almost half of the total population – have MetS, which is an important health issue worldwide (WHO, 2010). Among office workers, there has been an increase in several health conditions such as obesity,

hypertension, diabetes and hyperlipidaemia, which are components of MetS (Ryu *et al*., 2016:1433). It is expected that these workers will be at greater risk of developing CVD and MetS (Jung *et al*., 2002:649; Konradi *et al*., 2011:337; Lallukka *et al*., 2008:1681; Lohsoonthorn *et al*., 2007:1908). Additional studies found that office workers (such as managers, professionals and related workers) were at a higher risk for developing MetS compared with non-office workers (such as sales and service, industrial, or manual workers) (Kim & Oh, 2012:108). Cavagione *et al*. (2008:1015) studied 258 men who are professional long-haul drivers and found a prevalence of MetS of 24% according to the NCEP-ATP III criteria. A study of administrative officials from the petroleum industry used the NCEP-ATP III criteria and IDF, and found the MetS prevalence to be 15%; and determined that sex, age, and smoking were associated with the presence of MetS in the study population (Felipe-de-Melo *et al*., 2011:3443). According to the Centre of Statistics of Iran (2014), it was reported that 15% of staff employed in the public sector showed a prevalence of MetS. A study conducted in Botswana also found that 34% of hospital workers had MetS, with 21% at risk of developing it (Garrido *et al*., 2009:331). Similarly, a study conducted among corporate executives in South Africa showed that 31% fulfilled the criteria for the diagnoses of MetS (Ker *et al*., 2007:30). In comparison with other categories of employees, shift workers have been identified as a group with higher incidence of MetS (Lin *et al*., 2009:740), and a study of a Midwestern manufacturing corporation found that 30.2% of employees met the criteria for MetS (Wayne *et al*., 2014:1143). Davilla *et al*. (2010:2390) established that the prevalence of MetS has not only increased in shift workers, but also among farm workers in the Boland district of Cape Town, South Africa. A study of 203 employees in a leading global energy company reported a MetS prevalence of 23.6% based on laboratory and medical aid data (Birnbaum *et al*., 2011:27).

The work environment itself may contribute to health behaviours and a sedentary lifestyle due to long work hours, smoking, excessive alcohol intake and job stress, all of which may result in the development of MetS among employees (Bernardo *et al*., 2013:26; Konradi *et al*., 2011:337; Lin *et al*., 2014:262; Maruyama *et al*., 2010:11). The lack of PA associated with excessive working hours is one of the most significant risk factors for chronic diseases, including MetS, among employees worldwide (Kim, 2013; Konradi *et al*., 2011:337; Yang, 2011:697; Yap *et al*., 2009:330; Brien *et al*., 2007:143; Halldin *et al*., 2007:349; Irwin *et al*., 2002: 1030; Laaksonen *et al*., 2002:1612).

Employees in any institution represent an important population category; their quality of life, health awareness and ability to embrace healthy behaviours influences their productivity, and reduces the risk of NCD and MetS prevalence, thus reducing health care costs and as a result improving the economic status of the workplace (Carnethon *et al*., 2009:1725). Several findings have indicated that regular PA would be beneficial to preventing and managing MetS and its components among employees (Bergstrom *et al*., 2012; Park *et al*., 2014).

2.5 PHYSICAL ACTIVITY AND COMORBIDITIES THAT CLUSTER INTO RISK FACTORS OF METABOLIC SYNDROME

2.5.1 Overweight and obesity

The World Health Organization (WHO) (2017) defines obesity as 'a condition of abnormal or excessive fat accumulation in adipose tissue, to the extent that health may be impaired. The accumulation of body fat is an indication that more energy has been stored than has been used (Rossouw *et al.,* 2012:1). It is defined by the body mass index (BMI) and further evaluated in terms of fat distribution characterized with an elevated body mass index, WHR, WC and body fat percentage (De Onis & Lobstein, 2010:458; Groenewald *et al*., 2007:674).

Obesity increases the risk of various physical and mental conditions (Moen, 2017:7). These comorbidities are most commonly shown in MetS, a combination of medical disorders which includes type 2 diabetes mellitus, high BP, high cholesterol and high triglyceride levels (De Onis *et al*., 2010:1258; IDF, 2006; Grundy, 2004:2595; Grundy *et al.,* 2004: 433). Complications are either directly caused by obesity or indirectly related through mechanisms sharing common cause, such as poor diet and sedentary lifestyle (Chakrabory & Chakraborty, 2012:451). Obesity is an emerging pandemic worldwide (Sattar *et al*., 2008:1927). As reported by the World Health Organization, 2.8 million people die each year from being overweight or obese (WHO, 2017).

The prevalence of obesity is a problem in both developed and developing countries (Ali & Crowther, 2005:878). Obesity affects people regardless of gender across the whole life spectrum and is influenced by lifestyle, environment and socio-economic status (Antipas & Gill, 2001:21). Overweight and obesity are associated with an increased risk for chronic diseases including hypertension, diabetes and cancer, as well as psychosocial ailments and

cardiovascular heart disease (Gortmaker *et al.,* 1993:1008; Mokdad *et al.,* 2001:76; Must *et al.,* 1999; 1523, DHHS, 1990). The risk for NCDs increases progressively as BMI increases and can be prevented by increased PA levels and a healthy diet (Antipas & Gill, 2001:21).

In a study conducted by SANHANES-1 (2013:0), overall 25% of South African adult women were overweight and 40.1% were obese, while 19.6% and 11.6% of adult men were overweight and obese respectively. The mean BMI was 29.0 kg/m² for women and 23.2 kg/m² for men. It has been estimated that in the age group of people 30 years or older, 32 men and 68 women die per day because of high BMI in South Africa (Joubert *et al*., 2007:683). A higher prevalence of obesity and abdominal obesity has been seen in women compared with men in many developing countries, consistent with the sedentary lifestyle (Gu *et al*., 2005:1398; Misra & Khurana, 2008:9). Possible causes for this increased prevalence of obesity are modernisation, rapid urbanisation in developing countries and unsafe environments, which all lead to a more inactive lifestyle (Wang *et al*., 2007:272). In 2000, 25.6% of urban and 17.3% of the rural China population were overweight or obese, compared to 12.2% and 7.7% in 1989 (Wang *et al*., 2007:272). In South Africa, nutritional surveys highlighted that individuals living in urban areas were more exposed to diets rich in fat and refined carbohydrates that contribute to obesity, compared to diets of individuals living in rural areas (Steyn *et al*., 2006:40; Steyn, 2007:12). Goedecke *et al*. (2006:65) reported South Africa to be on its way to becoming the country with the highest prevalence of overweight and obesity due to urbanisation and adopting Westernised eating habits rich in saturated fats. According to SADHS (2016), percentage of women and men aged 15 and older with a body mass index (BMI) ≥35, according to background characteristics, showed that one in five women (20%) are in the severely obese category; only 3% of men are severely obese. Severe obesity was most common among coloured and black/African women (26% and 20%, respectively). However, it was also high among Indian/Asian and white women (18% and 15%, respectively). In the case of men, the prevalence of severe obesity was 14% for white men, 7% for coloured men, and only 2% for black/African men. A study conducted in South Africa in 2009 reported that central obesity measured by WC was the most prevalent component of the metabolic syndrome (58.6% vs 49.5%) for rural and urban women respectively (Motala *et al.,* 2009:S28). Another hospital-based study in Botswana showed that obesity (28.7%) and overweight (27.3%) were the major risk factors for MetS among hospital workers (Kelliny *et al.,* 2007:70). In addition to WC, waist-to-hip ratio (WHR) has widely been

used to detect the risk of metabolic complications (WHO, 1995; WHO, 2011). The WHtR with cut-off point of 0.54 was the best performance indicator (AUC=0.72; P<0.05; sensitivity=67%, specificity=66%)(Caminha *et al.,* 2017:4). Additionally, Caminha *et al.* (2017:4) stated that WHtR with cut-off point of 0.54 has constituted the most accurate indicator in thescreening of women with hypertension.

Anderson *et al*. (2009a:340) described the workplace as a sedentary setting with easy access to energy-dense food and beverages. In modern society, adults spend most of their time sitting (sedentary), which is associated with low energy expenditure and likely to be an important cause of obesity (Donnelly *et al*., 2009:463; Wallace, 2003:149). Anderson *et al*. (2009a:340) reported that economic and industrial innovation has resulted in fewer workers in primary industries (agriculture, fishing, mining or forestry). They also indicated that automation in production industries resulted in more people being exposed to a sedentary workplace. Consequently Anderson *et al*. (2009a:340) reported this to be a contributing factor to overweight and obesity among employees. Epidemiologic studies of characteristics of working conditions and employee obesity have shown associations between greater BMI values and long work hours, shift work, and job stress (Schulte *et al*., 2007:428–429). Ostbye *et al*. (2007:766–777) reported obesity as an important driver of costs associated with absenteeism, sick leave, disability, injuries and health care claims.

Franco *et al*. (2007:1377) studied the Cuban population and reported that a reduced dietary energy intake and increased energy expenditure (i.e. exercise, mainly walking and cycling), resulted in average individual weight loss of 4.5 kg. Donnelly *et al*. (2009:459) reported that PA of moderate intensity (3.0 to 5.9 METs) > 250 min per week was associated with clinically significant weight loss and prevention of weight regain while moderate intensity PA between 150 and 250 min per week was associated with moderate weight loss (Donnelly *et al*., 2009:459).

Belay *et al*. (2013:59) reported weight loss benefits in obese individuals from both aerobic (4.0%) and resistance training (3.4%). According to Wiklund *et al*. (2014:17), aerobic exercise resulted in more energy expenditure and greater metabolic stress. They reported that regular exercise (as little as six weeks), resulted in improved muscular mitochondrial biogenesis and enhanced fatty acid oxidation, which was associated with weight loss and reduced risk of

coronary heart disease (CHD). Wiklund *et al*. (2014:217) indicated that even when moderate intensity aerobic exercise among obese individuals did not necessarily result in weight loss; it was associated with health benefits such as reduced serum-free fatty acid and glucose levels. According to Belay *et al*. (2013:59), various interventions have shown the magnitude of weight loss that is achievable with exercise alone compared to di*et al*one, or the combination of diet plus exercise. Wiklund *et al*. (2014:217) concluded that exercise therefore contributed to improved health status, even in the absence of weight loss.

2.5.2 Hyperlipidaemia (elevated cholesterol)

Hyperlipidaemia is any condition that elevates fasting blood triglycerides (TG) or cholesterol concentrations; however, when genetic, environmental and pathological factors combine to alter blood lipid and lipoprotein concentration abnormally, the condition is termed dyslipidaemia (Biggerstraff & Wooten, 2009:247). Elevated cholesterol remains an important cardiovascular risk factor in all population groups in South Africa (Norman *et al*., 2007:708). Furthermore, the abnormal blood lipid level of hyperlipidaemia is a crucial component in the genesis of atherosclerosis (McArdle *et al.,* 2010:865). Atherosclerotic disease originates through the interactions of genes and modifiable as well as non-modifiable environmental exposures, which influence lipid and lipoprotein pathways that provide transport for delivery, metabolism or elimination (Grandjean *et al.*, 2013:160). Lipids are substances such as fatty acids, cholesterol, and triglycerides generated by the body and needed for crucial physiological roles such as energy storage, body insulation, maintenance of bile acids, hormone production, cell membrane structure and metabolic regulation (Grandjean *et al.,* 2013:155, 156). Lipids are not soluble in body fluids and need to combine with apolipoproteins to form lipoproteins. There are four general classes of lipoproteins viz. chylomicrons (triglyceride-rich lipoprotein), very low-density lipoproteins (VLDL), lowdensity lipoproteins (LDL) and high-density lipoproteins (HDL). LDL is formed in the circulation from lipid and protein exchanges and is the principle means for transporting cholesterol in the body. HDL is formed in the liver and intestine and known as antiatherogenic as it poses antioxidant effects and transports cholesterol from the body tissues to the liver for catabolism - a process known as "reverse cholesterol transport" eliminating the cholesterol from the peripheral tissue (Grandjean *et al.,* 2013:155, 161).

Byrne (1991:9) indicated that an interrelationship exists between cholesterol and other coronary risk factors (stress, obesity, and diabetes mellitus) as it increases TC concentration in the blood. The Heart Foundation of South Africa (2017) indicated that one in four adults have high total cholesterol (23.9%) and LDL-cholesterol (28.8%), and one in two (47.9%) have low HDL-cholesterol. The American Heart Association (2017:146) reported that 95 million U.S. adults age 20 or older have total cholesterol levels greater than 200 mg/dL (5.17 mmol/l) and nearly 29 million adult Americans have total cholesterol levels higher than 240 mg/dL (6.21 mmol/l).

Research by Swanepoel *et al.* (2015:1478) also reported that the overall prevalence of elevated total cholesterol amongst employees in a South African corporate financial setting was low. The lowest value occurred in younger males (4.1%) and females (4.9%) while the highest prevalence (13.0%) was amongst older females. Employees at risk for hypercholesterolemia showed a prevalence of 30%.

In a study conducted to determine the impact of chronic diseases of lifestyle and related risk factors on mortality in South Africa, hypercholesterolemia and raised low-density lipoprotein-cholesterol (LDL-C), indicated an increased risk for ischaemic heart disease (Steyn & Fourie, 2005:267). Diets high in saturated fats, physical inactivity and genetics can increase cholesterol levels (Goodacre *et al.*, 2013:103). Research shows that low- and high- density lipoproteins may also play an important role in cardiovascular health (WHO, 2011). Elevated cholesterol increases the risks of heart diseases, stroke and other vascular diseases (Steyn & Fourie, 2005:267). Globally one-third of ischaemic heart diseases is attributable to elevated cholesterol cholesterol (Murray *et al*., 2007:109). High blood cholesterol increases the risk of heart diseases, most in middle-income European countries and least in the low- and middle- income countries in Asia (WHO, 2011). Astrup *et al.* (2010:685) and Lewington *et al*. (2007:1829) suggested that the risk for CHD could be reduced by lowering cholesterol concentration. The results of the study reported a 1% reduction in cholesterol concentration to be associated with a 2% reduction in risk for MI (Astrup *et al.*, 2010:685).

Combination of lifestyle therapies is an efficacious intervention of improving cholesterol levels in those with dyslipidaemia (Varady & Jones, 2005:1829). According to Varady and Jones (2005:1829), exercise intervention alone resulted in increased HDL-C and a decrease in TG, while a combination of exercise and nutrition intervention resulted in an increase in HDL-C and

a decrease in TG, LDL-C and total cholesterol (TC). Regular exercise has positive, longitudinal effects on plasma lipid levels associated with the risk of cardiovascular heart disease and can reduce morbidity and mortality of cardiovascular disease (Teramota & Golding, 2009:138). Several studies indicated the positive effect of physical activity on lipids (Carvalho *et al*., 2010:3; Halverstadt *et al*., 2007:444; Kodama *et al*., 2007:999; Teramota & Golding, 2009:143–144). Kelley and Kelley (2006:213) indicated that aerobic exercise is efficacious for an increase in HDL-C and decreasing TC, LDL-C and TG in man and women. According to Kelley and Kelley (2006:213), aerobic exercise and resistance training can also increase HDL2-C independent of changes in body weight. Halverstadt *et al*. (2007:448) found that a 24-week combination of aerobic and resistance endurance exercise programme resulted in a significant increase in the HDL subfractions HDL2-C and HDL3-C, as well as a significant decrease in TC, TG and low-density lipoprotein-cholesterol. These favourable changes in plasma lipoprotein were independent of diet and baseline or change in body fat. Carvalho *et al*. (2010:3) conducted a similar study that also found that an 8-month of both aerobic and resistance exerciseprogramme of moderate intensity (3x per week), resulted in an improvement in blood lipid profiles, a significant decrease in TG and TC/HDL ratio and a significant increase in HDL-C. They also found a positive modulation of antioxidant capacity; however, no effect on TC and LDL-C was documented. According to Teramota and Golding (2009:143–144), regular exercise could improve HDL-C and TG levels, and LDL-C and TC could be affected by exercise by means of possibly reducing weight. Kodama *et al*. (2007:1006) agreed that exercise increases HDL-C levels, but stated that it appears there is a minimum exercise threshold in order for a significant increase to exist, which is 120 minutes per week or a 900 kcal energy expenditure per week. Kodama *et al*. (2007:1006) concluded that exercise duration per session is the most important element of an exercise prescription to affect lipid profiles positively.

The effect of resistance and combination exercise programmes has also shown to be efficient in the reduction of cholesterol levels (Mann *et al.* 2014:211; Ghaharmanloo *et al*., 2009:765; Marques *et al*., 2009:87; Shaw *et al*., 2009:293–294; Jose *et al*., 2007:60). According to Jose *et al*. (2007:60), resistance training programmes resulted in significant decreases in TC, LDL-C and TG in men and women with a BMI greater than 27kg/m^2. The study conduced by Shaw *et al*. (2009:293–294) indicated that there was a difference in the effect exercise on LDL-C levels among previously untrained men and women. Individuals were divided into two groups, one

consisting of aerobic training only and the other, aerobic training combined with resistance training. Both groups trained for 16 weeks at a moderate intensity for 45 minutes per session, three times a week. Both groups showed significant and similar decreases in LDL-C. This indicates that a larger dose of aerobic exercise does not necessarily equate to a greater improvement in LDL-C concentration if the lost aerobic exercise is replaced with resistance training (Shaw *et al*., 2009:294).

According to Marques *et al*. (2009:87), an exercise programme of eight months (2 times per week) allowed for a significant decrease in TG and an increase in HDL-C in a multicomponent exercise programme (aerobic exercise, muscular endurance exercise and activities to improve balance and flexibility). This multicomponent programme proves to be more effective than resistance exercise on its own among older indivividuals. Ghaharmanloo *et al*. (2009:760) found that after an 8-week concurrent training period there is a significant improvement in lipid profile in untrained apparently healthy men and women. HDL-C and LDL-C improved significantly with endurance training. Total glycerides and TC improved with endurance training, concurrent training and strength training (Ghaharmanloo *et al*., 2009:760). Furthermore, studies that have measured HDL subfractions have found that the increased level of HDL-C seen in endurance athletes seems to be almost entirely caused by an increase in the HDL_2 subfraction while HDL_3 is similar to that of the sedentary population (Mann *et al.*, 2014:211; Herbert *et al.*, 1984:1034). The link between the elevated HDL_2 and exercise could be mediated through the enzyme lecithin cholesterol acyltransferase (LCAT), whereby an increase in LCAT during exercise training results in more cholesterol being esterified and transported to the core of the HDL particles (Gupta *et al*., 1993:694). This enables the HDL molecule to bind more unesterified cholesterol on its surface and gives rise to more HDL_2; increases in HDL_2 particles result in reduced amounts of unesterified cholesterol in the plasma entering the peripheral cells (Gupta *et al*., 1993:64). It has been suggested that the major factor leading to an improved blood lipid profile following exercise regime is the weight loss and decrease in body fat often seen with exercise training (Sharma *et al*., 2003:1494).

Mann *et al.* (2014:211) also reported that PA has been shown to have a positive effect on the pathogenesis, symptomatology and physical fitness of individuals with dyslipidaemia, as exercise reduced cholesterol levels. Mann *et al.* (2014:212) indicated that PA appeared to enhance the ability of skeletal muscles to utilize lipids as opposed to glycogen, resulting in

reducing plasma lipid levels. Therefore, lifetime PA should be promoted to reduce hyperlipidemia as one of the risk factors of cardiovascular disease, which will improve mortality and morbidity caused by cardiovascular disease and increase longevity (Teramota & Golding, 2009:143).

2.5.3 Diabetes mellitus

Diabetes mellitus (DM) is defined as a group of metabolic diseases characterised by high blood glucose resulting from defects in insulin secretion, insulin action or both (Albright, 2009:191; Nieman, 2007:482). There are four categories of diabetes mellitus (Albright, 2009:192; Nieman, 2007:482), namely:

1. Type 1 diabetes mellitus

   There are two major forms of type 1 diabetes: immune-mediated diabetes (type 1A) and idiopathic diabetes (type 1B) (Guven *et al*., 2009:1054). Immune-mediated diabetes results from the destruction of the beta cells and commonly occurs in childhood and adolescence, although it can occur at any age. Autoimmune destruction of beta cells has multiple genetic predispositions and is also related to environmental factors that are still poorly defined (Nieman, 2007:482). Idiopathic diabetes refers to rare forms of the disease that have no known cause. This form of diabetes is mostly inherited and lacks immunological evidence for beta cell destruction (Guven *et al*., 2009:1056; Nieman, 2007:482; Widmaier *et al*., 2011:581).

2. Type 2 diabetes mellitus

   Type 2 diabetes usually arises from insulin resistance combined with relative insulin deficiency (Nieman, 2007:483; Widmaier *et al*., 2011:581). Individuals with type 2 diabetes mellitus can range from predominantly insulin resistant with relative insulin deficiency, to predominant deficiency in insulin secretion with some insulin resistance (Nieman, 2007:482).

3. Gestational diabetes

Gestational diabetes mellitus refers to any degree of glucose intolerance that is first detected and develops during pregnancy, but disappears afterwards (Guven *et al*., 2009:1056; Nieman, 2007:482).

4. Other specific types of diabetes

   These result from specific genetic syndromes, surgery, drugs, malnutrition, infection and other illnesses (Nieman, 2007:482).

The World Health Organization (WHO, 2018) reported that approximately 150 million people have diabetes mellitus worldwide, and that this number may well double by the year 2025 due to population growth, ageing, unhealthy diets, obesity and sedentary lifestyles, and another 2.2 million deaths were attributable to high blood glucose in 2012. According to SADHS (2007:200), 3% of men and 4% of women in South African have diabetes. Chronic hyperglycaemia is associated with long-term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels (Nieman, 2007:477; WHO, 2011b).

Dracup *et al*. (2008) and the South African Department of Health (1998) reported that employees were often unaware of diabetes, hypertension, obesity and CHD risks. Swanepoel *et al*. (2015:1482) reported that more than 23.5% of males and 16.7% of females ≥ 45 years showed high casual blood glucose among employees in financial institutions. These values were higher compared to the broader South African population, which found that 11.9% (males) and 11.7% (females), indicating an increased risk to develop CHD due to diabetes (WHO, 2014).

Employees with diabetes are more absent from work and have lower productivity levels while at work (presenteeism) due to inability to work as a results of diabetes (The American Association, 2013). Diabetes may also affect employees' physical and emotional status and lead to reduced productivity and a burden on the economy due to early retirement, increased sick days, reduced quality of life, disability, and mortality (Bertram *et al*., 2013:206; IDF, 2011; Vijan *et al*., 2004:1653).

Exercise is considered to be one of the cornerstones of diabetic care, and therefore an exercise programme has the potential to provide several benefits for individuals with diabetes (Hornsby & Albright, 2009:184). However, the benefits of exercise for individuals with diabetes are accompanied by an increased risk for hypoglycaemia; therefore, extreme caution must be taken

by diabetic individuals who participate in exercise (Albright, 2009:192; Guven *et al*., 2009:1062). Other complications that may arise and must be taken into account when a diabetic individual exercises are chronic complications like macro- and micro-vascular diseases and neuropathy, which involve both the peripheral and autonomic nervous system (Albright, 2009:192; Guven *et al*., 2009:1067-1070). Macro-vascular diseases include coronary artery disease with or without angina, myocardial infarction, cerebrovascular incidents and peripheral arterial disease (Scott, 2013:73). Micro-vascular diseases include diabetic retinopathy and diabetic nephropathy (ADA, 2010:S1). Peripheral neuropathy typically affects the legs and is initially accompanied with sensory symptoms and loss of tendon reflexes (Anderson, 2012:83; Said, 2013:579). Diabetic autonomic neuropathy may occur in any system of the body (Albright, 2009:192; Guven *et al*., 2009:1067–1075). Even with the risks and complications, the correct precautions regular PA can have several health benefits for the diabetic individual (Powers & Howley, 2009:346-347).

Individuals with type 1 diabetes are encouraged to exercise to gain health benefits, but blood glucose must be reasonably controlled for the person to exercise safely (Hornsby & Albright, 2009:184). Regular exercise can reduce the insulin requirements of well-controlled type 1 diabetes individuals by 30–50% (Toni *et al.,* 2006:34). Each bout of exercise leads to an improvement in insulin sensitivity that lasts for 1–2 days before falling back to pre-exercise levels (Nieman, 2007:499).

Physical activity is associated with a lower risk of type 2 diabetes mellitus (Borodulin *et al*., 2006:1027; Brouwer *et al*., 2010:377; Hsia *et al*., 2005:24). The combination of PA and being non-obese is associated with a lowered risk of developing type 2 diabetes mellitus (Brouwer *et al*., 2010:372). Jeon *et al*. (2007:750) suggested moderate intensity PA, such as brisk walking, to substantially reduce the risk of type 2 diabetes. According to Hu *et al*. (2007:592), 30 minutes of moderate or high level of PA a day, avoiding excessive weight gain and a healthy diet are effective and safe ways to prevent type 2 diabetes.

Borodulin *et al*. (2006:1027) stated that higher levels of leisure time PA were associated with decreased levels of fasting insulin and reduced the risk of having impaired glucose tolerance and type 2 diabetes, independent of the level of abdominal obesity. Even with these recommendations for PA, studies have shown that any physical activity is better than no

physical activity. Gill and Cooper (2008:822) conducted a review of the literature and reached the conclusion that the majority of the studies suggest that there is no clear minimum threshold of activity that needs to be achieved before being beneficial – all levels of activity above baseline appear to be beneficial. According to Brouwer *et al*. (2010:377), insufficient and sufficient PA are both likely to improve health in high-risk patients leading to a lower risk of developing type 2 diabetes and new cardiovascular events.

Recent reviews and meta-analyses, including the 2016 joint position statement on physical activity and type 2 diabetes from the American Diabetes Association (Colberg *et al.*, 2016:2065), have highlighted the beneficial effects of chronic endurance training, resistance training and combined (endurance training and resistance training) interventions for ameliorating insulin sensitivity and glycemic control in individuals with diabetes (Mann *et al*., 2014:257, Schwingshackl *et al.,* 2014:1789). A limited number of studies have demonstrated that chronic resistance training alone enhances glycemic control (Bacchi *et al.,* 2013:1287; Church *et al.,* 2010: 2253) and muscle substrate metabolism in individuals with diabetes (Sparks *et al.,* 2013:1964), yet the underlying mechanisms inducing these health benefits, particularly those related to muscle mitochondrial function, remain to be elucidated.

2.5.4 Hypertension

Hypertension is define as a transitory or sustained elevation of systemic arterial BP to a level likely to induce cardiovascular damage or result in other adverse consequences (Contractor & Gordon, 2009:233). The aetiology of hypertension is unknown in 80–90% of cases and called essential, idiopathic or primary hypertension (Camm & Bunce, 2009:798; Contractor & Gordon, 2009:233). There are, however, multi-factorial aetiologies linked to essential hypertension including; genetic, foetal and environmental factors such as obesity, excessive alcohol and sodium intake as well as stress (Camm & Bunce, 2009:798). Secondary hypertension is systemic hypertension where BP elevation is the result of a specific and potentially treatable cause. Conditions, which was brought about by hypertension, include renal disease, endocrine causes, drugs and in some females, pregnancy (Camm & Bunce, 2009:799; Contractor & Gordon, 2009:233).

Elevated arterial BP is a major cause of premature vascular disease leading to cerebrovascular events, ischaemic heart disease and peripheral vascular disease (Camm & Bunce, 2009:799).

These pathological conditions arise due to damage of the endothelium from hypertension, which predisposes the individual to atherosclerosis and other vascular pathologies (Ehrman *et al.*, 2018:140, Rajendran *et al.*, 2013:1057). In the presence of hyperlipidaemia and a damaged endothelium, atherosclerotic plaque develops (Camm & Bunce, 2009:799). This hypertension-induced vascular damage can lead to strokes and transient ischaemic attacks (Contractor & Gordon, 2009:235; Ehrman *et al.*, 2018:140).

Hypertension confers increased risk of CVD in the absence of risk factors, but absolute risk increases dramatically when other risk factors are presence and often found clustered with other cardiovascular risk factors (Black & Elliot, 2012:10). High BP contributes considerable to burden of cardiovascular disease in South Africa and especially poorly managed elevated BP (Lloyd-Sherlock *et al.*, 2014:116; Peltzer, & Phaswana-Mafuya, 2013: 67; Norman *et al*., 2007:697). High BP is the second leading risk factor for death in South Africa (Ntuli *et al.*, 2015:847; Norman *et al*., 2007:695). In 2000, almost 47,000 deaths in South Africa were attributed to hypertension (Norman *et al*., 2007:695). SADHS (2016:48) indicated that 46% of women and 44% of men are hypertensive based on their systolic blood pressure being above 140mmHg, their diastolic blood pressure being above 90 mmHg or taking antihypertensive medication.

High BP remains the most important risk factor for stroke (Alberti *et al*., 2009: 1640). SADHS data acquired in 2016 indicated self-reported hypertension was particularly high in the Western Cape (52% of women and 59% of men), Northern Cape (53% of women and 52% of men), and Free State (54% of women and 48% of men); it is lowest in Limpopo (34% of women and 29% of men) (SADHS, 2016:65). In a South African study conducted by Conner *et al*. in 2005, the overall hypertension prevalence rate in a study population of 9,731 people was 55% in the age group 30 years and older. The overall hypertension prevalence was highest for whites (60% and 66% for women and men, respectively), followed by coloureds (57% and 58% for women and men, respectively) and the black/African women and men had the lowest prevalence of hypertension (44% and 41%, respectively) (SADHS, 2016:65).

Research by Strydom *et al*. (1998:125), on 392 South African executives from the construction, steel, mining, motor and financial industries, indicated that these executives found themselves in the high-risk zones of four primary risk factors (high cholesterol, smoking, hypertension and

physical inactivity) of coronary heart disease. They concluded that 38.7% of the executives' systolic blood pressure (SBP) was higher than the acceptable value of <140mmHg, and 58.9% of the executives diastolic blood pressure (DBP) was higher than the acceptable value of <90 mmHg. Kolbe-Alexander and Lambert (2013:4) studied 18 South African companies and reported that 81% of the employees had high BP levels. Swanepoel *et al*. (2015:1478) indicated that male employees ≥ 45 years of age showed the highest prevalence of prehypertension (SBP 51.3%) and hypertension (SBP 26.7%), while a similar trend was indicated for DBP with 45.6% pre-hypertensive and 28.5% hypertensive. They reported the overall prevalence of employees at risk for hypertension in South African corporate setting as 62.1% (SBP) and 56.6% (DBP) (Swanepoel *et al*., 2015:1478).

Considering the above information about BP, the implications for executives will be the development of a higher number of chronic diseases, which will result in a higher probability of absenteeism or presenteeism (Kessler *et al*., 2001:1257). The employees and executives' high BP increases the number of health risks, with a consequent increase in work limitation, as each additional risk factor is associated with additional 2.4% excess productivity loss (Burton *et al*., 2005:769).

It has been indicated that physical inactivity is associated with an increased prevalence of hypertension (Brown *et al*., 2006:144). Therefore, physical activity has been identified as a possible lifestyle intervention in the prevention and management of hypertension. Studies have shown that exercise helps prevent the development of hypertension (Barlow *et al*., 2006:142; Contractor & Gordon, 2009:245; Parker *et al*. 2007). Parker *et al*. (2007) observed a statistically significant inverse association between PA and incidence of hypertension in adults. Vigorous physical activity was independently associated with a low incidence of hypertension in men and women respectively (Hernelahti *et al*., 2004:306). According to Contractor et al., (2013:145) and Barlow *et al*. (2006:142), an active lifestyle have been promoted for the primary prevention of hypertension.

Exercise also helps reduce the BP of those with hypertension (Collier *et al*., 2008:682; Contractor & Gordon, 2009:245; Sohn *et al*., 2007:506; Terra *et al*., 2008:275). According to Collier *et al*. (2008:682), as little as four weeks of exercise can reduce systolic blood pressure (SBP) on average by 4.6 mmHg, and diastolic blood pressure (DBP) by 3.1 mmHg. Thus, mean

arterial pressure can be reduced on average by 3.2 mmHg in individuals who are pre-hypertensive and those with essential hypertension. Viecili *et al*. (2009:366) found that physical exercise, such as walking at moderate intensity for 20 minutes on alternate days resulted in an important decrease in BP, and most of the hypotensive effect occurred as early as after the first five sessions. Sohn *et al*. (2007:503) have the same opinion and stated that increasing an individual's daily walking by 30 minutes, results in a reduction in systolic and diastolic blood pressure in newly diagnosed hypertensive individuals (Sohn *et al*., 2007:506). According to Sohn *et al*. (2007:503), walking is considered one of the safest and simplest modes of exercise for hypertension patients of all age groups (Sohn *et al*., 2007:503). Terra *et al*. (2008:276) investigated the effect of resistance training on individuals with hypertension, and found that a 12-week resistance training programme promotes significant reduction in SBP, DBP and mean arterial BP, as well as the resting blood pressure values among individuals with controlled hypertension. However, although the mechanism is still unclear this reduction can help reduce the risk of acute myocardial infarction and coronary disease (Terra *et al*., 2008:275). The mechanisms put forward to explain the BP-lowering and cardio-protective effects of regular exercise are based on neurohormonal and structural adaptations in vessels, muscles and adipocytes (Yung *et al*., 2009:45). The neuro-endocrinological factors involved include reductions in circulating noradrenaline and its receptors, and in angiotensin II, and increases in nitric oxide bioavailability, antioxidant capacity, insulin sensitivity, and expression of cardio-protective factors such as apelin (Zhang *et al*., 2006:1153). Structural adaptations include vascular remodelling (increased length and lumen diameter and number of precapillary sphincters) and neoangiogenesis (Yung *et al*., 2009:45).

Physical activity does not only help reduce the prevalence and severity of the pathology, but also plays a role in the quality of life of individuals of all ages with hypertension (Contractor, 2013:146). Physical activity is associated with high levels of health-related quality of health among individuals with hypertension (Brown *et al*. 2006:137). Brown *et al*. (2006:144) observed a higher prevalence of lower levels of health-related quality of health among individuals with hypertension compared to those without. Fernandez *et al*. (2007:354) show a positive connection of physical exercise and quality of life has been established and especially in women over 65 years. From the discussion, it is clear that PA should be part of the intervention to treat and prevent hypertension. According to Norman *et al*. (2007:692), the

results indicate the potential for health gain from implementing BP-lowering interventions that include physical activity, which is known to be highly cost effective.

2.6 MODIFIABLE RISK FACTORS AND LIFESTYLE BEHAVIOUR THAT CONTRIBUTE TO THE DEVELOPMENT OF METABOLIC SYNDROME

2.6.1 Physical inactivity and metabolic syndrome

Physical inactivity is not about formal exercise, but is defined as doing no or little PA at work, home, for transport or in one's discretionary time (Mash, 2010:439). The evidence is strong that a sedentary lifestyle causes heart diseases along with its risk factors (Lee *et al*., 2012:219; Najdi *et al*., 2011:122; Woodcock *et al*., 2011:122). According to Guthold *et al*. (2008:487) data from 212,021 adults in 51 developing countries showed that 15% of men and 20% of women were at risk for NCDs due to physical inactivity.

In South Africa, over a quarter of men (27.9%) and almost half of women (45.2%) are physically inactive (Shisana *et al.*, 2013:131). Available data suggest that 31% of the world's population is not meeting the minimum recommendations for physical activity (Hallal *et al*., 2012:140) while in 2009 the global prevalence of inactivity was 17% (WHO, 2012). Despite promising positive trends in leisure time physical activity in some countries, incidental, transport-related and occupational PA have all reduced, therefore the global challenge of physical inactivity is further amplified by the risk it conveys (Brownson *et al*., 2005:421; Church *et al*., 2011:6; Knuth & Hallal, 2009:548; Stamatikas *et al*., 2007:416). Lee *et al*. (2012:9) presented persuasive evidence that 6–10% of all deaths from NCDs worldwide can be attributed to physical inactivity, and this percentage is even higher for specific diseases, such as ischaemic heart disease (30%) (WHO, 2012).

According to the World Health Organization (2018), for adults between 18–64 years of age, physical activity includes recreational or leisure time physical activity, transportation (walking or cycling), occupational, household chores, play, games and sports or planned exercise. Epidemiological studies indicate that moderate-vigorous physical activity (MVPA) is associated with decreased risk of developing metabolic syndrome (Brien & Katzmaryzyk, 2006:40; Dunkley *et al.*, 2012:616; Lakka & Laaksonen, 2007:76). Physical activity has been shown to improve BP and cholesterol levels, and equalise blood sugar regulation (Krauss *et al*.,

2002:1483). Regular physical activity also promotes weight control and abdominal obesity (Rennie *et al*., 2003:600). Another study showed that individuals who did not exercise were 1.7 times more likely to develop metabolic syndrome than those who exercised regularly (Lee *et al*., 2004:70).

2.6.2 Smoking and metabolic syndrome

Smoking has long been widely accepted as a risk factor for cardiovascular disease, with dose-response correlation between CHD morbidity and mortality and the number of cigarettes smoked (Frati *et al*., 1996:112; Kannel, 2011:338). Therefore, smoking predisposes an individual to metabolic syndrome because long-term smoking lowers the protective HDL cholesterol, increases LDL-cholesterol and increases triglycerides; these logically will lead to increased MetS risk (Cena *et al*., 2011:745). Several studies have shown that smoking induces the mechanism of insulin resistance and leads to type 2 diabetes by increasing levels of inflammatory markers (Attvall *et al*., 1993:327; Facchini *et al*., 1992:1128; Nakanishi *et al*., 2000:183; Śliwińska-Mossoń *et al*., 2012:295). Substances present in tobacco smoke undoubtedly trigger free radical processes, interfere with vascular homeostasis and proper functioning of the vascular endothelium (Śliwińska-Mossoń *et al*., 2015:288; Sliwińska-Mossoń *et al*., 2013:745) and also increase inflammation/oxidative stress (Śliwińska-Mossoń *et al*., 2012:295), in addition to directly damaging β-cell function (Milnerowicz *et al*., 2007:46). Because higher levels of inflammatory markers [C-reactive protein and interleukin-6 (IL-6)] herald the development of diabetes (Pradhan *et al*., 2001:327). Increased insulin resistance may underlie the clustering of the metabolic and haemodynamic abnormalities that have potent atherosclerotic properties, which result in metabolic syndrome (Reaven, 2002:286). In addition, cigarette smoking increases the circulating levels of free fatty acids that indicate increases in lipolysis (Bergman & Ader, 2000:351). It is well known that smoking raises sympathetic activity and increases the circulating cortisol, catecholamines, vasopressin, and growth hormone levels and is consequently detrimental to health (Chiolera *et al*., 2008:801)

Weitzman *et al*. (2005:862) demonstrated a strong correlation between MetS and tobacco smoke. Results show that exposure to tobacco smoke, either active or passive, is associated with a fourfold increase in the risk of MetS in individuals who are overweight (Kawada *et al*., 2010:e163). A study on an Asian population of 4,000 adults demonstrated that individuals that

smoked at least 20 packs a year, were twice as likely to develop MetS as non-smokers (Lee *et al.,* 2004:70).

According to SANHNES (2013) latest national statistics (South African National Health and Nutrition Examination Survey), 32% of South Africans were smokers in 1993 compared to 16.4% in 2012. They attributed the drop in numbers mainly to stricter smoking legislation, advertising limitations and steeper tobacco prices. Similarly, Bradshaw *et al*. (2011) reported an increase in NCD risk factors for South Africa, except for smoking and ascribed this to effective comprehensive tobacco legislation promulgated in the 1990s. Kolbe-Alexander *et al*. (2008:7) reported a smoking prevalence rate of 19.9% and Swanepoel *et al*. (2015:1478) a prevalence of 18.6% among employees in the corporate sector. Mendis *et al*. (2007:1578) demonstrated that the age of quitting among ex-smokers had a major impact on survival prospects and that those who quit between 35 and 44 years of age had the same survival rates as those who had never smoked. Mukamal *et al*. (2006) reported that the estimated effect of smoke cessation was the single change in lifestyle that gave the greatest benefit to reducing the risk of CHD.

Black *et al*. (2015:857) indicated that job displacement (downsizing, restructuring) was significantly associated with increased smoking among males as well as females, and had a significant effect on markers for cardiovascular disease. The CDC (2011) anticipated that smoking in the workplace affected individual health and exposed co-workers to second-hand smoke, which is associated with lung cancer, heart disease and respiratory illnesses. WHO (2013) reported that each smoker on average costs the employer an estimated $4,256 in 2012. More than $3,800 of the cost was due to lost productivity related to smoking breaks, and more than $400 due to absenteeism. They further indicated that this cost had increased by more than 25% since 2005. The cost of smoking-related disease to the South African economy was estimated at R1.2 billion in 2013 (Van Zyl-Smith *et al*., 2013:869).

2.6.3 Alcohol consumption and metabolic syndrome

Alcohol consumption is one of most prevalent lifestyles in the world (Maria *et al.,* 2013:797). It has recently been interested in its association with risk of MetS and its components (Xiao *et al.,* 2015:5). Several studies reported that alcohol consumption has a higher risk of developing type II diabetes (Alkerwi *et al.,* 2009:624; Seike *et al.,* 2008:545), hypertension (Sesso *et al*., 2008:1080), obesity (Schroder *et al.,* 2007:369), high triglycerides (TG) (Zhang *et al*.,

2011:509) and high fasting glucose (Chen *et al.,* 2012:12), which are the principal components of MetS (Alkerwi *et al.,* 2009:624). There are many proposed mechanisms for alcohol-induced hypertension including activation of the sympathetic nervous system causing vasocontriction, increased cardiac contractility and decreased baroreceptor sensitivity in blood vessel walls resulting in aberrant autoregulation (Rehm *et al.,* 2010:817). Alcohol consumption has also shown to inhibit hepatic fatty acid oxidation, which in turn increases triglyceride synthesis (Naarene & Sellke, 2013:5). However, the mechanism for high dose of alcohol among diabetes, it reduces insulin sensitivity and tip the balance towards insulin resistance and type 2 diabetes by increasing in ammation, decreasing β-cell survival and secretion, decreasing ligand binding to insulin receptor, downregulating the insulin signalling cascade, and decreasing expression of glucose transporters (Nguyen *et al.,* 2012: 89; Ronis *et al.,* 2007:1269). Clerc *et al*. (2010:1241) indicated that in a study of 6,172 individuals, those who consume a low to moderate amount of alcohol experienced a statistically significant increase in the risk of MetS compared to non-drinkers. In studies on Portuguese and Korean populations, no statistical significance in alcohol consumption and metabolic syndrome has been noted (Lee *et al*., 2004:70; Santos *et al*., 2007:328). In a similar study on a Korean population, high alcohol consumption has shown to be strongly associated with metabolic syndrome (Lee *et al*., 2010:196). Sayon *et al*. (2011:419) found that severe drinkers were associated with weight gain while light to moderate alcohol drinkers, especially wine drinkers, was not associated with obesity. Moderate alcohol consumption has shown to have some protective effects against metabolic syndrome (Alkerwi *et al*., 2009: 624).

Alcohol abuse among employees on-site and/or off-site inevitably results in decreased productivity, work errors, wasted materials and tardiness that translate into productivity losses (Eberlein, 2010:35-36; ICAP, 2013; NDMP, 2013:168). Alcohol abuse in the workplace relates to increased costs associated with absenteeism, poor productivity, high job turnover, interpersonal conflict, injuries and damage to property (Seggie, 2012:587). The cost of alcohol abuse was estimated to be around R9 billion per year, equivalent to 1% of GDP (Seggie, 2012:587). McCann *et al*. (2011:48) estimated that more than 50% of accidents in the workplace could be related to alcohol abuse, and that theft and criminal activities at work resulted from substance abuse that could cost employers a further 25% of their annual wages.

2.7 CONCLUSION

Metabolic syndrome is a clustering of abdominal obesity elevated blood pressure, low serum high -density lipoprotein cholesterol (HDL-C) levels, elevated serum triglycerides and impaired fasting glucose , its prevalence is increasing worldwide (Alexander *et al.,* 2003:1210). MetS and its components, such as dyslipidemia and hypertension increases the risk of CVD and some cancers (Cantiello *et al.,* 2015:22). The most important causes are ageing, unhealthy diets and sedentary lifestyles (Churilla & Fitzhugh, 2012:70; Lutsey *et al.,* 2008:754). Additionally, work-related factors, including sedentary work, long work periods, and high occupational stress, put workers at high risk for the development of MetS (Almadi *et al.,* 2013:821). Smoking and excessive alcohol consumption are also the contributing factors for developing MetS (Lee *et al.,* 2011:499). Employees of several categories are therefore considered as a high-risk population with respect to the prevalence of MetS based on literature. Concerning management of MetS encouraging workers' physical activity (PA) and healthy eating behaviour are the main health-promoting programs in the workplace to prevent MetS. However, discrepancies in the potential benefits of different types and levels of PA for reducing the risk of MetS or its components among workers remain and therefore require further study. Finally, the literature showed a correlation of different modifiable risk factors with metabolic syndrome. It is clear that as there are many factors that lead to the development of metabolic syndrome, clinicians need a strategy to decrease risks. With the overwhelming prevalence of metabolic syndrome among both the general population and employees along with the lack of awareness and diagnosis, as such it was apparent from the reviewed literature that more studies investigating physical activity and metabolic risk factors in relation to lifestyle behaviour among employees in local government need to be done.

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CHAPTER 3:

Relationship between selected metabolic risk factors and waist-to-height ration among employees in Vhembe District municipality of Limpopo Province, South Africa

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Relationship between Selected Metabolic Risk Factors and Waist-to-Height Ratio among Employees in Vhembe District municipality of Limpopo Province, South Africa

TAKALANI CLEARANCE MULUVHU[1,2], MAKAMA ANDRIES MONYEKI[1], GERT LUKAS STRYDOM[1]& ABEL LAMINA TORIOLA[2]

[1]Physical Activity, Sport and Recreation (PhASRec), Faculty of Health Sciences North-West University, Potchefstroom, 2520, South Africa

[2]Department of Sport, Rehabilitation and Dental Sciences, Tshwane University of Technology, Pretoria, 0001, South Africa

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Running head: Metabolic risk factors and waist-to-height ratio

Corresponding Author's Address

TC Muluvhu

Department of Sport, Rehabilitation and Dental Sciences,

Tshwane University of Technology,

Pretoria, 0001,

South Africa

Email: MuluvhuTC@tut.ac.za

Tel no: +27712 312 4324/ +2773 432 5234

LiveDNAiDs: http://livedna.org/27.16563

Significance statement: The study investigated the relationship between selected metabolic risk factors and waist-to-height ratio, which results in cardio-metabolic risk among employees. This study will help the researcher to uncover that waist-to-height ratio is an alternative index of determining obesity which has a positive relationship with cardio-metabolic risk factors but has not been researched among employees within municipalities of South Africa. Thus, additional evidence in ascertaining WHtR as a practical determinant of fatness and its possible use in larger employee samples may be significant in epidemiological studies.

AUTHOR CONTRIBUTION:

1. Takalani Clearance Muluvhu: Main researcher, planned, collected data and write-up of the manuscript.

2. Makama Andries Monyeki: Planning, supervise with data collection, capturing, analyses and interpretation, gave comments on the final version of the manuscript.

3. Gert Lukas Strydom: Provided inputs in the design of the study and commented on the manuscript.

4. Abel Lamina Toriola: Critical review of the manuscript and provided comments on the final version of the manuscript

ABSTRACT

Background and Objective: Relationship between metabolic risk factors and waist-to-height (WHtR) in population studies are well known. The aim of the study was to investigate the relationship between selected metabolic risk factors and waist-to-height ratio among employees in Vhembe District municipality of Limpopo Province, South Africa. **Material and Methods:** Using a cross-sectional design, the following anthropometric and metabolic variables were assessed in 535 (Men=249; Women=286) local government employees (aged 24–65 years) of the Vhembe District, Limpopo Province based on standardised protocols: Body mass index BMI, waist circumference (WC), waist-to-height ratio (WHtR), cholesterol (mmol/l; TC), and fasting blood glucose (FBG) (mmol/l; FG). Data was analysed using SPSS statistics version 21. **Results:** Majority (88.6%; males: 85.1%, females: 3.5%) of the participants were ground maintenance workers. The participants (65.2%) were classified as overweight (21.3%) and obese (43.9%): females (20.6%; 60.5%) being more overweight and obese as compared to males (22%; 25%). Twenty-five per cent of the total participants had an elevated level of FG; females (3.8%) being more affected than males (3.2%). Fasting glucose was positively associated with the BMI, WC and WHtR, especially in the grounds maintenance workers. **Conclusion:** Female employees were more overweight and obese than their male counterparts. Furthermore, FG was high among the employees; with female been more affected than the males. Municipality managers had higher levels of TC as compared to the grounds maintenance workers. It was evident that fatness was positively associated with elevated fasting glucose. From a public health perspective, the current results indicate the need for urgent strategic health promotion intervention among the employees in the Vhembe local municipality.

Keywords: Obesity, chronic diseases, fasting glucose, total cholesterol, anthropometry, employees.

INTRODUCTION

Obesity is a metabolic disorder resulting inter alia from the imbalance between energy intake and expenditure[1]. In the past four decades, obesity has been recognised as the most common risk factor for a number of chronic diseases such as heart diseases, hypertension, stroke, high cholesterol, adult –onset type 2 diabetes and certain forms of cancers[2,3]. Current estimates from the International Obesity Task Force suggest that at least 1.1 billion people across the globe are overweight and 312 million of them obese[4]. In developed countries like the USA, the prevalence of overweight is as high as 36%in adults and 17% in youth[5].Research has also shown that more than 30% of the population in Latin America, the Caribbean, Middle East and Northern Africa are overweight[2]. In Southern Africa, obesity is a major public health concern along with HIV/Aids and malnutrition; it is also apparent that in developing countries obesity and malnutrition co-exist[6]. The South African National Health and Nutrition Examination Survey (SANHANES-1)[7] reported a high prevalence of overweight and obesity in females than males (25% and 40.1% compared with 19.6% and 11.6% for females and males, respectively)[6]. High prevalence of obesity was also found among South African employees at one of the South African diamond mines[8] in which 25% of adult women were overweight and 40.1% obese, while 19.6% of adult men were overweight and 11.6% obese.

Experimental research has demonstrated that altered levels of metabolites in multiple metabolic pathways were associated with obesity, for example glucose [9,10]and lipid metabolism[11]. However, it has been accepted that the location of excess adiposity is a strong determinant of cardio-metabolic risk[12]. Specifically, the central deposition of excess weight has been proven to be a stronger predictor of risk of morbidity and mortality in comparison with overall obesity as defined by BMI alone[13-17]. Although WC is often advocated as a simple and accurate anthropometric marker of central obesity and associated cardio-

metabolic risk, its use has been adopted into clinical guidelines[18]. The application of WC to assess cardio-metabolic risk may even differ between Asians and other racial groups[19,20]. The application of WC to assess cardio-metabolic risk also assumes, albeit erroneously, that risk stratification does not influence patient height. For example, it has been shown that the risk of metabolic syndrome within given WC strata is significantly higher among shorter individuals than taller persons[21].

The waist-to-height ratio (WHtR) is an alternative anthropometric index of central obesity that circumvents the limitations of waist circumference [22]. First, due to the inclusion of height into the index, any potential confounding of cardio-metabolic risk by height is avoided; second, studies have found similar WHtR cut-offs for increased cardio-metabolic risk among Caucasian[22] and Asians[23]. WHtR cut-offs of 0.5 has been proposed as an indicator of cardio-metabolic risk for both Japanese[24], Korean[25] and British[26] both men and women.

WHtR has also been shown to denote cardio-metabolic risk among individuals who are not obese when other anthropometric indices were used[26-27]. For example, as compared to BMI and WC, WHtR is a better discriminator for hypertension, diabetes and dyslipidemia in both sexes[28-29]. An Iranian study has shown that WC and WHtR showed greater correlation with TC, FG, LDL, HDL-C Level than did BMI[30] The study carried out in African women has also demonstrated the association of abdominal obesity with TG, LDL and high LDL-C[31]. However, there are limited studies which assessed the relationship between selected metabolic risk profiles and WHtR in employees of South African municipalities. Therefore, the aim of this study was to investigate the relationship between selected risk factors of metabolic disease and waist-to-height ratio among local government employees in Vhembe District municipality, Limpopo Province of South Africa. This study will advance knowledge because waist-to-height WHtR ratio assessment can be used as a tool to measure obesity rather than using body mass index and WC measurement only.

METHODOLOGY

Research Design: The research was based on a cross-sectional design, on a convenience sample of local government employees in the Vhembe District of the Limpopo Province of South Africa.

Participants: Participants were 535 (Men = 249; Women = 286) local government (i.e. Local government is a form of public administration in South Africa which, in a majority context, exists as the lowest tier of administration within a given state) employees in the Vhembe District, which is one of the five (5) districts of Limpopo Province of South Africa. Vhembe District is located in the northern part of the country and shares its boarders with Beitbridge District in Matabeleland South, Zimbabwe. According to 2001 Census, 800 000 of the Vhembe District residents speak Tshivenda their mother tongue, while 400 000 speak Tsonga and 27 000 speak Northern Sotho[32]. Majority of the participants in this study were employed as grounds maintenance workers, clerical workers, managers and councillors. The employees were categorised into three age groups as follows: 24-29; 30-44, and 45-65 years. Participants were included in the study if they were within the age ranges and deemed apparently healthy.

Height and body mass: Standing height was measured to the nearest 0.1 cm, using a Harpenden Portable Stadiometer (Holtain Limited, Crymych, Dyfed, UK). Body mass was measured using a portable calibrated scale (SECA) and recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated as body mass (kg) divided by height (m) squared (kg/m^2).

Waist circumference: Waist circumference was measured using a standard tape measure and in accordance with procedure recommended by the American College of Sports Medicine[33]. For men, a normal WC classification is defined as less than 94cm, high as 94-102cm and very high as greater than 102cm. For women, a normal WC is less than 80cm, high is 80-88cm, and very high is greater than 88cm[18,19]. WHtR was determined from waist circumferences

(cm) divided by height (cm), Normal WHtR<0.5 and WHtR>0.5 indicating increased risk for both male and females[23].

Cholesterol and glucose screening: Total blood cholesterol and glucose levels were determined after a fasting period of ten hours from capillary blood samples obtained using a finger prick. The sample was placed on the PTS panel glucose and lipids test strips and analysed from the Cardiocheck® PA Analyzer (Polymer technology systems, Inc., USA). The Cardiocheck analyser was calibrated regularly following the instructions of the manufacturer.

Cut-off points: The American College of Sports Medicine (ACSM) has identified thresholds above which individuals will be at increased risk for cardiovascular disease[33]. The thresholds that were used to describe risk included the following:

- Obesity – BMI < 18.5 as underweight; between 18.5-24.9kg/m² as normal weight; between 25-29.9 kg/m² as overweight and ≥ 30kg/m² as obese.
- Total cholesterol- ≥ 5.18 mmol/l or patient using lipid-lowering drugs.
- Impaired FG - ≥ 5.5 mmol/l or patient using diabetic medication.

Procedure: The aim of the study was explained to the participants and their employers, who were also informed that the data would be treated confidential and will only be used for the research purpose. The participants were requested to complete and sign the informed consent form before participating in the study. The measurements took place during weekdays as per arrangement with the participants. A researcher (a Biokineticist, registered with the Health Professions Council of South Africa: registration number BK 0016195- HPCSA) conducted the measurements. The anthropometric measurements of height and weight were measured in allocated separate rooms for males and females. An investigator and the well-trained research

assistants performed the measurements for cholesterol and glucose. After all the participants had completed all the anthropometric measurements, fasting TC and glucose, they were guided by a researcher and well-trained research assistants to complete the questionnaires. Given the high level of illiteracy in the sample, assistance was provided in terms of clarifying questions in the participants' native languages without losing the meaning of each question. The study received ethical approval (NWU-00125-13-S1) from the North-West University's ethics committee.

Statistical analyses: Data was analysed using SPSS statistics version 21[34]. Descriptive statistic of mean, standard deviation, percentage were calculated for selected metabolic risk profiles (FG and TC levels) and waist-to-height ratio (WHtR; <0.5 and WHtR>0.5). Percentages were calculated for several metabolic risk profiles (FG and TC) and WHtR. The relationship between selected metabolic risk profiles (FG and TC levels) and WHtR ratio was determined by using Pearson's product moment correlation coefficients. A significant level was set at $p \leq 0.05$.

RESULTS

Table 1 indicates that out of the 535 employees, majority of workers work as grounds maintenance workers with few in skilled positions. Additionally, majority of employees were in the age group 45-65 years. The results also showed that the majority of the employees have no formal education and were grounds maintenance workers.

Table 1: Description of age, education and occupation of the participants

	Total (%)	Male (%)	Female (%)
Sex	**535**	**249(46.5)**	**286(53.5)**
Age (years):			
24-29	14(2.6)	3(1.2)	3.8(3.8)
30-44	58(10.8)	24(9.6)	11.9(11.9)
45-65	463(86.5)	222(89.2)	84.3(84.3)
Educational level:			
No formal education	376(70.3)	177(71.1)	199(69.9)
Std 8	27(5.0)	17(6.8)	10(3.5)
Matric	50(9.3)	19(7.6)	31(10.3)
Diploma	48(9.0)	20(8.0)	28(9.8)
Degree 1	8(1.5)	5(5.0)	3(1.0)
Degree2	2(0.4)	1(0.4)	1(0.3)
Degree 3	12(2.2)	5(2.0)	7(2.4)
Degree4	9(1.7)	4(1.6)	5(1.7)
Certificate	3(0.6)	1(0.4)	2(0.7)
Occupation:			
General clerk	52(9.6)	28(11.2)	1(0.3)
Accounting clerk	12(2.2)	2(0.8)	22(7.7)
Grounds maintenance workers	460(84.6)	212(85.1)	10(3.5)
Municipality manager (MM)	12(2.2)	6(2.4)	240(83.9)
Councillor	8(1.5)	1(0.4)	6(2.4)

Figure 1 presents the WC for the total group and by gender. The results show that female employees in the study are presented with high WC compared to their male counterparts.

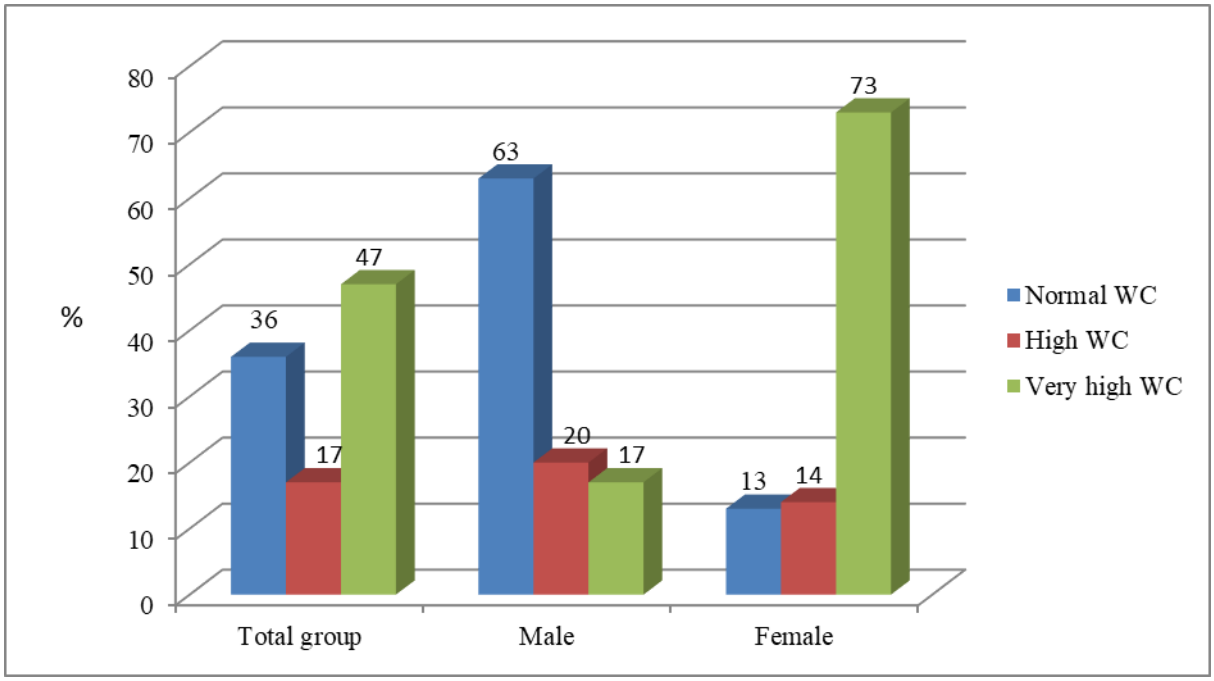

Figure 1: Percentage (%) of WC for the total group and gender

Figure 2 provides the percentage of BMI categories for the total group and by gender. The results showed high percentages for overweight and obesity for the total group. When analyses were done separately for males and females, females showed high percentages of overweight and obese compared to males.

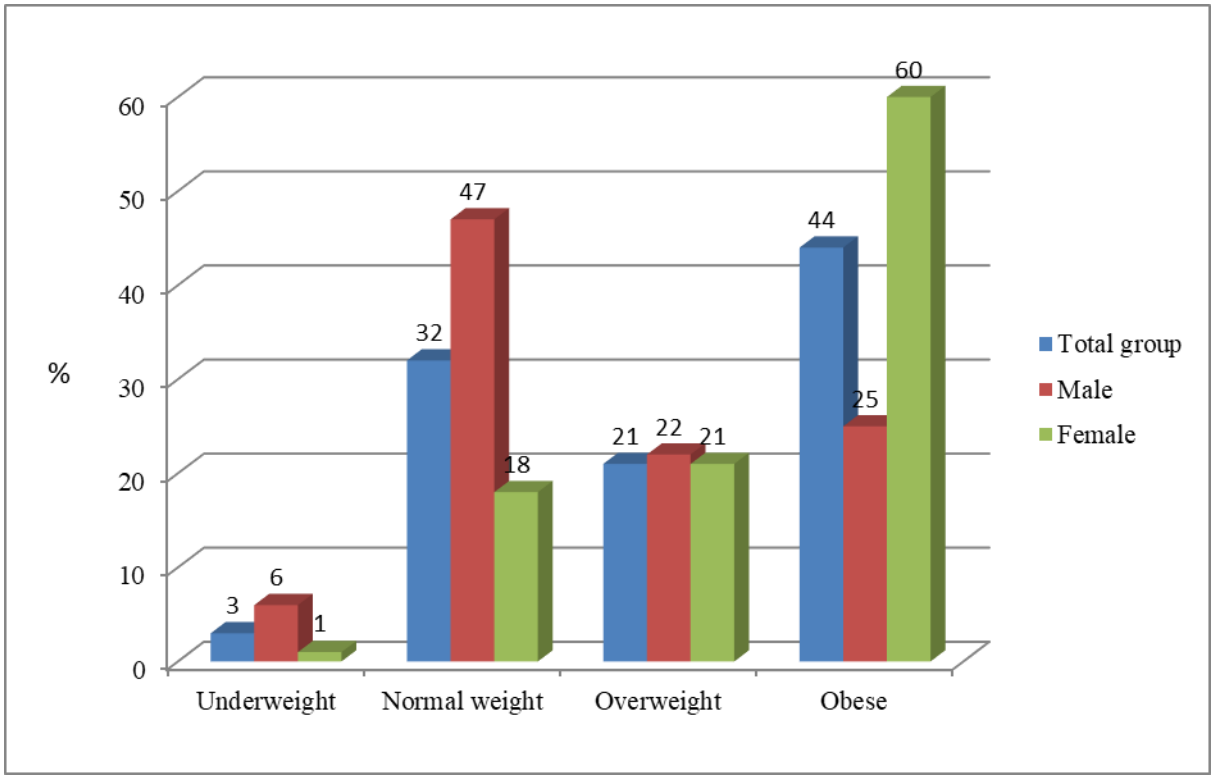

Figure 2: Percentage (%) of BMI categories for the total group and gender

Figure 3 presents the percentage of WHtR categories for the total group and gender. The results showed that one-third of the total group presented with a normal WHtR category, whereas two- thirds were in high WHtR category. A total of fourth-fifth of the females showed higher percentage of WHtR as compared to half of males.

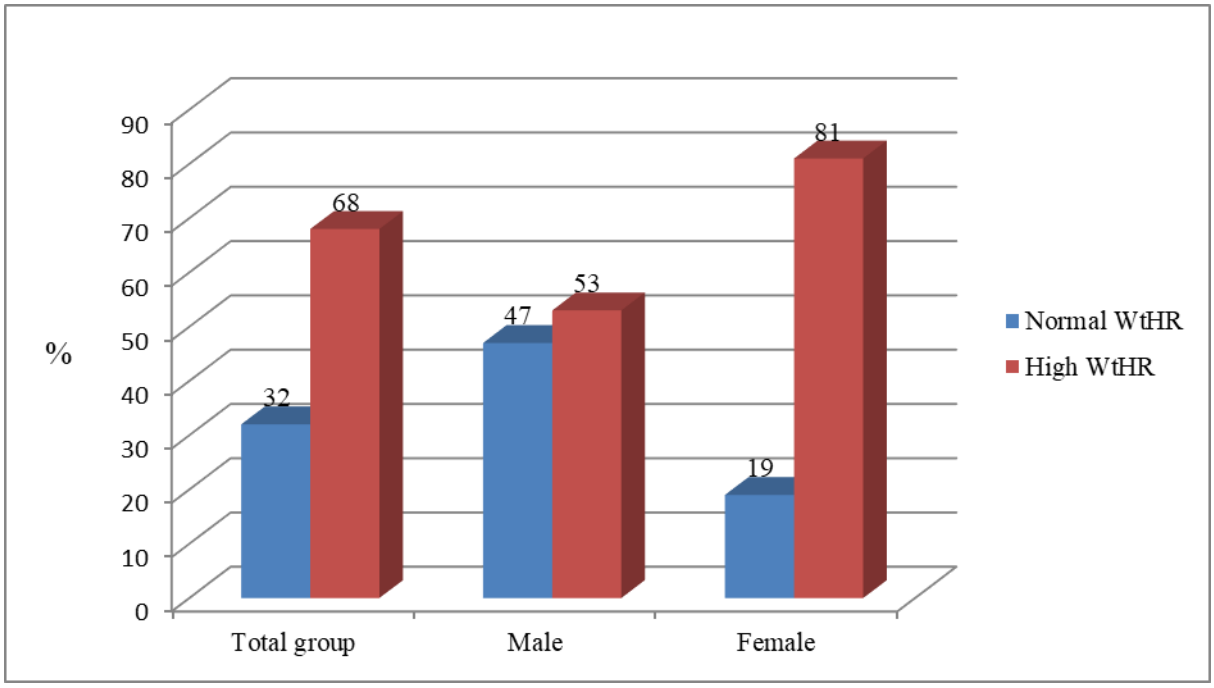

Figure 3: Percentage (%) of WHtR for the total group by gender

Figure 4 shows the percentage of FG levels for the total group and by gender. The results showed that almost 60% of the total group respectively had normal with almost a quarter had high FG levels. Females are presented with high percentages of FG compared to males.

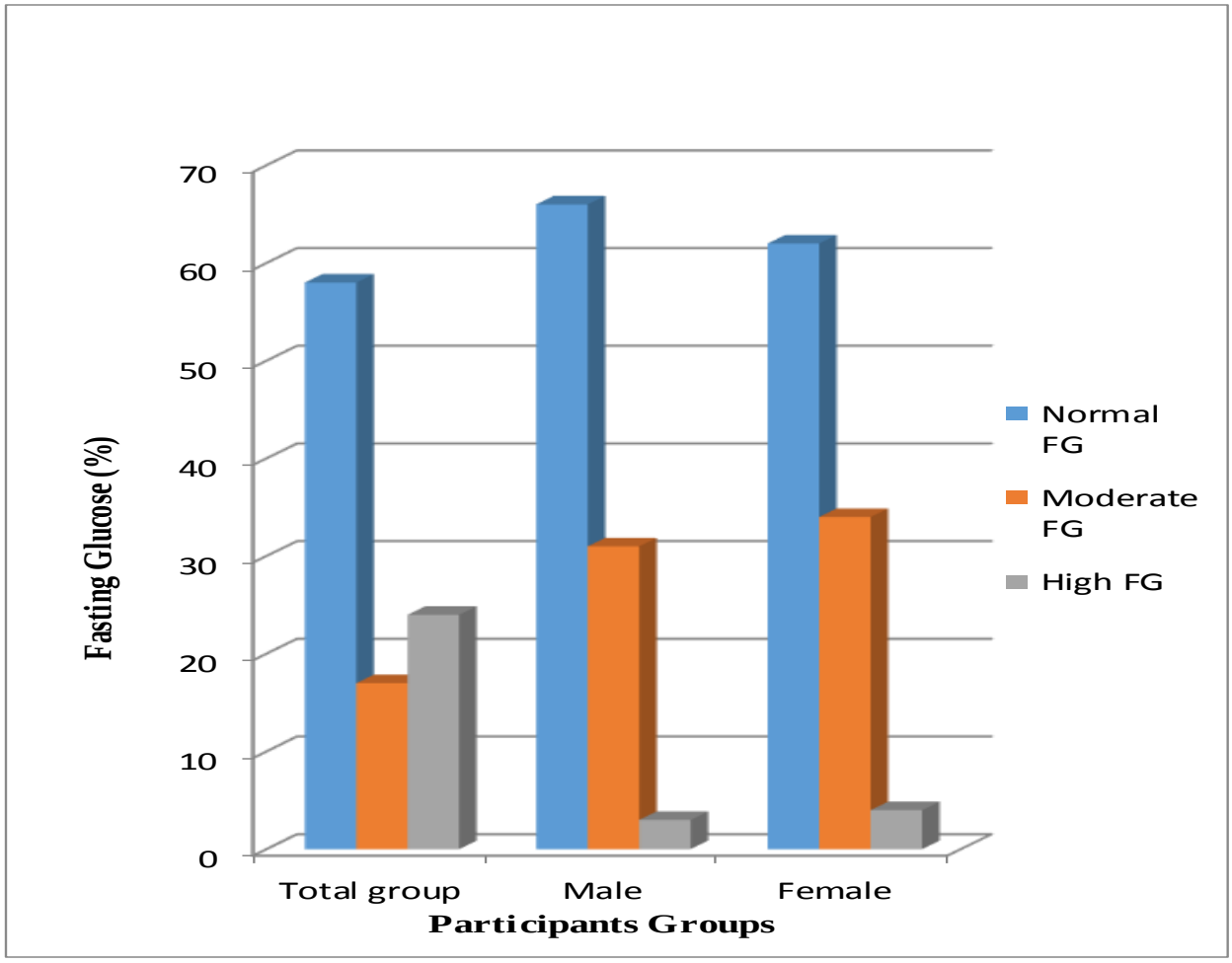

Figure 4: Percentage (%) of fasting glucose levels for the total group and gender

Figure 5 indicates the percentage of TC levels for the total group and by gender. The results showed that more than half of the combined sample had normal TC levels, whereas, one-third had moderate cholesterol levels and small number of the participants had high TC levels. When data was analysed separately by gender, the results show that females are presented with high percentages in both moderate and high cholesterol than the males.

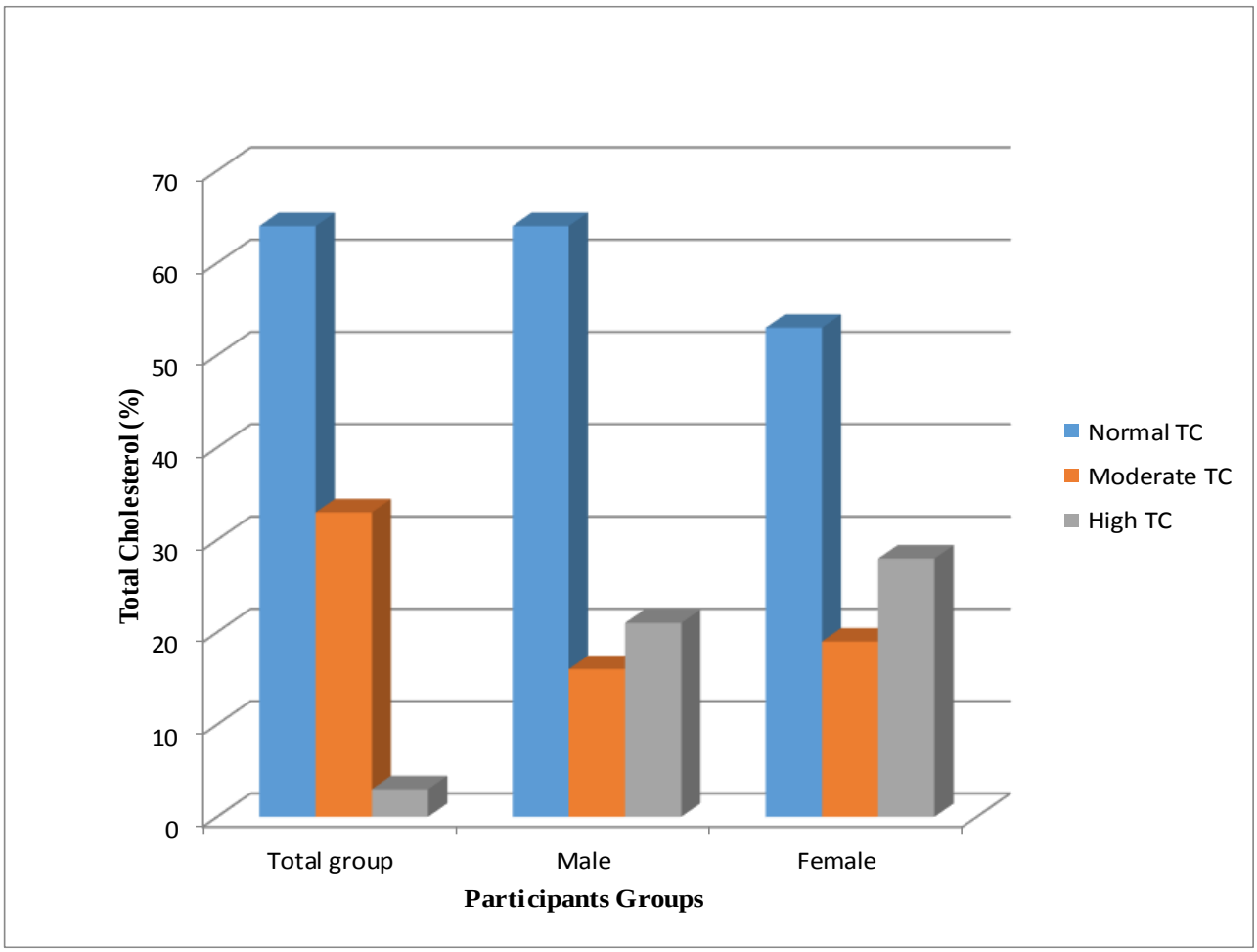

Figure 5: Percentage (%) of total cholesterol (TC) for the total group and gender

Figure 6 presents the percentage of BMI categories by occupation. The results show that employees in the skilled positions were obese as compared to the grounds maintenance workers.

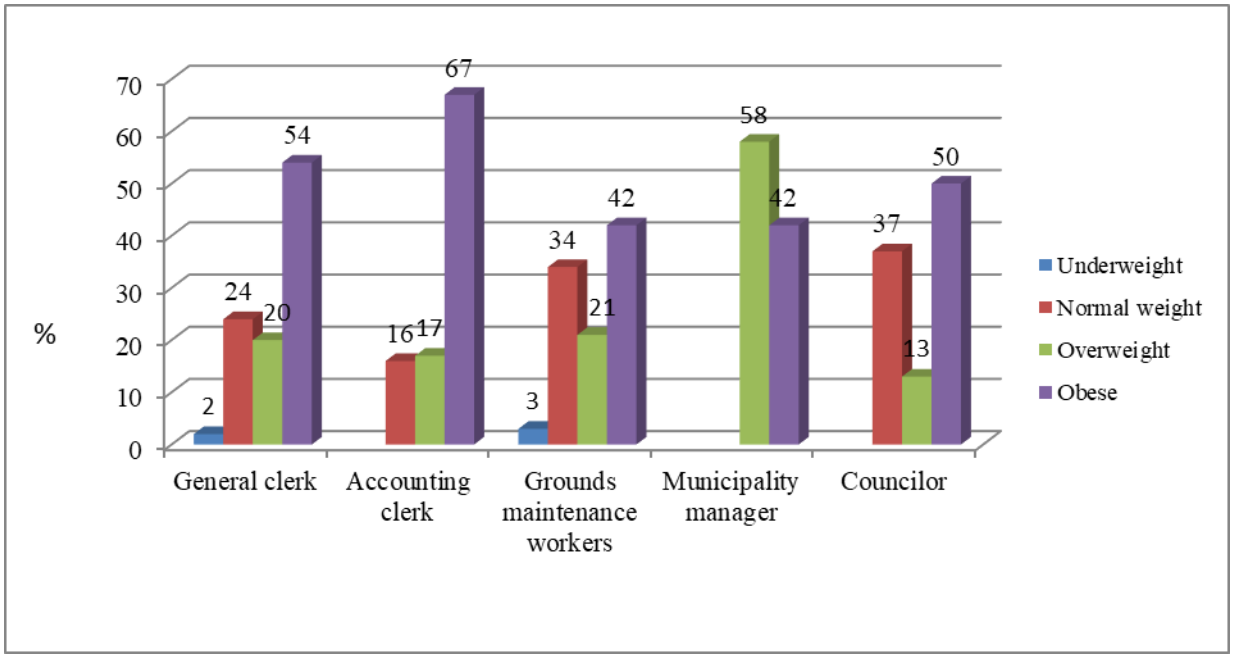

Figure 6: Percentage (%) of BMI categories by occupation.

Figure 7 presents the percentage of WC categories by occupations. Overall, employees in the study are presented with high percentages of very high WC. Additionally, the results show that grounds maintenance workers had low percentages of high WC compared to the other groups.

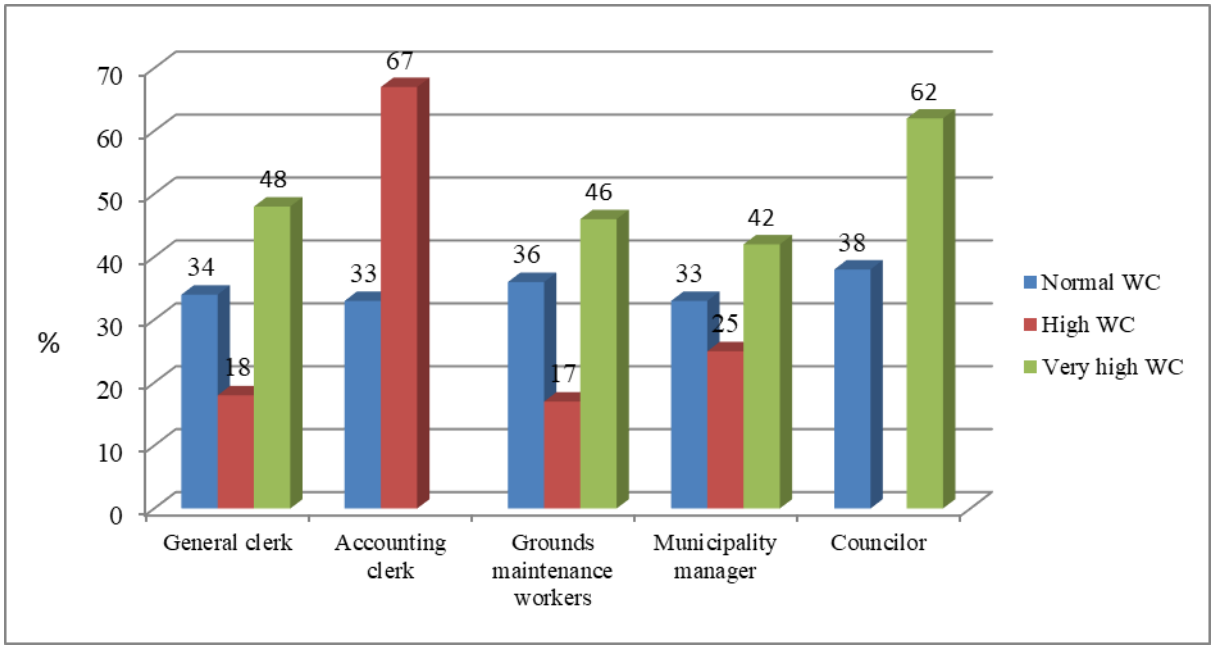

Figure 7: Percentage (%) of WC by occupation

Figure 8 presents the percentage of WHtR categories by occupation. The results indicated that clerks had high WHtR. Municipal managers and grounds maintenance workers are presented with high WHtR compared to the councillors.

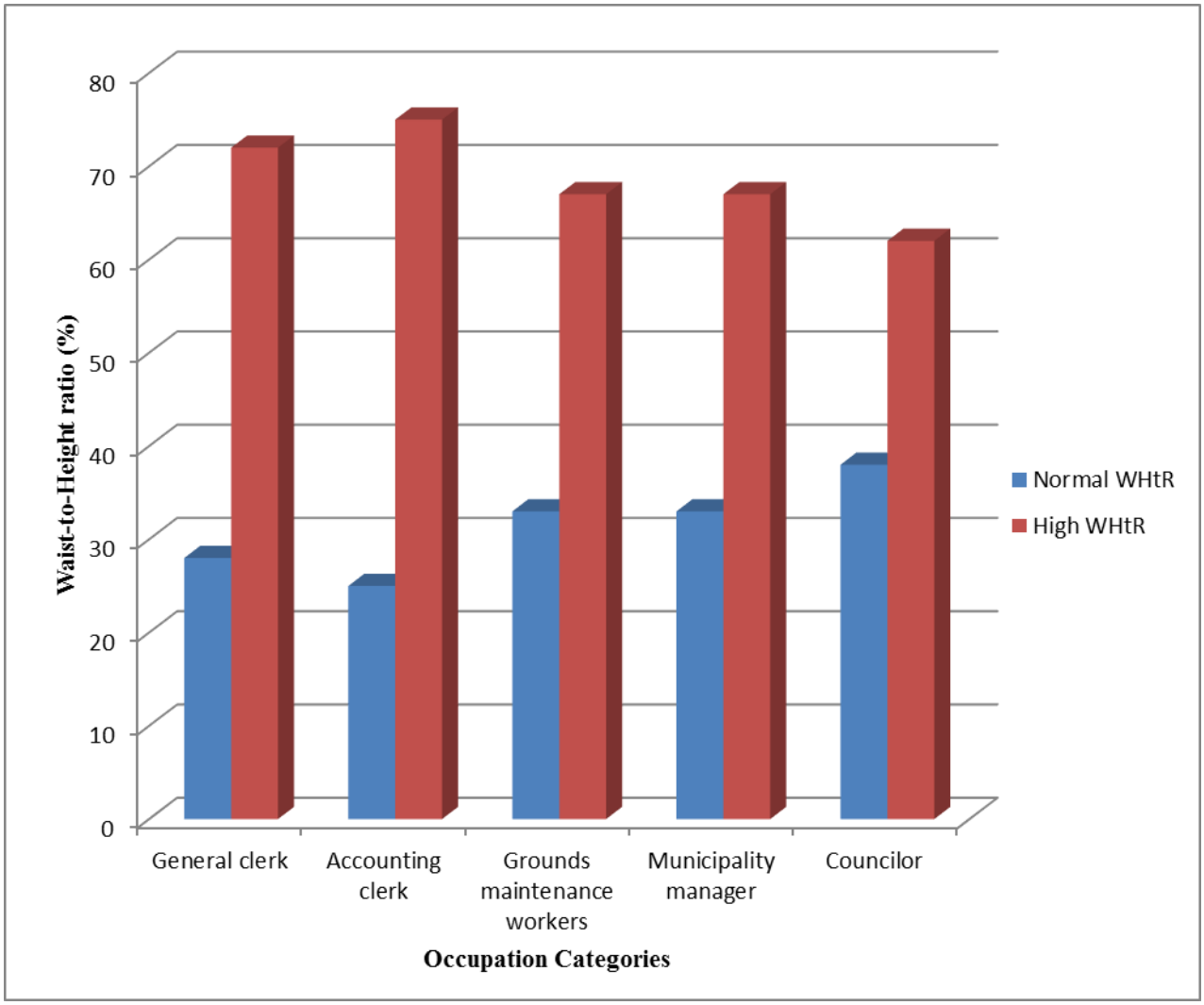

Figure 8: Percentage (%) of WHtR by occupation

Figure 9 presents the percentage of FG levels by occupation. The results showed that a quarter of general and accounting clerks had high FG levels as compared to accounting clerks respectively, a quarter of municipality managers, councillors and grounds maintenance workers also had high FG levels.

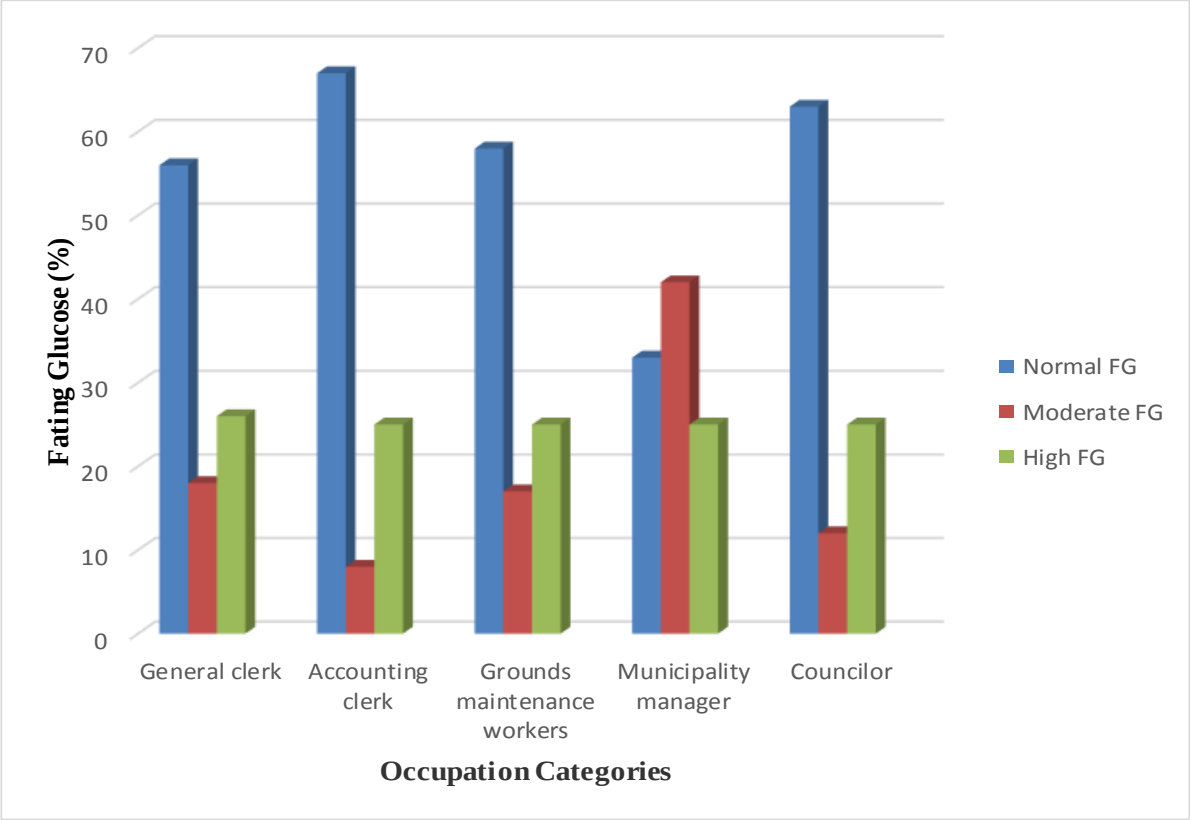

Figure 9: Percentage (%) fasting glucose (FG) by occupation

Figure 10 presents the percentage of TC levels by occupation. The results showed that municipality managers had high levels of TC as the grounds maintenance workers.

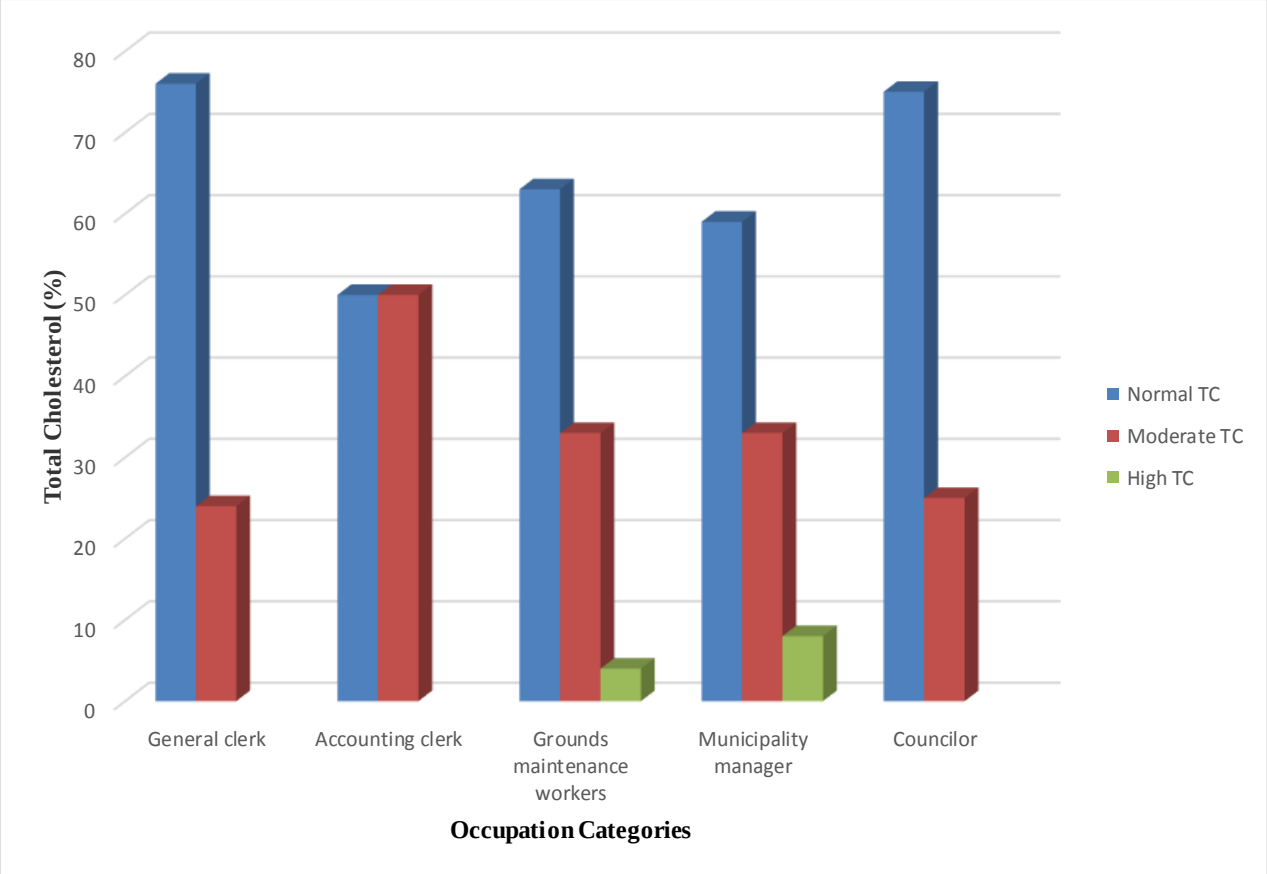

Figure 10: Percentage (%) of total cholesterol (TC) by occupation

The results showed significant ($p \leq 0.01$) positive correlations between FG, and BMI and WHtR for the total group. When the data were analysed based on employment position, FG was positively associated with BMI and WHtR in the grounds maintenance workers. No significant relationships were found for TC and anthropometric measures.

Table 2: Pearson correlation coefficients between glucose, cholesterol levels and selected anthropometric measures for the total group and by employment position (N=535)

	BMI	WC	WHtR
Total group	***r***	***r***	***r***
Total cholesterol	.05	.02	.04
Fasting glucose	.20**	.24**	.23**
Grounds maintenance worker			
Total cholesterol	.01	-.01	.01
Fasting glucose	.13**	.19**	.16**
Admin clerk			
Total cholesterol	.16	.20	-.06
Fasting glucose	-.19	-.07	-.01
Municipal manager			
Total cholesterol	.09	.18	.27
Fasting glucose	.03	-.13	-.05
Councillors			
Total cholesterol	-.07	.23	.35
Fasting glucose	.55	.56	.60

**. p≤0.05; WC=waist circumference; WHtR=waist-to-height ratio

DISCUSSION

The purpose of this study was to investigate the relationship between selected metabolic risk factors (FG and TC levels) among employees in Vhembe District municipality of Limpopo Province, South Africa. The results showed high WHtR of 68% for the total group, in which 80% and 53% were females and males, respectively as indicated in Figure 3. These rates are higher than those of a study reported by Raimi *et al*.[35] which showed that more participants were classified more centrally obese when using WHtR than WC (29% versus 13% in males and 62% versus 57% in females). Ashwell and Hsien[22] suggested that the WHtR is more useful for assessing health risk than BMI, further a cut-off value of

WHtR≥0.05 indicates increased risk for both males and females across ethnic and population groups.

Additionally, the results showed high prevalence of obesity (44%) for the total group comprising 60% were females as compared to 25% males, as indicated in Figure 2. These are higher when compared to the results of Puone *et al.*'s[6] study, which indicated that 56.6% of women were obese as compared to 29.9% of men. It is generally accepted that obesity as defined by BMI, increases the risk of type 2 diabetes, hypertension, cardiovascular disease and all- cause mortality[35-37]. The present study showed that 3% of the total group had high total cholesterol levels, with 28% of females showing high TC levels as compared to males (21%), as indicated in Figure 5. The results are lower than those reported by Chehrei[30], in which high TC levels was found in 28% of their sample, with 30% prevalence observed in males compared to 23%in females. Significant positive relationships between total glucose, BMI, WC and WHtR were found in the present study, which are consistent with results of the study by Sangafi-Asl[38] which showed that WHtR had the strongest correlation with blood lipid profiles (r=0.37; p=0.004 for TC) and (r=0.33; p=0.011 for LDL-C) compared with BMI and WC. The results of a meta-analysis support the superiority of central obesity, especially WHtR over BMI for detecting cardiovascular risk factor in both males and females[29]. WHtR and WC are positively strong associated with cardiovascular risk factors than WHR[28]. Also in our study, BMI, WC and WHtR significantly ($p<.05$) correlated with FG which showed the highest correlation observed for WHtR than BMI and WC[30].

The present study has several limitations which should be noted when interpreting the results: The cross-sectional design of the study may one way or the other may have confounded the results of metabolic risk factors observed in the study. The Vhembe District municipality employee data, which is not representative of all municipalities' employees in South Africa, also limits the generalisation of the present findings. The strength of the study

is that it was, to our knowledge, the first of its kind that assessed the relationship between anthropometric indicators and selected risk factors of CVD among employees in the Vhembe District of the Limpopo Province of South Africa.

CONCLUSION

The study concluded that municipality employees were overweight and obese with females being more affected than males. A similar trend was noted regarding the findings on total cholesterol. Furthermore, it was evident that fatness was more positively associated with FG, especially in grounds maintenance workers than the other categories of employees. A significant proportion of the employees presented with health risks that may decrease productivity. From a public health perspective, the current results implicate the need for urgent strategic intervention targeted at promoting physically healthy lifestyle among the employees in the Vhembe local municipality.

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Competing Interest: No competing interest exists among the authors.

Data Availability: All relevant data related to the paper have been included.

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CHAPTER 4:

Relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa

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Relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa

Takalani Clearance Muluvhu[1, 2], Makama Andries Monyeki[1], Gert Lukas Strydom[1] & Abel Lamina Toriola[2]

[1]*Physical Activity, Sport and Recreation (PhASRec), Faculty of Health Sciences North-West University, Potchefstroom, 2520, South Africa*

[2]*Department of Sport, Rehabilitation and Dental Sciences, Tshwane University of Technology, Pretoria, 0001, South Africa*

Corresponding Author's Address

Takalani Clearance Muluvhu

Department of Sport, Rehabilitation and Dental Sciences,

Tshwane University of Technology,

Pretoria, 0001,

South Africa

Email: MuluvhuTC@tut.ac.za

Tel no: +27712 312 4324/ +2773 432 5234

4.1 ABSTRACT

Background: Obesity correlates high with major metabolic abnormalities such as; hypertension, dyslipidaemia, hyperglycaemia and is independently associated with increased cardiovascular diseases. **Objective:** The aim of this study was to investigate the relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province. **Methods:** A cross-sectional study was conducted among 452 local government employees (207 males; 245 females) aged 24–65 years. BMI, BP, WC and WHtR measurements were assessed. Data was analysed using SPSS statistics version 21. **Findings:** The results showed that 27% of the participants were classified as overweight and 34% as obese, with females being more overweight and obese (29%, 48% respectively) compared to males (24%, 17%). Twenty-five percent of the participants were hypertensive, with females (27%) showing a higher prevalence compared to males (22%). Based on BMI categories the obese group (35%) had a higher prevalence of hypertension in contrast to groups that were of normal weight (18%) and overweight (22%). The results also showed that SBP was positively ($p \leq 0.05$) correlated with BMI (r=0.15), WC (r=0.26) and WHtR (r=0.29) in normal group and in the overweight group (WC, r=0.23 and WHtR, r=0.26); WHtR correlated with SBP (r=0.26) and DBP (r=0.19). **Conclusion:** The study showed high prevalence of overweight, obesity and hypertension, with females more affected than their male counterparts. BMI, WC and WHtR were positively correlated with SBP in the normal and overwight groups, with WHtR positively correlated with both SBP and DBP in theoverweight group. It is recommended therefore, that intervention regimes designed to address obesity and hypertension should pay attention to the risk awareness for cardiovascular diseases, impaired quality of life and productivity among local government employees.

Keywords: Obesity, hypertension, employees, blood pressure, body mass index

4.2 INTRODUCTION

Obesity is one of the most important public health problems worldwide.[1] It is a major independent risk factor for chronic diseases such as cardiovascular disease and diabetes mellitus, and is associated with high morbidity and mortality rates.[2] According to the World Health Organization, up to 20% of the population in developed countries may suffer from obesity-associated hypertension, which may account for 78% and 65% essential hypertension in males and females respectively.[3,4] The World Health Organization[4] reported that one in six adults is obese and one in three has elevated BP, with the highest prevalence recorded in Africa. Obesity and hypertension are among the preventable risk factors for cardiovascular disease that impose a considerable economic burden, particularly in developing countries.[5]

Hypertension is one of the ten leading contributors to the global burden of disease and the most important risk factor for mortality worldwide[4,6,7] and has been described as a silent killer due to its asymptomatic nature among sufferers.[8] Studies have reported that about nine million people die from hypertension annually.[9,10] The prevalence of hypertension in Africa has also been reported in several previous studies.[9,11.12] Hypertension was once considered a disease of affluence, but is now prevalent among the poor.[13] South Africa is facing a serious burden of hypertension.[14] More than 6.2 million South Africans are hypertensive with 3.2 million having a BP of > 160mmHg.[15]

Several studies have shown a clear association of BP increase with weight gain.[5,17] It has been reported that obese subjects have a 3.5 times increased likelihood of hypertension and that 60% of hypertension is attributable to an increase in adipose tissue stores.[2] Data from the National Health and Nutrition Examination Survey indicates the prevalence of hypertension among obese individuals with a BMI > 30kg/m² to be 42.5% compared with 15.3% of lean individuals.[18] The visceral fat distribution is another genetic factor that contributes to the increase in BP levels among obese individuals.[19] Environmental factors such as alcohol intake, cigarette smoking, timing of onset childhood obesity, change in daily lifestyle habits and alteration in lipid profile may be implicated in visceral fat distribution and increase in BP values.[20,21,22] Most studies suggest that centrally located body fat is a stronger determinant of BP elevation than peripheral body fat in both men and women.[21,23]

A positive association of BMI and BP has been reported among Ghananian adults aged 30 to 50 years old.[24] Certain occupations predispose individuals to a sedentary lifestyle and some of these are white-collar jobs characterised by sitting for long periods of time, for instance

workers in financial institutions and administration offices.[25] Eventually these individuals will spend the most part of their adult working lives less engaged in PA outside of working hours, making them very susceptible to develop obesity and/or overweight, which predisposes them to chronic diseases.[26] A study in India reported a higher prevalence of hypertension, which was positively correlated to obesity among employees than among the general population of the country.[27]

A recent systematic review among workers in West Africa reported a prevalence of hypertension of 12–69% among workers.[28] The prevalence of obesity among workers ranged from 2% among automobile garage workers in Kumasi, Ghana,[29] to 42.1% among health workers in Umuahia, Nigeria.[30] The prevalence of hypertension ranged from 27.9% to 78.9% among obese workers compared with 7.3% to 65.4% among non-obese employees in West Africa.[31] Among health workers in a university teaching hospital, the odd ratio of the association between obesity and hypertension was 2.2, p =0.004.[32] Civil servants in Kaduna younger than 40 years who were overweight or obese were five times as likely to have hypertension compared with healthy weight workers.[33] Schutte *et al*.[34] reported a prevalence of 48% overweight and obesity among South African employees from 18 companies participating in health screening programmes. Cardiovascular risk factors – specifically diabetes and hypertension – were found to be associated with obesity among public service workers in Ondo State, Nigeria.[35] This study will be first of its kind among employees in Vhembe District municipalities in Limpopo Province to investigate the relationship between obesity and BP, and will provide insight into strategic interventions that need to be devised to manage the unhealthy outcomes of this association. Therefore, the aim of this study was to investigate relationship between obesity and BP among employees in the Vhembe District municipality of Limpopo Province, South Africa.

4.3 METHODS

4.3.1 Research design

The research based on a cross-sectional design, was conducted on a convenience sample of local government employees in the Vhembe District of the Limpopo Province in South Africa.

4.3.2 Participants

The participants were 452 (Men = 207; Women = 245) local government employees in the Vhembe District, which is one of the five (5) districts of Limpopo Province of South Africa (Local government is a form of public administration in South Africa which exists as the lowest tier of administration in the provinces). Vhembe District is located in the northern part of the country and shares its borders with the Beitbridge District in Matabeleland South, Zimbabwe. According to the 2001 Census, 800,000 of the Vhembe District residents speak Tshivenda as their mother tongue, while 400,000 speak Tsonga and 27,000 speak Northern Sotho.[36] The majority of the participants in this study were employed as grounds maintenance workers, clerical workers, managers and councillors. The employees were categorised into three age groups as follows: 24–29, 30–44 and 45–65 years. Participants were included in the study if they were within the age categories and deemed apparently healthy.

4.3.3 Height and body mass

Standing height was measured to the nearest 0.1 cm, using a Harpenden Portable Stadiometer (Holtain Limited, Crymych, Dyfed, UK). Body mass was measured using a portable calibrated scale (SECA) and recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated as body mass (kg) divided by height (m) squared (kg/m^2).

4.3.4 Waist circumference

Waist circumference (WC) was measured using a steel tape measure and in accordance with the procedure recommended by the American College of Sports Medicine.[37] For men, low waist circumference in this classification is defined as less than 94 cm, high as 94–102 cm and very high as greater than 102 cm. For women, low WC is less than 80 cm, high is 80–88 cm and very high is greater than 88 cm.[38,39] Waist-to-height ratio (WHtR) was determined from waist circumferences (cm) divided by height (cm). The norms for WHtR were as follows: Normal is WHtR<0.5 while WHtR>0.5 indicates increased risk for both males and females.[40]

4.3.5 Blood pressure

Blood pressure was measured by using an automated sphygmomanometer (Omron, Health care, Inc., USA). The participants were seated, and systolic (SBP) and diastolic (DBP) blood pressure measurements were determined according to the protocols suggested by ACSM.[37]

4.3.6 Cut-off points

The American College of Sports Medicine (ACSM) has identified thresholds above which individuals will be at increased risk for cardiovascular disease.[37] The thresholds that were used to describe risk included the following:

- Obesity – A BMI of 25–29.9 kg/m² is considered overweight, and ≥ 30kg/m² obese.
- Hypertension – systolic blood pressure ≥ 140 mmHg, and diastolic blood pressure ≥ 90 mmHg as well as for participants on hypertension treatment.

4.4 PROCEDURES

The aim of the study was explained to the participants and their employers, who were also informed that the data would be treated confidentially and would only be used for the research purpose. The participants were requested to complete and sign an informed consent form before participating in the study. The measurements took place during weekdays as arranged with the participants. The researcher (a biokineticist, registered with the Health Professions Council of South Africa: registration number BK 0016195-HPCSA) assisted by well-trained research assistants conducted the measurements. The anthropometric measurements of height, weight, WC and BP were taken in allocated separate rooms for males and females. The study received ethical approval (Ref: NWU-00125-13-S1) from the ethics committee of North-West University, Potchefstroom, South Africa.

4.5 STATISTICAL ANALYSIS

Descriptive statistics were calculated for all variables, according to gender. Numerical data were expressed as mean and standard deviation (mean & SD), and categorical data were expressed as percentages. A *t*-test was used to determined differences in the means of variables (age, height, weight, body mass index, waist circumference, waist-to-height ratio, systolic and diatolic blood pressure between study groups), and the Chi-square test was used to compare the prevalence of general obesity and central obesity in men and women. The differences in BMI and WC across age groups were described by sex, and the Chi-square test was used to compare the prevalence of obesity between different age groups in the study sample. To determine the differences among the BMI categories/groups, an analysis of variance (ANOVA) was calculated for all variables. Descriptive characteristics of the hypertensive and normotensive groups were determined and compared. Pearson correlation coeffients were used to determine the relationship between relationship between obesity and

BP among employees. All statistical analyses were performed with the SPSS version 21. The statistical level of the p-values was set at $p \leq 0.05$.

4.6 RESULTS

Figure 1 presents the percentage for BMI categories for the total group and by gender. The results show that of the total group 39% have normal weight, 27% are overweight and 34% obese. The results also show that 29% of women are overweight compared to 24% of men and 48% of women are obese as compared to 17% of men.

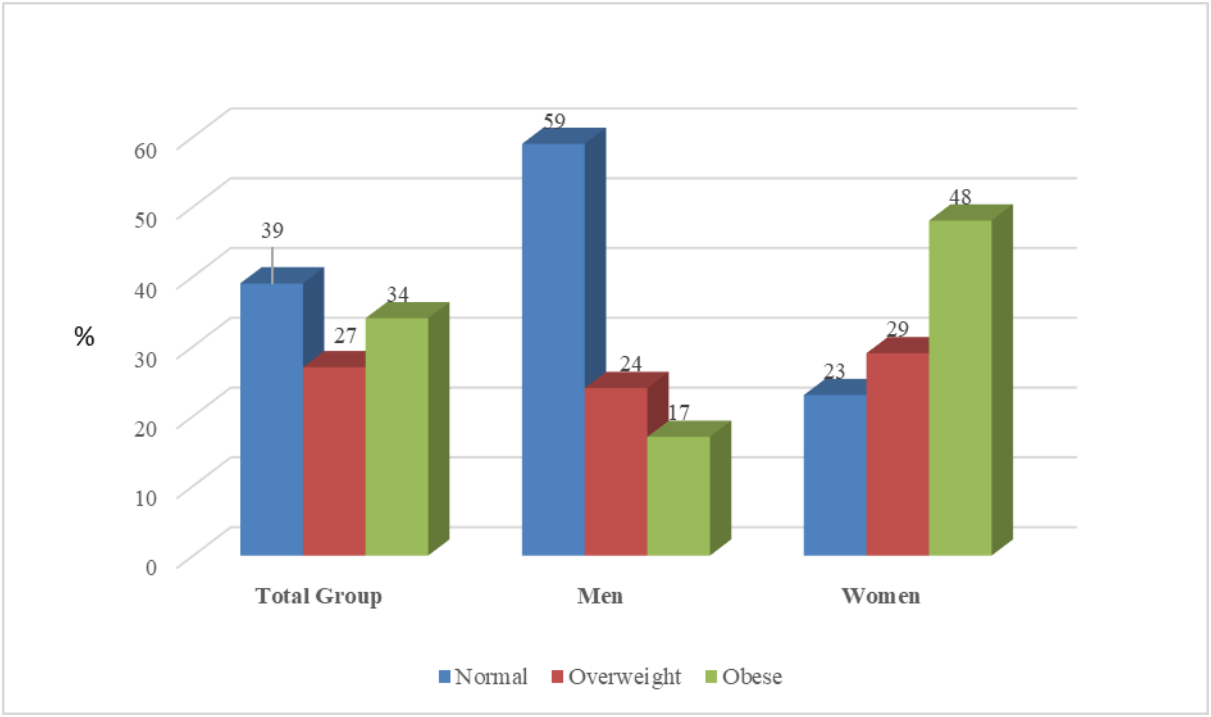

Figure 1: BMI categories for the total group and by gender

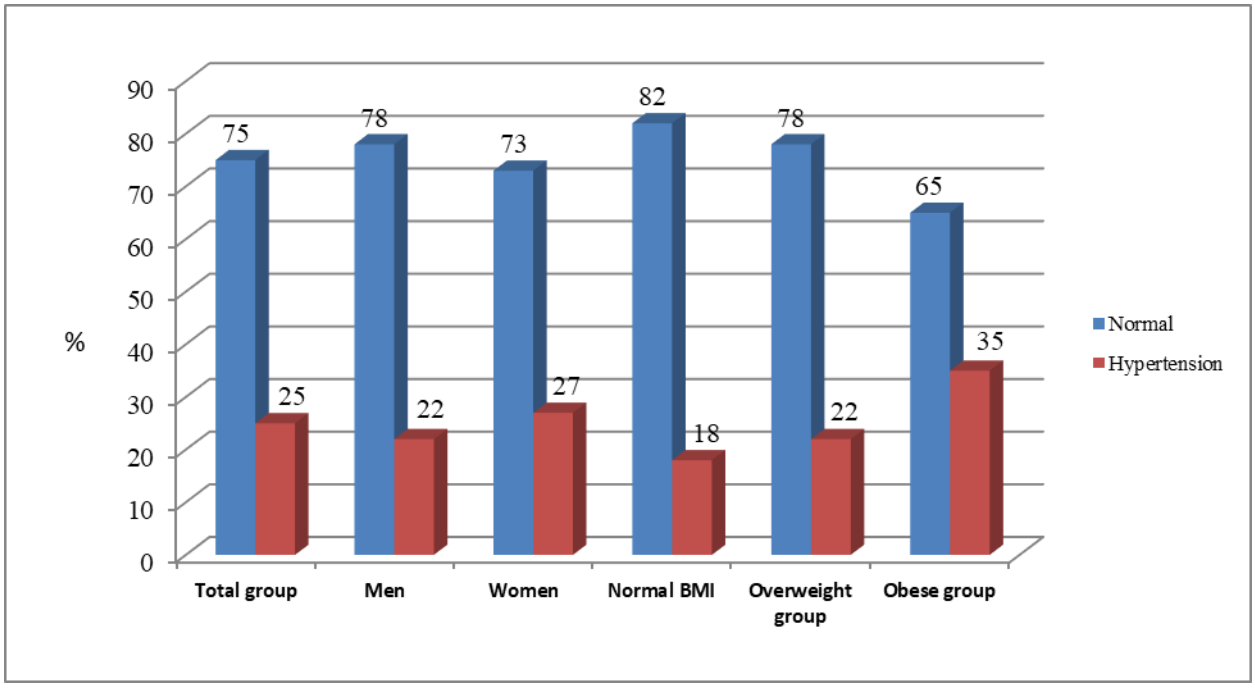

Figure 2: Hypertension for the total group, gender and by BMI categories

Figure 2 presents the percentage of hypertension for the total group, gender and by BMI categories. In the total group, the results show that 25% of the employees are presented with hypertension, with women (27%) being more affected compared to the men (22%). When data was analysed according to BMI categories, the results showed a significantly higher percentage hypertension in both the overweight and obese groups.

Table 1: Subject characteristics total group for non-obese and obese group

	Non-obese group			Obese group					
	Total participants	Men	Women	Total participants		Men		Women	
				OV	OB	OV	OB	OV	OB
	n(%)	n(%)	n(%)	n(%)		n(%)		n(%)	
Age groups									
24–29 yrs	17(9.6)	4(3.3)	13(23.6)	8(7)	5(3)	1(2)	2(5.7)	7(9.7)	3(2.5)
30–44 yrs	14(7.9)	8(6.5)	6(10.9)	13(11)	16(11)	9(18)	4(11.4)	4(5.6)	12(10.2)
45–65 yrs	147(82.6)	111(90.2)	36(65.5)	100(83)	132(86)	39(76.6)	29(82.9)	61(84.7)	103(87.3)
Qualification									
No formal education	124(69.7)	92(74.8)	32(58.2)	86(71.1)	101(10)	31(63.3)	23(65.7)	55(76.4)	78(66.1)
StD8	8(4.5)	8(6.5)	8(14.5)	4(8.3)	10(6.5)	2(4.1)	4(11.4)	2(2.8)	6(5.1)
Matric	20(11.2)	12(9.8)	10(18.2)	7(5.8)	18(12)	3(6.1)	2(5.7)	4(5.6)	16(13.6)
Diploma	17(9.6)	7(5.7)	1(1.8)	9(7.4)	16(10.5)	5(10.2)	4(11.4)	4(5.6)	12(10.2)
Degree1	2(1.1)	1(0.8)	1(1.8)	2(1.7)	3(2)	2(4.1)	1	-	2(1.7)
Degree3	1(0.6)	1(0.8)	2(3.6)	5(4.1)	4(2.6)	3(6.1)	1	2(2.8)	3(2.5)
Degree4	3(1.7)	1(0.8)	1(1.8)	7(5.8)	-	3(6.1)		4(5.6)	
Certificate	2(1.1)	1(0.8)	-	1(0.8)	1(0.7)	-		1(1.4)	1(0.8)
Occupation									
General clerk	12(6.7)	11(8.9)	1(1.8)	11(9.1)	18(11.8)	8(16.3)	4(11.4)	3(4.2)	14(11.9)
Accounting clerk	3(1.7)	1(0.8)	2(3.6)	2(1.7)	7(4.6)	1(2.0)	31(88.6)	1(1.4)	7(5.9)
Grounds maintenance workers	160(89.9)	111(90.2)	49(89.1)	101(83.5)	122(79.)	36(73.5)		65(90.3)	91(77.1)
Municipality manager (MM)	1(0.6)	-	1(1.8)	(6)6	2(1.3)	4(8.2)		2(2.8)	2(1.7)
Councillors	2(1.1)	-	2(3.6)	(1)1	4(2.6)	-		1(1.4)	4(3.4)

OV = overweight; OB = obesity

Table 1 presents the percentages regarding subject's characteristics for the total, non-obese and obese groups. The results show that women in the age group of 45–65 years have a higher prevalence of overweight (84.7%) and obese (87.3%) compared to 76.6% overweight and 82.9% obese in men. The results also show that participants with no education tend to have a higher percentage of overweight (71.1%) compared to those with other qualifications where women are 76.4% overweight and 66.1% obese, compared to men who are 63.3% overweight and 65.7% obese. The results also indicate that 83.5% of grounds maintenance workers are overweight and 79.7% obese in comparison to other occupations where women show a higher percentage of overweight (90.3%) and obesity (77.1%) compared to men who are 73.5% overweight. The accounting clerks show a higher percentage of obesity (88.6%) within the obese category

Table 2: Descriptive statistics (mean and SD) of overweight and obese groups for the total group and by gender

	Total participants (n=178)	Non-obese group			Overweight and Obese group (n=274)							
					Total participants		Overweight			Obese group		
		Men (n=123)	Women (n=55)	P-values	OV (n-=121)	OB (n=153)	Men (n=49)	Women (n=72)	P-values	Men (n=35)	Women (n=118)	P-values
	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
Height	167.94±8.80	170.71±7.19	161.76±9.27	<0.001	164.15±8.39	160.87±10.73	170.22±7.38	160.01±6.26	<0.001	165.60±17.34	159.47±7.31	0.003
Weight	64.90±7.97	66.75±7.93	60.75±6.38	<0.001	76.67±7.77	92.85±14.67	81.50±7.68	73.38±5.93	<0.001	95.09±14.77	92.19±14.77	0.31
BMI	22.99±2.05	22.89±2.13	23.23±1.83	0.30	28.42±1.46	35.92±4.92	28.09±1.42	28.65±1.46	0.04	34.97±5.06	36.20±4.87	0.19
WC	84.20±11.02	85.24±12.30	81.85±6.92	0.05	93.92±10.76	105.42±14.42	96.53±7.13	92.15±12.39	0.03	105.81±15.70	105.31±14.08	0.86
SBP	138.53±23.10	142.20±23.05	130.31± 21.17	0.001	137.74±21.71	145.76±24.06	138.45±18.07	137.25±23.98	0.77	138.23±21.06	147.99±24.52	0.05
DBP	77.04±13.62	78.05±14.53	74.80±11.11	0.14	79.26±11.26	84.90±12.49	80.67±10.97	78.31±11.43	0.26	79.57±10.49	86.48±12.63	0.004
WtHR	0.50±0.07	0.50±0.07	0.51±0.05	0.58	0.57±0.07	0.65±0.08	0.57±0.04	0.58±0.08	0.43	0.62±0.07	0.66±0.08	0.04

OW = overweight; OB = obesity

Table 2 presents the mean and SD for the overweight and obese group for the total group and by gender. The results show that the mean height for the non-obese group was 167.94±8.80 cm for the total group, whereas men are taller on average (170.71±7.19cm) than the women (161.76±9.27cm). The mean weight was 64.90±7.97 kg for the total group whereas men are heavier (66.75±7.93kg) than women (60.75±6.38kg). The mean BMI for the total group was 22.99±2.05kg/m², but specific values are 22.89±2.13kg/m² for the men and 23.23±1.83kg/m² for women. The mean BP values for the total group are as follows: SBP (138.53±23.10 mmHg); DBP (77.04±13.62 mmHg) whereas corresponding values for men and women respectively are SBP 142.20±23.05 mmHg and DBP 78.05±14.53 mmHg; and SBP 130.31±21.17 mmHg and DBP 74.80±11.11 mmHg. The mean height for overweight and obese was 164.15±8.39 cm and 160.87±10.73 cm respectively for the total participants. The mean weight for overweight and obese group for the total participants was 76.67±7.77 kg and 92.85±14.67kg respectively for the total group; however, the mean BMI for overweight and obese group was 28.42±1.46 kg/m² and 35.92±4.92 kg/m² respectively. For the total group the mean SBP for the overweight and obese group respectively was 137.74±21.71 mmHg and 145.76±24.06 mmHg, with the mean DBP of 79.26±11.26 mmHg and 84.90±12.49 mmHg.

Table 3: Participants characteristics for men and women according to BMI categories

		Men				Women			
Variables	**BMI Categories**	**N**	**Mean**	**SD**	**p-value of the differences**	**N**	**Mean**	**SD**	**p-value of the differences**
Height (cm)	Underweight	15	169.73	9.94		1	169.00	.	
	Normal	123	170.71	7.19		55	161.76	9.27	
	Overweight	49	170.22	7.38	0.05	72	160.01	6.26	0.18
	Obese	35	165.60	17.34		118	159.46	7.31	
	Total	222	169.73	9.81		246	160.18	7.55	
Body weight (kg)	Underweight	15	49.51	5.77		1	51.00	.	
	Normal	123	66.75	7.93		55	60.75	6.38	
	Overweight	49	81.50	7.68	<0.001	72	73.38	5.93	<0.001
	Obese	35	95.09	14.77		118	92.19	14.63	
	Total	222	73.31	15.35		246	79.49	17.09	
BMI (kg/m^2)	Underweight	15	17.17	1.23		1	17.85	.	
	Normal	123	22.89	2.13		55	23.23	1.84	
	Overweight	49	28.09	1.42	<0.001	72	28.65	1.46	<0.001
	Obese	35	34.97	5.07		118	36.20	4.87	
	Total	222	25.55	5.58		246	31.01	6.45	
WC (cm)	Underweight	15	73.47	4.56		1	79.00	.	
	Normal	123	85.24	12.30		55	81.85	6.92	
	Overweight	49	96.53	7.13	<0.001	72	92.15	12.39	<0.001
	Obese	35	105.81	15.70		118	105.31	14.08	
	Total	222	90.18	14.63		246	96.11	15.56	
SBP (mmHg)	Underweight	15	138.80	27.28		1	156.00	.	
	Normal	123	142.20	23.05		55	130.31	21.17	
	Overweight	49	138.45	18.07	0.65	72	137.25	23.98	<0.001
	Obese	35	138.23	21.06		118	147.99	24.52	
	Total	222	140.52	21.98		246	140.93	24.63	
DBP (mmHg)	Underweight	15	83.27	15.13		1	92.00	.	
	Normal	123	78.05	14.53		55	74.80	11.11	
	Overweight	49	80.67	10.96	0.44	72	78.30	11.43	<0.001
	Obese	35	79.57	10.49		118	86.48	12.63	
	Total	222	79.22	13.29		246	81.50	12.91	
WHtR	Underweight	15	.43	.02		1	.46	.	
	Normal	123	.50	.08		55	.50	.05	
	Overweight	49	.56	.04	<0.001	72	.57	.07	<0.001
	Obese	35	.62	.07		118	.65	.08	
	Total	222	.53	.08		246	.60	.09	

BMI = body mass index, WC = waist circumference. SBP = systolic blood pressure, DBP = diastolic blood pressure, WHtR= waist-to-height ratio, n=number, SD=standard deviation

In table 3 analyses of variances (ANOVA) was used to analysed the data for all varaibels of interest according to the tree BMI categories. The results showed significant group differences (p=0.05) was found for height with the normal and overweight men being taller than the underweight and obese groups, whilst no significant group differences (p=0.18) was found among the BMI categories in women. Significant group differences ($p \leq 0.05$) were observed for body weight, BMI, WC and WHtR with the overweight and obese group having high mean values. Additionally, the results showed significant differences in the systolic and diastolic blood pressure for both the overweight and obese women. No significant group differences ($p \geq 0.05$) in blood pressure variables for men.

Table 4 indicates the descriptive data (mean, minimum, maximum and SD) for the overweight and obese group by gender. The mean age of the participants in the obese group was 51.84± 8.60 years for the men and 52.95±9.07 years for the women; with a mean height of 168.34±11.90 cm for the men and 159.46±6.94 cm for the women; and a mean weight of 83.97±13.43 kg for the men and 83.80±15.67 cm for the women. The mean BMI of the obese group was 29.76±4.81 kg/m² for the men and 32.91±5.52 kg/m² for the women with a mean WC (cm) 98.06±11.96 cm for the men and 99.41±15.04 cm for the women. The mean SBP of the obese group was 140.44±20.21 mmHg for the men and 143.61±24.61 mmHg for the women, whereas the mean DBP was 80.23±12.93 mmHg for the men and 82.79±12.93 mmHg for the women. The results also show that there was a significant difference ($p \leq 0.05$) in height, BMI and WHtR among both men and women.

Table 4: Correlation coefficients (*r*) for normal, overweight and obese groups

		BW (kg)	BMI	WC	SBP	DBP	WtHR
		r	*r*	*r*	*r*	*r*	*r*
Normal group	BW (kg)	-	.51**	.50**	.05	-.02	.09
	BMI	.51**	-	.42**	.15*	.004	.52**
	WC	.50**	.42**	-	.26**	.11	.82**
	WtHR	.09	.52**	.82**	.29**	.14	-
Overweight	BW (kg)	-	.22*	.51**	.01	.08	-.09
	BMI	.22*	-	.23*	.17	.23*	.44**
	WC	.51**	.23*	-	.23*	.18	.71**
	WtHR	-.09	.44**	.71**	.26**	.19*	-
Obese group	BW (kg)	-	.57**	.59**	.02	.09	.19*
	BMI	.57**	-	.47**	.04	.11	.57**
	WC	.59**	.47**	-	.15	.07	.78**
	WtHR	.19*	.57**	.78**	.14	.08	-

**. Correlation is significant at the 0.01 level (2-tailed)

*. Correlation is significant at the 0.05 level (2-tailed)

Table 4 presents the correlation coefficients for the normal, overweight and obese groups. In all the three BMI groups, BW, WC, BMI and WHtR were significantly and positively related to each other. In the normal group, SBP was positively ($p \leq 0.05$) correlated with BMI (r=0.150), WC (r=0.26) and WHtR (r=0.29). In the overweight group, WC wassignificantly ($p \leq 0.05$) and postive correlation with SBP (r = 0.23), and WHtR correlated positively with both SBP (r = 0.26) and DBP (r= 0.19).

4.7 DISCUSSION

The purpose of this study was to investigate the relationship between obesity and BP among employees in the Vhembe District municipality of Limpopo Province, South Africa. The results showed that 27% and 35% of the total participants are respectively overweight and obese. These findings were higher in comparison to a study by Lategan *et al.*,[41] which found that half of the participants have a BMI above normal (23% overweight and 32% obese) in the black, urban population of the Free State community. The results of this study concur with the findings by WHO,[42] which estimated that 45.1% of the South African population were overweight and obese. Schutte *et al.*[34] reported a prevalence of 48% overweight and obesity among South African employees from 18 companies participating in health screening programmes. The results of this study according to gender showed that females are more overweight and obese (29%, 48%) compared to males (24%, 17%). This is higher when compared to findings by the South African Demographic and Health Survey, [43] reporting 18.7% of urban black men as overweight and 8.1% as obese, with 27.1% of urban black women as overweight and 33.8% as obese. Our findings confirmed the trend that black South African women have substantially higher BMIs than their male counterparts do. Overweight or obese individuals are at greater risk of developing metabolic (type II diabetes and dyslipidaemia) and non-metabolic disorders.[44]

The study also found a 25% prevalence of hypertension in the total group; this is lower when compared with a study by Maepa *et al.,* [45] which reported a 39.5% prevalence of hypertension among employees in gold mines of Gauteng Harmony mine operations in South Africa. This also corresponds with findings by Owalabi *et al.*[46], which revealed that 49.2% of Buffalo City metropolitan municipality adults have a high prevalence of hypertension. The findings of the study are also lower when compared to a study by Day *et al.*[47], which reported a 40% prevalence of hypertension among adults in South African provinces during 2010. Peer *et al.*[48] also reported a lower prevalence of hypertension (38.9%) among black urban South

African adults between the ages of 24 and 65 years in Cape Town. The study showed that women (27%) have a higher prevalence of hypertension compared to males (22%); this is lower as than a study by Ntuli *et al.*[49] on adults in a rural community of Dikgale in the Limpopo Province which showed that 42% of males and 41% of females were hypertensive. The findings of our study were also similar to a study by SADHS[50], which reported that using a cut-off of 140/90 mmHg and gender adjusting, 25% men and 26% of women had hypertension. Based on BMI categories our study showed that obese groups (35%) have a high prevalence of hypertension when compared to the normal (18%) and overweight groups (22%). These findings are similar to a study by Dua *et al.*[51] that found that the prevalence of high BP was greater in those with high BMI. This has also been reported in other studies.[52,53] The WHO,[4] reported that hypertension was globally responsible for 45% of deaths due to CHD and 51% of deaths due to stroke. According to Ibrahim and Damasceno[54] as well as the WHO,[4] an estimate of 1 billion people worldwide are hypertensive and this number is expected to grow to 1.56 billion people by 2025.

These studies also found that all measures of body composition (WC, BMI and WHtR) significantly correlated; with a high correlation between WC and WHtR. Body mass index and WC positively correlated with systolic BP in the normal group. The same trend was observed in other studies where a statistically significant association was found between hypertension and BMI among employees working at Port Said University.[55] The results of the study also found that in the overweight group WC correlated significantly with SBP (r = 0.23), and WHtR correlated positively with both SBP (r= 0.26) and DBP (r = 0.19). These findings correspond with Dua *et al.*,[51] which showed the statistically significant positive correlation between all the anthropometric measures, and blood pressure parameters (SBP and DBP). These findings are also in agreement with other studies, which found that fat-related variables such as BMI, WC and WHtR were frequently positively associated with BP among workers in West Africa.[28] Obesity emerged as a strong predictor of hypertension among workers in Ghana.[31]

The high prevalence of overweight/obesity in this study linked to the prevalence of hypertension, agrees with the International Study of Salt and Blood Pressure,[56] which reported a strong, significant independent association between BMI and blood pressure.

From the literature it was revealed that obesity is associated with more pronounced changes in BP variability during a 24-hour cycle, higher systolic, diastolic and pulse pressure,

indicating autonomic dysfunction or hypertension[57], even though BP was not assessed for 24 hours in the current findings but its contribution to the results may be speculated. All these risk factors may contribute to increase the prevalence of chronic diseases, presenteeism and absenteeism among employees.[58,59]

4.8 LIMITATIONS OF THE STUDY

The major limitation of the study was not receiving the necessary permission from some local municipalities in the Vhembe District (Makhado, Mutale and Musina) to conduct this study. If all municipalities had participated, the results regarding the health and wellness status of employees from the Vhembe District would have been more reliable. The unavailability of a 24 hours BP data in the current study is another limitation in the sense that a well-monitered 24 hours BP may have provided a clarity regarding the observed relationships between WC and WHtR measures. Additionally, the limited studies in municipalities employee in the studied contributed much in the interpretation of the current results of which further studies in this area are highly recommended.

4.9 CONCLUSION

Females showed a higher percentage of obesity and hypertension than their male counterparts. The obese group showed a high prevalence of hypertension compared with other groups. Body composition measures were associated with BP parameters (more especially BMI, WC and WHtR), which showed a positive significant relationship in both normal weight and overweight groups. It is recommended therefore, that intervention regimes designed to address the risk of obesity and hypertension should focus on the awareness of CVD, impaired quality of life and productivity associated with obesity and hypertension among local government employees in the Vhembe District of Limpopo Province.

4.10 COMPETING INTEREST

The authors declare that they have no competing interest.

4.11 AUTHORS' CONTRIBUTIONS

TCM designed the cross-sectional study, performed data collection and wrote the paper. MAM assisted in the statistical analysis, interpretation of the data and write-up of the paper, GLS assisted guidance and write-up of the paper. ALT assisted with guidance, write-up of the paper and provided critical review in the manuscript.

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CHAPTER 5:

Relationship between physical activity, lifestyle behaviour and metabolic disease risk among municipality employees in South Africa

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Relationship between physical activity, selected lifestyle behaviour and metabolic disease risk among municipality employees in South Africa

Takalani Clearance Muluvhu[1, 2], Makama Andries Monyeki[1], Gert Lukas Strydom[1] & Abel Lamina Toriola[2]

[1]Physical Activity, Sport and Recreation (PhASRec), Faculty of Health Sciences North-West University, Potchefstroom South Africa

[2]Department of Sport, Rehabilitation and Dental Sciences, Tshwane University of Technology, Pretoria, South Africa

5.1 ABSTRACT

Objective: This study examined the relationship between PA and selected lifestyle behaviour (smoking and alcohol consuption) associated with metabolic disease risk among municipality employees of Vhembe District, Limpopo Province of South Africa, **Methods:** A cross-sectional study was conducted among 468 (men = 222; women = 246) employees (aged 24–65 years). PA levels were assessed using the International Physical Activity Questionnaire (IPAQ). Participants' selected lifestyle habits (smoking and alcohol consumption), anthropometric, BP, FG and TC measurements were determined using standardised protocols. **Results:** Fifty-five percent of employees were classified with MetS (NCEP-ATPIII and IDF diagnostic criteria), with males showing a higher percentage (87%) compared to females (26%). The results also showed that the total group of employees who participated in low physical activity had a propensity for developing MetS (OR 1.17) in contrast to those who engage in moderate to high PA. Among men with low PA, the risk of MetS was significantly higher than those with moderate to high PA after adjusting for age, smoking, alcohol, and BMI (OR 5.20; 95% CI:1.77–15.28). Among participants without MetS, alcohol consumption was positively correlated with DBP, SBP, BMI and WC (r =0.200; p=0,004). Smoking was positively associated with DBP in participants with MetS (r=0.158; p=0.01). Additionally, SBP correlated positvely with WHtR (r =0.240; p=0.01). BMI was also related with alcohol consumption (r=0.281), SBP with TCHL (r=0.169), FGluc with WC (r=0.140) and WHtR with SBP (R=0.240). The results indicated non-significant inverse correlations between PA and MetS risk factors. **Conclusion:** The present study showed that low PA was positively associated with relatively higher prevalence of metabolic risk factors, especially among male employees. There is an urgent need to develop culturally sensitive health promotion and lifestyle education programmes addressing the risk factors of metabolic syndrome among municipality employees.

Keywords: Metabolic risk factors, physical activity, metabolic syndrome, employees, lifestyle behaviour.

5.2 INTRODUCTION

Metabolic syndrome (MetS) is a clustering of abdominal obesity, high blood pressure (BP), high total cholesterol levels (TC) and impaired fasting blood glucose (FBG) [1]. MetS has increased twofold the risk of cardiovascular disease and five to ninefold the risk of type 2 diabetes [2–3]. In addition, MetS has a 40% increased risk of cardiovascular disease mortality [4–5], and the prevalence of MetS varies around 20–45% worldwide [6–7]. However, the levels of MetS prevalence may vary greatly according to cut-off points of the National Cholesterol Education Programme Adult Treatment Panel III and the International Diabetes Federation diagnostic criteria and the ethnic group studied [8]. In sub-Saharan Africa, the majority of countries are experiencing rapid demographic and epidemiological transition [9–10]. Available information from studies in African populations indicates a prevalence of MetS ranging from 0% to as high as about 50% or more, depending on the population studied [11]. Some studies of MetS incidence have been conducted at individual corporations and results indicate that its prevalence varies by occupation type [12].

In comparison with other categories of employees, shift workers have been identified as having a higher incidence of MetS [13], while a study of a Midwestern manufacturing corporation in the USA found that 30.2% of employees met the criteria of MetS [14]. Davilla *et al.* [15] established that the prevalence of MetS did not increase in shift workers only, but also among farm workers in the Boland district of Cape Town, South Africa. A study of 203 employees in a leading global energy company reported a MetS prevalence of 23.6% based on laboratory and medical aid data [16]. The MetS prevalence of 22.6% reported in a global financial services corporation was associated with increased sick leave, and rampant trend of short-term disability claims, but no significant association was found with the frequency of presenteeism or short-term disability [17].

The study by Cardiovascular Risk in Black South Africans (CRIBSA) has reported a high prevalence of MetS (38.9%) [18]. For instance, Motala *et al.* [19] reported an overall high prevalence of MetS in rural South African women (30.2%) while a study in an urban area of Cape Town in 2012 revealed the prevalence of MetS to be 60.6% [20]. In China, the prevalence was reported to be 10.6% and 4.3% respectively in urban and rural areas in 2002 [21]. However, MetS prevalence in rural China has dramatically increased, and had reached 24.2% in 2014 because of rapid economic progress and lifestyle transitions in the country [2].

The most important causes of MetS are ageing, unhealthy diet, and sedentary lifestyle [22–23]. The characteristics of work, including job types and long working hours, are also associated with MetS [24–26]. Lutsey *et al.* [22] suggested that consumption of a Western diet, meat and fried food promote the incidence of MetS. Smoking and excessive alcohol drinking habits can also contribute to the development of MetS [27–28]. While smoking may increase the risk of low HDL-C, high triglycerides and abdominal obesity [29], alcohol consumption was reported to be inversely associated with the risk of low HDL-C, but showed an increasing positive dose-response relationship with the risk of MetS [30].

Several categories of employees in Taiwan are considered to be at high risk for the development of MetS [31]. In the Taiwanese workplace, wellness programmes have been proposed to prevent the development of MetS and such strategies focus mainly on promoting workers' PA and healthy eating habits [32] as research findings have indicated that regular leisure time PA could be beneficial for the prevention and/or management of MetS [33–35].

A number of studies have reported that the effectiveness of leisure time PA in reducing MetS depends on the type, intensity, duration and frequency of activity [33, 36]. Compared with a low level of leisure time PA, a high level of PA resulted in a lower risk of MetS, but a moderate level of leisure time PA was only weakly related to its reduced risk [33]. Therefore, engaging in at least 150 minutes of moderate intensity aerobic PA weekly, at least 75 minutes of vigorous intensity, or an equivalent combination of moderate and vigorous intensity PA is recommended for beneficial health outcomes [9].

The association of physical inactivity with the prevalence of MetS at work and in daily life has been shown in various studies [37–38]. A study by Méndez-Hernández *et al.* [39] reported that the risk of MetS decreased by 0.75% in a group with more than three hours of PA when at work compared with those in a category that was sedentary. Choi *et al.* [40] also reported that those with sedentary tasks and low PA levels among 1,001 US workers had a higher risk of abdominal obesity, which is the essential identifying factor of MetS. In addition, a study by Kim *et al.* [41], which analysed the risk of MetS for different occupational groups in South Korea, revealed that the relative risk for MetS was 1.25% higher among office workers than it was among non-office workers, and that the PA level of the former was low. Therefore, the risk of MetS can be associated with PA levels according to a person's occupation [42].

Previous research has rarely investigated the relationship between PA, lifestyle behaviour and MetS risk among municipality employees. Such studies are direly needed in view of the role of lifestyle factors in the pathogenesis of MetS as well as its impact on the health and

productivity of municipality employees. Although Vhembe District municipality has a wellness programme, it is mainly targeted at improving employees' emotional wellbeing and poorly implemented. Consequently, many of the employees are vulnerable to MetS as their duties are largely sedentary and they have limited opportunity to engage in PA at the workplace. Based on the above background it is hypothesised that the employees of Vhembe District municipality would have a high prevalence of MetS. The objective of this study was, therefore, to examine the relationship between physical activity, lifestyle behaviour and metabolic disease risk among employees in Vhembe District local municipality of Limpopo Province, South Africa. The findings of the study will promote awareness of the risk factors of MetS and its implications for the overall wellbeing and productivity of the employees. The results could also be useful for designing and implementing strategic health promotion intervention targeted at preventing risk factors of MetS among municipality employees.

5.3 METHODS

5.3.1 Study design

The research was based on a cross-sectional survey design, involving a convenience sample of local government employees in the Vhembe District of Limpopo Province, South Africa.

5.3.2 Participants and study setting

Participants were 468 (Men = 222; Women = 246: Aged: 24–65 years) employees in local government (local government is a form of public administration in South Africa which exists as the lowest tier of public administration in the provinces) in the Vhembe District, which is one of the five districts of the Limpopo Province of South Africa. Vhembe District is located in the northern part of the country and shares its borders with Beitbridge District in Matabeleland South, Zimbabwe. According to the 2001 Census, 800,000 residents of Vhembe District speak Tshivenda as their mother tongue, while 400,000 speak Tsonga and 27,000 speak Northern Sotho [43]. Demographi questionnaire asked paticipants about the following: gender, age, company working for, place of residence, job description, ethnic grpoup, educational level with choices to choose from (e.g. grade 11, grade 12, diploma, other etc.). The majority of the participants were employed as grounds maintenance workers, clerical staff, managers and councillors. For the purpose of this study, the employees were categorised into three age groups (24–29; 30–44, and 45–65 years), provided they were deemed apparently healthy [44].

5.3.3 Ethical considerations

The purpose and procedure of the study were explained to the participants and their employers, who completed and signed an informed consent form before the study. The study received ethics approval (Ref: NWU-00125-13-S1) from North-West University, Potchefstroom, South Africa. The researchers collected data with the assistance of well-trained fieldworkers. Specifically, height, weight, WC, BP, glucose and cholesterol measurements were taken in separate rooms for males and females.

5.3.4 Measures

5.3.4.1 Height and body mass:

Stature was measured to the nearest 0.1 cm, using a Harpenden Portable Stadiometer (Holtain Limited, Crymych, Dyfed, UK). Body mass was measured using a portable calibrated scale (SECA) and recorded to the nearest 0.5 kg. Body mass index (BMI) was calculated as body mass (kg) divided by height (m) squared (kg/m^2).

5.3.4.2 Waist circumference and waist-to-height:

WC was measured using a steel tape measure using ACSM's [44] protocol. For men, low waist circumference in this classification is defined as less than 94 cm, high as 94–102 cm and very high as greater than 102 cm. For women, low WC is less than 80 cm, high is 80–88 cm and very high is greater than 88 cm (45–46). Waist-to-height ratio (WHtR) was determined from waist circumferences (cm) divided by height (cm). The norms for WHtR were as follows: Normal as WHtR<0.5 and WHtR>0.5 indicating increased risk for both males and females [47].

5.3.4.3 Cholesterol and glucose screening:

Total blood cholesterol and glucose levels were determined after ten hours fast using capillary blood samples obtained with a finger prick. The samples were placed on PTS panels (i.e. glucose and lipids test strips) and analysed using the Cardiocheck® PA Analyser (Polymer technology systems, Inc., USA). The Cardiocheck® analyser was calibrated regularly following the instructions of the manufacturer.

5.3.4.4 Blood pressure:

Blood pressure was measured using an automated aneroid sphygmomanometer (Omron, Health care, Inc., USA). The participants were comfortably seated for 15 minutes in a well-ventilated room, before systolic (SBP) and diastolic (DBP) blood pressure measurements were taken using the protocol of American College of Sports Medicine (ACSM, 2014).

5.3.5 Measurement cut-off points

The ACSM (2014) has identified the following thresholds above which individuals will be at increased risk for cardiovascular disease:

- Obesity – BMI between 25–29.9 kg/m² as overweight and ≥ 30kg/m² as obese.
- Hypertension – systolic blood pressure ≥ 140 mmHg; diastolic blood pressure ≥ 90 mmHg as well as for participants on hypertension treatment.
- Total cholesterol – ≥ 5.18 mmol/l or patient using lipid-lowering drugs.
- Impaired FG ≥ 5.5 mmol/l or patient using diabetic medication.

5.3.6 Assessment of smoking and alcohol drinking habits

In line with the objective of this study life style habits were delimited to information regarding smoking and alcohol drinking collected using the Belloc and Breslow listed seven lifestyle habits associated with general health [48]. The questionnaire based on yes or no answers without specifying quantity of intake asked the participants whether do he/she smoke, and also is he/she drinking alcohol.

5.3.7 Subjective assessment of physical activity

Physical activity levels were assessed using the IPAQ, which consists of 15 questions that assess physical activities related to work, transport and leisure time. Craig *et al.* [49] concluded that the IPAQ has acceptable measurement properties for use in many settings and in different languages. Based on each individual participant's IPAQ data, their PAI was determined to be either active or sedentary. Physical activity levels were categorised as active or sedentary. Participants who accumulate less than 600 MET-minutes per week were considered as having low physical activity, while those who accumulate 600 and more MET-minutes per week were regarded as being moderately and highly active [49].

5.3.8 Definition or metabolic syndrome criteria

The criteria of IDF for diagnosis of MetS and the 2005 revised (NCEP-ATPIII) criteria as proposed by the AHA/NHLB were used [50]. The revised NCEP criteria require at least three of the following components [51]:

1. Abdominal obesity: Waist circumference (WC) ≥102 cm (>40 in) in men or ≥88 cm (>35 in) in women;
2. Serum triglycerides (TGs): ≥150 mg/dL (≥1.7 mmol/L);

3. High-Density Lipoprotein-Cholesterol (HDL-C): <40 mg/dL (<1.03 mmol/L) in men or <50 mg/dL (<1.29 mmol/L) in women;
4. Fasting blood glucose (FBG) level: ≥100 mg/dL (≥5.6 mmol/L); and
5. Blood pressure (BP): ≥130/85 mmHg.

For NCEP criteria, abdominal obesity is a component of the syndrome but not a prerequisite for diagnosis. The IDF criteria of MetS use central obesity (waist circumference ≥90 cm for South Asian men or ≥80 cm for South Asian women) as a mandatory indicator and the presence of at least two of the other four criteria, which are identical to those provided by NCEP-ATPIII [52]. We subsequently used alcohol and smoking to verify their lifestyle behaviour and corroborate with MetS classification.

5.4 STATISTICAL ANALYSES

Data was analysed using SPSS for Windows version 24.0. Categorical variables were presented as frequency and percentages while quantitative variables were presented as mean with 95% confidence interval where appropriate. The Kappa statistics model was used to measure agreement between the two criteria. An independent t-test was used to compare the cardio-metabolic risks among gender. The characteristics of those participants who presented with MetS and those without were compared using ANOVA for normally distributed data, and Wilcoxon rank sum test for non-normally distributed variables. A Mann-Whitney U and Chi-square tests were used to determine the differences in the non-parametric data. Pearson correlation coefficients (*r*) were calculated separately for the participants who presented with MetS and participants without MetS. Odd ratios (ORs) and 95% confidence interval (CIs) were estimated using a common logistic regression in determining the relationship between PA and MetS. Two dummy variables were created for PA (Dummy 1= Low PA; Dummy 2=Moderate-to-vigorous PA). The logistic regression model was used as adjusted for each potential confounders in the analysis. Ordinal variables (PA dummies) were used as continuous parameters to test the linear trend. The potential confounding variables, that is, age, BMI, smoking, drinking, occupation and education were included in the logistic regression model. All p-values were based on two-tailed test with a p-value of ≤0.05 considered statistically significant.

5.5 RESULTS

Table 1 indicates that out of the 468 employees, the majority (83%) worked as ground maintenance staff, with few in skilled positions (17%), and the majority had no formal education (69%). Mean ages for MetS and non-MetS participants were as follows: men (53.40±7.86 years and 53.06±7.98 years) and women (53.74±8.05 years and 48.00±12.47 years). The results also indicated that male participants (73%) with no formal education had a higher prevalence of MetS than the females (62%). Male groundsmen (87%) had a higher percentage of MetS compared to female ground staff (86%). Additionally, women with MetS (80%) were physically inactive compared to their male (72%) counterparts. The results also showed a significant difference for smoking and alcohol consumption among participants ($p<0.05$) as 29% of employees consumed alcohol and 51% were smokers.

Table 1: Subject characteristics stratified by metabolic syndrome status and gender*

		Men (N=222)			Women (N= 246)		
	All participants Mean ±SD	**MetS participants Mean ±SD**	**Non-MetS participants Mean ±SD**	**P-values**	**MetS participants Mean ±SD**	**Non-MetS participants Mean ±SD**	**P-values**
Age (Year)	52.64±8.93	53.40±7.86	53.06±7.98	0.56	53.74±8.05	48.00±12.47	0.50
Weight (kg, mean±SD)	76.56±9.91	95.55±15.73	69.83±12.04	0.00*	84.84±16.12	64.58±8.98	0.00*
Height (cm, mean±SD)	164.70±9.91	171.36±6.57	169.47±10.21	0.00*	160.07±7.18	160.46±8.52	0.00*
BMI (kg/m^2, mean±SD)	28.42±6.63	32.45±4.67	24.47±4.91	0.00*	33.11±5.91	25.17±3.70	0.00*
WC (cm)	93.30±15.39	114.49±16.21	86.38±10.01	0.00*	102.50±12.06	78.30±8.89	0.00*
SBP (mmHg,)	140.73±23.39	141.83±21.49	140.31±22.10	0.006	144.39±24.71	131.26±21.82	0.006
DBP (mmHg)	80.41±13.12	80.33±10.60	79.04±13.67	0.00*	83.59±13.20	75.67±10.07	0.00*
WHtR (ratio)	0.56±0.09	0.65±0.86	0.51±0.06	0.00*	0.63±0.74	0.48±0.05	0.00*
T Chol (mmol)	5.86±23.02	4.73±1.30	6.50±5.33	0.23	4.91±1.32	5.64±1.72	0.28
F Glucose (mmol)	6.79±4.88	9.53±8.49	4.71±1.43	0.01*	7.04±4.15	4.75±1.20	0.01*
PAI Index	7.90±11.11	10.25±12.26	9.14±10.56	0.10	6.43±11.75	7.23±9.87	0.10
BMI Categories	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
Underweight (%)	16 (3)	15 (8)	0 (0)		1 (2)	0 (0)	
Normal weight (%)	178 (38)	120 (63)	3 (10)		41 (63)	14 (8)	
Overweight (%)	121 (26)	43 (22)	6 (20)		19 (29)	53 (29)	
Obesity (%)	153 (33)	14(7)	21(70)	0.00*	4 (6)	114 (63)	0.00*
Blood pressure categories	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
Normal (%)	351 (75)	150 (78)	23 (77)		59 (91)	119 (66)	
Hypertension (%)	117 (25)	42 (22)	7 (23)	0.00*	6 (9)	62 (34)	0.00*
Education (%)	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
No formal education	324 (69)	139(73)	19 (63)		40 (62)	126 (70)	
Std 8	24 (5)	12 (6)	4 (13)		0 (0)	8 (4)	
Matric	45 (10)	15 (8)	2 (7)		6 (9)	22 (12)	
Diploma	43 (9)	15 (8)	2 (7)		12 (19)	14 (8)	
Degree 1	7 (2)	3 (2)	1 (3.3)		0 (0)	3 (2)	
Degree2	1 (0.2)	0 (0)	0 (0)		1 (2)	0 (0)	
Degree 3	12 (3)	4 (2)	1 (3.3)		3 (5)	4 (2)	
Degree4	9 (2)	3 (2)	1 (3.3)		3 (5)	2 (1)	
Certificate	3 (0.6)	1(0.5)	0 (0)	0.00*	0 (0)	2 (1)	0.00*
Occupation:	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
General Clerk	42 (9)	21 (11)	3 (10)		2 (3)	16 (9)	
Accounting Clerk	12 (3)	2 (1)	0 (0)		2 (3)	8 (4)	
Grounds Maintenance Workers	398 (83)	166 (87)	26 (87)		56 (86)	150 (83)	
Municipality manager (MM)	9 (2)	3 (1)	1 (3)		3 (5)	2 (1)	

Councillor	7 (3)	0 (0)	0 (0)	0.00*	2 (3)	5 (3)	0.00*
Alcohol consumption	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
Yes	134 (29)	76 (40)	8 (27)		16 (25)	34 (19)	
No	334 (71)	116 (60)	22 (73)	0.01*	49 (75)	147 (81)	0.00*
Do you Smoke?	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
Yes	238 (51)	87 (45)	12 (40)		38 (59)	101 (56)	
No	230 (49)	104 (54)	18 (60)	0.27	27 (41)	80 (44)	0.11
PAI per week	**N (%)**	**N (%)**	**N (%)**		**N (%)**	**N (%)**	
PAI <16 Low activity	362 (77)	138 (72)	19 (63)		52 (80)	153 (85)	
PAI between 17-46 Moderately PA	102 (22)	54 (28)	11 (37)		12 (19)	25 (14)	
PAI>45 Highly active	4 (1)	0 (0)	0 (0)	0.14	1 (1)	3 (1)	0.00*

***p≤0.05 = significant**

Presented in Table 2 are the employees' MetS categories evaluated according to the NCEP-ATPIII and IDF criteria. In total, 45% had no MetS according to these criteria, whereas 55% had MetS or used medication according to NCEP-ATPIII and IDF benchmarks. When analysed according to gender, the results showed that males (87%) had a higher percentage of MetS than females (26%) (Table 2). The results also showed significant gender differences for the categories of MetS assessed according to NCEP-ATPIII and IDF (p=0.00).

Table 2: Gender differences in metabolic syndrome categories according to NCEP-ATPIII and IDF diagnostic criteria

MetS categories (%)	All participants	Men (N=222)	Women (N= 246)	P- values
No MetS according to NCEP-ATPIII and IDF (%)	211 (45%)	30 (13%)	181 (74%)	0.00*
Presence of MetS or use of medication according to NCEP-ATPIII and IDF (%)	257 (55%)	192 (87%)	65(26%)	0.00*

***p≤0.05= significant**

Table 3 presents the relationship of metabolic risk factors and their components among MetS and non-MetS categories according to NCEP-ATPIII and IDF diagnostic criteria for the total participants. In terms of the participants without MetS, alcohol was significantly positively correlated with DBP (r =0.200; p=0,004), and SBP related strongly with BMI and waist circumference. Smoking positively correlated with DBP (r=0.158) in participants with MetS. In addition, SBP correlated positvely with WHtR (r =0.240; p=0.01). BMI was also related with alcohol consumption (r=0.281), SBP with TCHL (r=0.169), FGluc with WC (r=0.140) and WHtR with SBP (R=0.240). Non-negative correlations were found between PA and components of MetS.

Table 3: Relationship of metabolic risk and its components among MetS and non-MetS categories according to NCEP-ATPIII and IDF diagnostic criteria for the total participants

No MetS according NCEP-ATPIII and IDF		**BMI**	**WC**	**SBP**	**DBP**	**PAI Index**	**Smoking**	**Alcohol**	**TChol.**	**FGluc.**	**WHtR**
BMI	*r*	1.000	.592**	.183**	.267**	-.095	.068	.051	-.041	.098	.632**
	p	.	.000	.008	.000	.167	.328	.462	.555	.154	.000
WC	*r*	.592**	1.000	.235**	.202**	-.003	.047	-.027	-.085	.214**	.836**
	p	.000	.	.001	.003	.965	.497	.697	.219	.002	.000
SBP	*r*	.183**	.235**	1.000	.571**	-.069	.086	.024	.226**	-.052	.270**
	p	.008	.001	.	.000	.316	.216	.724	.001	.455	.000
DBP	*r*	.267**	.202**	.571**	1.000	-.079	.088	.200**	.175*	-.026	.230**
	p	.000	.003	.000	.	.251	.204	.004	.011	.711	.001
PAI Index	*r*	-.095	-.003	-.069	-.079	1.000	-.034	-.038	-.002	-.043	-.112
	p	.167	.965	.316	.251	.	.628	.586	.972	.537	.106
Smoking	*r*	.068	.047	.086	.088	-.034	1.000	.202**	-.091	.088	-.004
	p	.328	.497	.216	.204	.628	.	.003	.187	.201	.958
Alcohol	*r*	.051	-.027	.024	.200**	-.038	.202**	1.000	-.044	-.134	-.058
	p	.462	.697	.724	.004	.586	.003	.	.529	.051	.398
TChol.	*r*	-.041	-.085	.226**	.175*	-.002	-.091	-.044	1.000	.000	-.066
	p	.555	.219	.001	.011	.972	.187	.529	.	.997	.341
FGluc.	*r*	.098	.214**	-.052	-.026	-.043	.088	-.134	.000	1.000	.168*
	p	.154	.002	.455	.711	.537	.201	.051	.997	.	.015
WHrR	*r*	.632**	.836**	.270**	.230**	-.112	-.004	-.058	-.066	.168*	1.000
	p	.000	.000	.000	.001	.106	.958	.398	.341	.015	.
Presence of MetS or use of medication according to NCEP-ATPIII and IDF		**BMI**	**WC**	**SBP**	**DBP**	**PAI Index**	**Smoking**	**Alcohol**	**TChol.**	**FGluc.**	**WHtR**
BMI	*r*	1.000	.557**	.043	.048	-.088	-.012	.281**	.062	.067	.673**
	p	.	.000	.492	.442	.159	.854	.000	.326	.285	.000
WC	*r*	.557**	1.000	.220**	.114	.015	.073	.112	.028	.140*	.865**
	p	.000	.	.000	.068	.812	.245	.073	.652	.024	.000
SBP	*r*	.043	.220**	1.000	.523**	-.063	.034	-.142*	.169**	-.016	.240**
	p	.492	.000	.	.000	.311	.587	.023	.007	.795	.000
DBP	*r*	.048	.114	.523**	1.000	-.020	.158*	-.055	.079	.004	.113
	p	.442	.068	.000	.	.750	.011	.380	.204	.943	.072
PAI Index	*r*	-.088	.015	-.063	-.020	1.000	-.055	-.001	-.070	-.016	-.031
	p	.159	.812	.311	.750	.	.380	.994	.263	.797	.615
Smoking	*r*	-.012	.073	.034	.158*	-.055	1.000	.182**	-.008	.024	.041
	p	.854	.245	.587	.011	.380	.	.003	.898	.697	.509
Alcohol	*r*	.281**	.112	-.142*	-.055	-.001	.182**	1.000	.094	-.040	.172**
	p	.000	.073	.023	.380	.994	.003	.	.134	.520	.006
TChol.	*r*	.062	.028	.169**	.079	-.070	-.008	.094	1.000	.107	.028
	p	.326	.652	.007	.204	.263	.898	.134	.	.088	.653
FGluc	*r*	.067	.140*	-.016	.004	-.016	.024	-.040	.107	1.000	.144*
	p	.285	.024	.795	.943	.797	.697	.520	.088	.	.021
WHtR	*r*	.673**	.865**	.240**	.113	-.031	.041	.172**	.028	.144*	1.000
	p	.000	.000	.000	.072	.615	.509	.006	.653	.021	.

**Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed).

Table 4: Odd ratios for the prevalence of MetS according to level of PA for the total group

		Low PA	Moderate to high PA	Total
MetS NCEP and IDF	No MetS according to NCEP-ATPIII and IDF	172	39	211
	Presence of MetS or use of medication according to NCEP-ATPIII and IDF	190	67	257
		OR (95%CI) 1.103 (1.001 to 1.215)	OR (95%CI) 0.709 (0.499 to 1.006)	
Total		362	106	468

Chi-square test for Fisher's Exact test =0.06

Table 4 showed that the cases identified for the total group were as follows: 45% (n=211) with no MetS and 55% (n=257) with the presence of MetS. When the analyses were done for participants according to PA participation, the results showed a borderline significant difference (p=0.06) for the prevalence of MetS in the two PA groups.

Table 5: Odd ratios for the prevalence of MetS according to physical activity level for the total group by gender

	Univariate Crude OR (95%CI)	**Multivariate adjusted OR (95% CI)**
Total group		
Moderate to high PA	1	1
Low PA	1.17(1.03–1.33)	2.85(0.39–20.98)#
Men		
Moderate to high PA	1	1
Low PA	0.83(0.58–1.17)	5.20(1.77 – 15.28)*
Women		
Moderate to high PA	1	1
Low PA	1.10(0.92–1.31)	2.78(0.37–21.41)

#adjusted for gender, age, smoking, alcohol, PA, BMI; *adjusted for age, smoking, alcohol, PA, BMI

The results of logistic regression analyses that examined the prevalence of MetS according to PA levels for the total group and by gender are presented in Table 5. In all the analyses, the group that met the PA reference standard of moderate to high PA (PAI between 17 and 45, and PAI ≥45) was used as the reference group. For the total group, the results showed that employees with low physical activity had a higher likelihood (OR 1.17) of developing MetS compared to those who engage in moderate to high PA. After adjusting for age, smoking, alcohol, PA and BMI, the risk of MetS occurring in the low PA group increased (though not significantly) [OR: 2.85 (0.39–20.98)]. In men with a low PA level, the risk of MetS was significantly higher than those in the moderate to high active group, after adjusting for age, smoking, alcohol, PA, BMI [OR: 5.20(1.77–15.28)]. In contrast, the risk for MetS in women was not significantly different between those in the moderate to high PA category and their

counterparts with low PA after adjusting for age, smoking, alcohol, PA and BMI [OR: 2.78(0.37–21.41)].

5.6 DISCUSSION

This study examined the relationship between PA and lifestyle behaviour associated with MetS risk factors among employees in the Vhembe District local municipality, South Africa. The results showed that age and high BMI, as well as behavioural factors such as smoking and drinking, were positively associated with the increased risk of metabolic syndrome in men and women employees overall, the prevalence of MetS among the employees, according to NCEP-ATPIII and IDF criteria, was 55% (87% in men and 26% in women). The prevalence of MetS in our study is higher than the 23.3% reported previously in Durban, South Africa [53] and those found in other countries such as Thailand (22.8%) [54] and India (41.4%) [55]. The higher prevalence of MetS in our study could be explained in light of the different criteria used for MetS diagnosis, such as IDF, WHO and NCEP-ATPIII. Therefore, the prevalence of MetS could be different even in the same population depending on the MetS diagnostic criteria used in studies [56].

Other factors such as diet, nutrition, physical inactivity and genetic background could have contributed to the high prevalence of MetS [57]. Therefore, in view of its implications (that individuals with MetS are prone to increased risk of cardiovascular mortality) municipality health practitioners should take note of the present results to design employee wellness promotion programmes [4–5]. With regard to PA levels, women (80%) with MetS were reported to be more physically inactive compared to their male (72%) counterparts. These findings showed strong evidence that physical inactivity increases the risk of many adverse health conditions, including major NCDS such as CHD and type 2 diabetes, and could shorten life expectancy among employees [58–59].

Our results further showed positive associations between low PA and MetS risk factors, such as obesity and hypertension among male municipality employees. Kohli and Greenland [60] reported similar findings – that the lack of PA increased the risk of obesity, diabetes and hypertension, which, in turn, increased proneness to MetS.

In terms of the participants without MetS, alcohol was significant and positively correlated with DBP, and again alcohol was positively related with SBP, BMI and waist circumference. The findings are consistent with those of Kruger and Nell [61], which indicated that alcohol

consumption was positively associated with SBP, DBP, BMI and WC in a community of farm workers in the Boland district, South Africa. The present results, which showed that smoking was positively correlated to DBP, contradict those of a study where no consistent association was found between smoking and BP or FBG among adult participants in the northeast region of the Netherlands [29]. It is well known that smoking raises sympathetic activity and increases the circulating cortisol, catecholamines, vasopressin, and growth hormone levels [62] and is consequently detrimental to health. Therefore, smoking plays a causal role in the development of MetS [63].

5.7 CONCLUSION

The prevalence of MetS factors in relation to lifestyle behaviour among employees in the Vhembe local municipality is alarmingly high. The results also showed that low PA is associated with a higher prevalence of MetS risk factors, more especially among male employees. Future studies should therefore not only focus on developing specific criteria for MetS diagnosis among Africans but also acknowledge every effort made to educate the employees about its risk factors and the proper use of therapeutics or other nutritional and/or exercise interventions for the prevention of MetS among municipality employees.

5.8 LIMITATIONS

An assessment of the nutritional intake of employees in this study could have elucidated the relationship between nutrition and risk factors of MetS, but this was not feasible in the present study. Additionally, the questionnaires used in the study are the limitations of the study (e.g. example, the questions used to gather information regarding the number of circarrette or quantity of alcohol drinks), because they failed to provide exact number of the quantity related to all variables of interest. Despite this limitation, the present findings aided our understanding of the association between PA and lifestyle behaviour with metabolic disease risk among South African municipality employees.

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5.10 AUTHORS' CONTRIBUTION

TCM contributed to the design of the study, conducted data collection and the write-up of the manuscript. MAM was involved in the planning and supervision of data collection, capturing, analyses and interpretation, as well as providing critical comments on the final version of the manuscript. GLS provided inputs in the design of the study, and ALT reviewed the manuscript and provided comments on its final version. All authors read and reached consensus on the contents of the final version of the manuscript before submission.

5.11 COMPETING INTEREST

No competing interest exists among the authors.

5.12 ABBREVIATIONS

PA	Physical activity
MetS	Metabolic syndrome
BMI	Body mass index
WC	Waist circumference
SBP	Systolic blood pressure
DBP	Diastolic blood pressure
NCEP-ATPIII	National Cholesterol Education Programme Adult Treatment Panel III
IDF	International Diabetes Federation

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CHAPTER 6:
Summary, conclusions, limitations and recommendations

6.1 SUMMARY

Metabolic syndrome (MetS) and its components and risk factors for the development of MetS increase the risk of cardiovascular disease (Isomaa *et al.*, 2001:683). The prevalence of MetS varies around 20–45% worldwide (Villegas *et al.*, 2009: 37; Ramli *et al.*, 2013:760), with the most important causes being physical inactivity, unhealthy diet, and sedentary lifestyle (Churilla & Fitzhugh, 2012:70; Lutsey *et al.*, 2008:754). Smoking and excessive alcohol consumption also contributes to the development MetS (Corwin *et al.*, 2006:119; Lee *et al.*, 2011: 499). The characteristics of the working environments including job types, stress and prolonged (sedentary) working hours are associated with MetS (Almadi *et al.*, 2013: 821; Kwon & Lee, 2013:232; Violanti *et al.*, 2009:194). Employees from different settings are considered as a high-risk population in the development of MetS (Huang *et al.*, 2017:13735). Therefore, increasing daily physical activity and eating a well-balanced diet are important for preventing MetS (Eckel *et al.*, 2005:1415; Faam *et al.*, 2013:36).

In order to reach the aim of the study the following objectives were to determine:

- The relationship between selected metabolic risk factors and waist-to-height ratio among employees in the Vhembe District municipality of Limpopo Province, South Africa.
- The relationship between obesity and BP among employees in the Vhembe District municipality of Limpopo Province, South Africa.
- The relationship between physical activity, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa**.**

Chapter 1 provided a brief introduction and outline of the problem statement that underlined the research questions, objectives and hypothesis that form the basis of the study. The thesis is submitted in article format as approved by the NWU research committees and includes a literature review (Chapter 2) and three research articles (Chapters 3, 4 and 5) to be presented to accredited peer-reviewed journals.

Chapter 2 presented a literature review that discussed the history of metabolic syndrome, its prevalence, metabolic risk factors among employees, physical activity and comorbidities that cluster into risk factors of metabolic syndrome, and modifiable risk factors and life style behaviour that contribute to the development of metabolic syndrome and chapter summary.

The findings from the investigation (Chapters 3, 4 and 5) are presented in the form of research manuscripts. Each chapter clearly indicates the method and procedure, research design, results and conclusion. The descriptions of the chapters are as follows:

- Chapter 3 – *Article 1,* investigated the relationship between selected risk factors of metabolic disease and waist-to-height ratio among local government employees in the Vhembe District municipality, Limpopo Province of South Africa.
- Chapter 4 – *Article 2,* investigated the relationship between obesity and BP among employees in the Vhembe District municipality of Limpopo Province, South Africa.
- Chapter 5 – *Article 3,* examined the relationship between physical activity, lifestyle behaviour and metabolic disease risk among municipality employees in South Africa.

6.2 CONCLUSION

The conclusions drawn from this research are in accordance with the hypothesis set in Chapter one.

6.2.1 Hypothesis (1) Chapter 3:

A significant positive relationship between selected metabolic risk factors and waist-to-height ratio among employees in the Vhembe District municipality of Limpopo Province, South Africa will be found.

Hypothesis 1 is partially accepted based on the findings, which showed that there was significant positive correlation between FG, BMI and WHtR for the total group; furthermore the results showed no significant correlation between the total cholesterol and anthropometric measures (BMI, WC and WHtR).

6.2.2 Hypothesis (2) Chapter 4:

A significant negative relationship between obesity and blood pressure among employees in the Vhembe District municipality of Limpopo Province, South Africa will be found.

Hypothesis 2 is not accepted based on the research findings which showed that BMI and WC were positively correlated with SBP in the normal weight group; while in the overweight group WC was significantly correlated with SBP (r=0.23), and WHtR was positively correlated with both SBP (r =0.26) and DBP (r= 0.19).

6.2.3 Hypothesis (3) Chapter 5:

A significant negative relationship between physical activity, lifestyle behaviour and metabolic disease risk among employees in the Vhembe District municipality of Limpopo Province, South Africa will be found.

Hypothesis 3 is not accepted based on the following findings of the study. Among participants without MetS, alcohol consumption was positively correlated with DBP, SBP, BMI and WC (*r* =0.200; p=0,004). Smoking was positively associated with DBP in participants with MetS (*r*=0.158; p=0.01). Finally, the results showed non-significant inverse correlations between PA and MetS risk factors.

6.3 LIMITATIONS

The present study has several limitations that should be noted when interpreting the results and which could be overcome in future research. The limitations are as follows:

- The exclusion of other local municipalities within the Vhembe District that did not participate in this study due to permissions not being granted: inclusion of more municipalities would have provided more reliable data about the risk factors of metabolic disease among government employees within the Vhembe District.
- Lack of knowledge about physical activity and its relationship with risk factors of MetS, which may have resulted in some participants not understanding how to answer the questions about physical activity and refusing to participate in some of the clinical measurements.
- Additionally, the use of subjective questionnaire in the assessment of physical activity, which often is associated with the problem of recall, was also a limitation of the study.
- An assessment of the nutritional intake of employees in this study could have elucidated the relationship between nutrition and risk factors of MetS, but this was not feasible in the present study.
- The paucity of research about risk factors of MetS in relation to lifestyle behaviour and physical activity in South African municipality employees leads to a limited review of literature.

6.4 RECOMMENDATIONS AND FURTHER RESEARCH

It appears from the study that there is a need for further research regarding the following:

- To implement health and wellness programmes for the management of risk factors of metabolic disease in relation to lifestyle behaviour among employees in the local government sector.

- To evaluate the relationship between nutritional intake and risk of metabolic disease among employees.

- To investigate the perception about physical activity participation and risk factors of metabolic syndrome among local government employees.

- To determine the relationship between physical activity and nutritional intake as a baseline for the prevalence of metabolic syndrome among municipality employees.
- To examine the effects of risk factors of metabolic disease in relation to lifestyle behaviour on the productivity and health cost of employees.
- To establish the relationship between objectively assessed physical activity and the metabolic syndrome among municipality employees.

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APPENDICES

Appendix A
Guidelines for Authors, the Asian Journal of Scientific Research

Asian Journal of Scientific Research: Guidelines to Authors

Publisher: Asian Network for Scientific Information

Asian Journal of Scientific Research is a peer-reviewed international journal dedicated to address the both applied and theoretical issues in the broad field of science and technology. Scope of the journal includes: Biology, chemistry, physics, zoology, medical studies, environmental sciences, mathematics, statistics, geology, engineering, computer science, social sciences, natural sciences, technological sciences, linguistics, medicine, industrial, and all other applied and theoretical sciences. Asian Journal of Scientific Research now accepting new submissions. Submit your next paper via online submission system.

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Minimum Requirements for Authorship

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Authorship credit should be based only on:

a) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data and

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Conditions a and b must meet the criteria. Acquisition of funding, the collection of data, or general supervision of the research group, by themselves, do not justify authorship.

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List all contributors who do not meet the criteria for authorship, such as a person who provided purely technical help, writing assistance, or a department chair who provided only general

support. Financial and material support should also be acknowledged.

Groups of persons who have contributed materially to the paper but whose contributions do not justify authorship may be listed under a heading such as "clinical investigators" or "participating investigators," and their function or contribution should be described, e.g., "served as scientific advisors," "critically reviewed the study proposal," "collected data," or "provided and cared for study". Because readers may infer their endorsement of the data and conclusions, all persons must have given written permission to be acknowledged.

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S.C.W., P.R.J.B., P.V.W. and I.K.T developed the concepts and also designed the experiments. S.C.W. and S.G. performed *P. infestans* transformations and plant inoculations. P.C.B. carried out confocal microscopy and advised on cell biology. S.C.W. performed GUS assays and light microscopy. A.O.A. and J.G.M. quantified gene expression. Antibody detection of tagged transformants was performed by I.H. and S.C. L.M., J.G.M., E.M.G. and M.R.A. carried out experiments with *P. atrosepticum*. L.P. conducted all the bioinformatics analyses.

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    - Do not underline: Use italics, bold or bold italics instead.
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Include, on a separate page, no more than 250 words that adequately describe the work and highlight its significance. The abstract should include only text. Avoid the use of abbreviations and references.

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Length	Meter	m
Mass	Kilogram	kg
Time	Second	s
Time	Minute	min
Electric current	Ampere	A
Area	square meter	m^2
Volume	cubic meter	m^3
Frequency	Hertz	Hz

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References must be cited in the text in superscript digits at end of sentence or paragraph before punctuation or full stop[1]. In case of two or more references, separate the superscript digits by comma[1,2,6]. Moreover, If there are more references but in continuous numbers then use dash between superscript digits[2-6].Citation may be direct or indirect, see the following examples;

Direct citation

a) Farooq *et al*. [1] studied the temperature effect on cuticular hydrocarbons of termite.
b) According to Shafqat and Saba[2], cuticular hydrocarbons can be used to identify termite species.
c) Variations in cuticular hydrocarbons may also assist for species recognition and foraging behaviour, investigated by Zeeshan and Pasha[3].

Indirect citation

a) Temperature affects cuticular hydrocarbons of termite[1]. Cuticular hydrocarbons can be used to identify termite species[2]. Variations in cuticular hydrocarbons may also assist for species recognition and foraging behavior[3].

List of References

The list of references appears at the end of your work and gives the full details of everything that you have used, according to same chronological order as cited in the text.

All sources must be referred in a consistent manner. Choose from the list of sources below, the examples given, provide a guide to the format and punctuation you should use.

• Journal (Print)
• Journal (Electronic)
• Book
• Book Chapter
• Conference Papers

Journal Article (Print)

Elements:
1. Author’s surname, Initial
2. Publication Year
3. Article Title
4. Name of Journal (in standard abbreviation)
5. Volume

6. Starting Pages
7. Ending Pages
8. Digital Object Identifier (DOI)
9. Direct link of the published article

Example
Sepaskhah, A.R. and M.M. Ghasemi, 2008. Every-other-furrow irrigation with different irrigation intervals for grain sorghum. Pak. J. Biol. Sci., 11: 1234-1239. DOI: 10.3923/pjbs.2008.1234.1239; PMID 236548759;

Journal Article (Electronic)

Elements:
1. Author's surname, Initial
2. Publication Year
3. Article Title
4. Name of Journal (with/without abbreviations)
5. Volume
6. Page Numbers (if applicable)
7. Available at
8. Accessed on (enter date you viewed the article)
9. Digital Object Identifier (DOI)

Example
Brittion, A., 2006. How much and how often should we drink? Br. Med. J., 332: 1224-1225. Available from: http://bmj.bjjournals.com/cgi/content/full/332/7552/1224 [Accessed 2 June 2006].

Book
• Author/Editor's Surname and initials
• Year of publication
• Title of Book
• Edition (if applicable)
• Place of publication: (followed by a colon)
• Name of publisher
• ISBN Number

Example
Anderson, J. and M. Poole, 1998. Assignment and thesis writing. 3re Edn., John While and Sons.

Book Chapter
• Author/Editor's Surname and initials

• Year of publication
• Title of Chapter
• In: (enter editor's surname and initials)
• Book Title
• Edition (if applicable)
• Place of publication: (followed by a colon)
• Name of publisher
• Page number
• ISBN

Example
Mason, J., 1999. Recent Developments in the Prediction of Global Warming. In: Energy Demand and Planning, McVeigh, J.C. and J.G. Morgue, (Eds.). E&FN Spon., pp: 34-52.

Conference Papers
Conference paper's should be referenced using the following format and punctuation.

• Author's surname, initials
• Date of publication
• Title of paper
• In: Editor's surname, initials, (if applicable)
• Title of proceeding
• Place of conference
• Date of conference
• Publishers
• Page numbers of contribution

Example
Clifton, J.J., 1999. Hazard prediction. In: Disaster prevention, planning and limitation. University of Bradford, 12-13 September 1989. Technical Communications Ltd., pp: 54-64.

Final Proof Corrections and Submission

The next step in the publication process involves reviewing the galley proofs for your article. *Please return the checked galley proofs via e-mail (support@scialert.com) or via online submission system within 72 hours of receipt*. Late return of galley proofs may mean postponement to a later issue. Please make a copy of the corrected proofs before returning them; keep the copy for your records.

This step is entirely the responsibility of the corresponding author. The galley proofs will not be read by editorial staff. Errors that you fail to mark will be published.

The corresponding author of an accepted manuscript will receive e-mail notification and complete instructions when page proofs are available for review via a secure Web site. Final proof will be provided in Portable document format (PDF) files of the typeset pages. The attention of the authors is directed to the instructions which accompany the proof, especially the requirement that all corrections, revisions, and additions be entered on the proof and not on the manuscript.

Note that you are being asked to correct errors, not to revise the paper. You will not be charged for our editing mistakes or typographical errors, but you will be charged for any alterations from the original text that you make on the galley proofs. Extensive alteration may require Editorial Board approval, possibly delaying publication.

Please follow these guidelines when reviewing the galley proofs:

- Mark your corrections, in red ink, directly on the galley proofs. Make sure that your corrections are noticeable and easy to understand.
- Check all type on the galley proofs. Check the title, the abbreviations list, and the author–paper documentation paragraph.
- Check the table data against that in your original tables.
- Check any equations against those in your original manuscript. Make sure special characters have not dropped out.
- Check to be sure that figures are entirely legible, including any small-print text.
- If you find an error, look again at the lines around the error. Mistakes tend to cluster.

Submission of Final Proof Corrections

The next step in the publication process is to submit finally checked galley proof. Take the following steps to provide the final proof corrections:

1. Scan only those pages marked with corrections.
2. Save each scanned page in JPG format.
3. Submit all scanned pages via online submission system OR
4. Submit all scanned pages via e-mail to support@scialert.com
5. Write the statement like “No modification on page number 1, 2, 3, 7, 8” about the pages required no corrections.

Note: If you are completely SATISFIEID from the final proof, just inform to the Editorial Office about your satisfaction via e-mail or via online submission system. Only on the receipt of

your *final satisfaction opinion*, Editorial Office will send your article for final publication.

Appendix B
Guidelines for Authors, the African Journal of Primary Health Care and Family Medicine

Author Guidelines

How to submit your paper online:

1. Registered authors must login to submit a paper
    - REGISTER HERE if you do not have a username and password
    - LOGIN HERE if you have already registered with SAJAA
2. Select Author
3. Click on CLICK HERE TO FOLLOW THE FIVE STEPS TO SUBMIT YOUR MANUSCRIPT
4. Follow the five steps to submit your paper
5. To view a video on how to submit a paper online CLICK HERE
6. To download instructions to authors CLICK HERE

Review policy and timelines

1. Immediate notification if submitted successfully
2. Notification within 3 weeks if not accepted for further review
3. Notification within 3 months if accepted for publication, if revisions are required or if rejected by both reviewers.
4. Publication within 6 months after submission.

Aims, scope and review policy

The *African Journal pf Primary Health Care and Family Medicine* aims to publish original research and review articles of relevance and interest to the in primary health care practitioners, family medicine specialists and academics from both the developing and developed worlds, public sector and private practice. Papers are peer reviewed to ensure that the contents are understandable, valid, important, interesting and enjoyed. All manuscripts must be submitted online. All articles in PHCFM will be peer reviewed.

Article sections and length

The author guideline is available in HTML format for convenience, as it contains large information. If you experience any difficulties please do not hesitate to contact us. For a video tutorial showing you how to submit your manuscript click here.

The following contributions are accepted (word counts exclude abstracts, tables and references):

* Original research (3500 and 5000 words)
* Scientific Letters(1000 words]
* Review Articles (4000 words]

* Correspondence (500 words]
* Book reviews [500 and 1000 words]
* Case studies [500 and 1000 words]
* Conference reports, proceedings and abstracts [1000 words]
* Educational material [3500 words]
Please see the journal's section policies section policies for further details.

FULL AUTHOR GUIDELINES

Title page: All articles must have a title page with the following information and in this particular order: title of the article; surname, initials, qualifications and affiliation of each author; the name, postal address, e-mail address and telephonic contact details of the corresponding author; at least 5 keywords.

Abstract: All original and review articles should include an abstract of around 250 words. The structured abstract for an Original Research article should consist of five paragraphs labelled Setting, Objective, Methods, Results and Conclusion. Abstracts for other types of articles need not follow the structured abstract format.

Structure of article: Original research articles should be organised according to the following sections: Introduction, Method, Results, Discussion and References.
Keywords: All articles should include keywords. Up to five words or short phrases should be used. Use terms from the Medical Subject Headings (MeSH) of Index Medicus when available and appropriate. Key words are used to index the article and may be published with the abstract.

Acknowledgements: In a separate section, acknowledge any financial support received. This section may also be used to acknowledge substantial contributions to the research or preparation of the manuscript made by persons other than the authors.

References: Cite references in numerical order in the text, in **superscript** format. Do not use brackets. In the References section, references must be numbered consecutively in the order in which they are cited, not alphabetically.

The style for references should follow the format set forth in the "Uniform Requirements for Manuscripts Submitted to Biomedical Journals" prepared by the International Committee of Medical Journal Editors.

Abbreviations for journal titles should follow Index Medicus format. Authors are responsible for the accuracy of all references. Personal communications and unpublished data should not be referenced. If essential, such material should be incorporated into the appropriate place in the text. List all authors when there are six or fewer; when there are seven or more, list the first three, then "et al.".
Please click here for sample references.

Tables: Tables should be self-explanatory, clearly organised and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and numbered in Arabic

numerals (1, 2, etc) in order of its appearance as called out in text. Tables must be inserted in the correct position in the text, or uploaded separately as supplementary files. Authors should place explanatory matter in footnotes, not in the heading. Explain all nonstandard abbreviations in table footnotes. For footnotes use the following symbols, in sequence: *,†,‡,§,‖,,**,††,‡‡.

Figures: All figures must be inserted in the appropriate position of the electronic document, or uploaded separately as supplementary files. Symbols, lettering and numbering (in Arabic numerals e.g. 1, 2, etc. in order of appearance in the text) should be placed below the figure, clear and large enough to remain legible after the figure has been reduced. Figures must have clear descriptive titles.

Photographs and images: If photographs of patients are used, the human subject should not be identifiable and use of the picture should be authorised by an enclosed written permission from the subject. The position of photographs and images should be clearly indicated in the text. Electronic images should be saved as either .jpeg or .gif files. All photographs should be scanned at a high resolution (300dpi, print optimised). Provision is made to upload individual images on the website as supplementary files. Please number the images appropriately.

Permission: Permission should be obtained from the author and publisher for the use of quotes, illustrations, tables, and other materials taken from previously published works which are not in the public domain. The author is responsible for the payment of any copyright fee(s) if these have not been waived. Letters of permission should accompany the manuscript. The original source(s) should be mentioned in the figure legend or as a footnote to a table.

Review and action: Manuscripts are initially examined by editorial staff and are sent by the Editor to independent reviewers who are not informed of the identity of the author(s). When publication in the article's original form is not recommended, the reviewers' comments (without the identity of the reviewer being disclosed) may be passed to the first author and may include suggested revisions. Manuscripts not approved for publication will not be returned, in any format.

Ethical considerations: Papers based on original research must adhere to the Declaration of Helsinki on "Ethical Principles for Medical Research Involving Human Subjects" and must specify from which recognised ethics committee approval for the research was obtained. Case studies must have the consent of the patient(s) or waiver of consent approved by an ethics committee.

Conflict of interest: Authors must declare all financial contributions to their work or other forms of conflict of interest which may potentially prevent them from executing and publishing unbiased research. [Conflict of interest exists when an author (or the author's institution), has financial or personal relationships with other persons or organisations that inappropriately influence (bias) his or her opinions or actions.]*
**Modified from: Davidoff F, et al. Sponsorship, Authorship, and Accountability. (Editorial) JAMA 2001: 286(10)*

The following declaration may be used if appropriate: "I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in writing this paper."

Submissions and correspondence
All submissions must be made online at www.phcfm.org and correspondence regarding manuscripts should be addressed to:

The Editor, PHCFM, E-mail: editor@phcfm.org

Note: Ensure that the article ID [reference] number is included in the subject of your email correspondence.

Electronic submissions by post
Authors with no e-mail or internet connection can mail their submissions on a CD to: PHCFM, Postnet Suite #55, Private Bag X22, Tygervalley, Cape Town, South Africa.

All manuscripts will be processed online. Submissions by post or by e-mail must be accompanied by a signed copy of the following indemnity and copyright form. CLICK HERE to download and save it to your computer. Please include a signed copy with your submission.

Appendix C
Guidelines for Authors, the International Journal of Environmental Research and Public Health

International Journal of Environmental Research and Public Health — Instructions for Authors

Shortcuts

Submission Checklist

Please.

1. read the Aims & Scope to gain an overview and assess if your manuscript is suitable for this journal;
2. use the Microsoft Word template or LaTeX template to prepare your manuscript;
3. make sure that issues about publication ethics, research ethics, copyright, authorship, figure formats, dataand references format have been appropriately considered; and
4. ensure that all authors have approved the content of the submitted manuscript.

Manuscript Submission Overview

Types of Publications

IJERPH has no restrictions on the length of manuscripts, provided that the text is concise and comprehensive. Full experimental details must be provided so that the results can be reproduced. *IJERPH* requires that authors publish all experimental controls and make full datasets available where possible (see the guidelines on Supplementary Materials and references to unpublished data).

Manuscripts submitted to *IJERPH* should neither been published before nor be under consideration for publication in another journal. The main article types are as follows:

- *Articles:* Original research manuscripts. The journal considers all original research manuscripts provided that the work reports scientifically sound experiments and provides a substantial amount of new information. Authors should not unnecessarily divide their work into several related manuscripts, although Short *Communications* of preliminary, but significant, results will be considered. Quality and impact of the study will be considered during peer review.

- *Reviews:* These provide concise and precise updates on the latest progress made in a given area of research. Systematic reviews should follow the PRISMA guidelines.
- *Case reports:* Case reports present detailed information on the symptoms, signs, diagnosis, treatment (including all types of interventions), and outcomes of an individual patient. Case reports usually describe new or uncommon conditions that serve to enhance medical care or highlight diagnostic approaches.

Submission Process

Manuscripts for *IJERPH* should be submitted online at susy.mdpi.com. The submitting author, who is generally the corresponding author, is responsible for the manuscript during the submission and peer-review process. The submitting author must ensure that all eligible co-authors have been included in the author list (read the criteria to qualify for authorship) and that they have all read and approved the submitted version of the manuscript. To submit your manuscript, register and log in to the submission website. Once you have registered, click here to go to the submission form for *IJERPH*. All co-authors can see the manuscript details in the submission system, if they register and log in using the e-mail address provided during manuscript submission.

Accepted File Formats

Authors must use the Microsoft Word template or LaTeX template to prepare their manuscript. Using the template file will substantially shorten the time to complete copy-editing and publication of accepted manuscripts. The total amount of data for all files must not exceed 120 MB. If this is a problem, please contact the editorial office ijerph@mdpi.com. Accepted file formats are:

- *Microsoft Word:* Manuscripts prepared in Microsoft Word must be converted into a single file before submission. When preparing manuscripts in Microsoft Word, the *IJERPH* Microsoft Word template file must be used. Please insert your graphics (schemes, figures, *etc.*) in the main text after the paragraph of its first citation.
- *LaTeX:* Manuscripts prepared in LaTeX must be collated into one ZIP folder (include all source files and images, so that the Editorial Office can recompile the submitted PDF). When preparing manuscripts in LaTeX, please use the *IJERPH* LaTeX template files. You can now also use the online application writeLaTeX to submit articles directly to *IJERPH*. The MDPI LaTeX template file should be selected from the writeLaTeX template gallery.
- *Supplementary files:* May be any format, but it is recommended that you use common, non-proprietary formats where possible (see below for further details).

Cover Letter

A cover letter must be included with each manuscript submission. It should be concise and explain why the content of the paper is significant, placing the findings in the context of existing work and why it fits the scope of the journal. Confirm that neither the manuscript nor any parts of its content are currently under consideration or published in another journal. Any prior submissions of the manuscript to MDPI journals must be acknowledged. The names of

proposed and excluded reviewers should be provided in the submission system, not in the cover letter.

Note for Authors Funded by the National Institutes of Health (NIH)

This journal automatically deposits papers to PubMed Central after publication of an issue. Authors do not need to separately submit their papers through the NIH Manuscript Submission System (NIHMS, http://nihms.nih.gov/).

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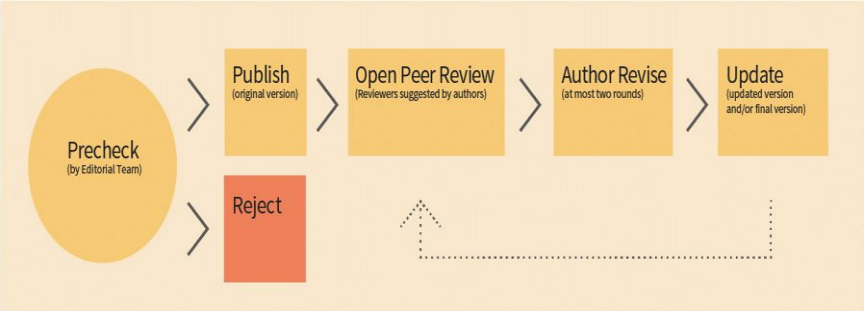
Publishing Process



It is an open publishing model. Papers will be published online immediately once the Editorial Team—including our Advisory Board comprised of high level experts in particular fields—approve a pre-check. All original versions, final versions and/or updated versions, together with the review reports, will be published and can be tracked and indexed. For peer review, authors must provide at least three review candidates for their papers during online submission with our Editorial Team.

Below are the criteria for peer reviewers.

1. Hold at least a Ph.D. degree (there as some fields, e.g. medicine and the arts, where this is not strictly required).
2. Have published >5 papers in last 5 years in the field of the submitted paper
3. No conflict of interest with authors (see below for further details)
4. Have a verified email address, i.e., one that appears on their institution's website or a published paper
5. Reviewers cannot belong to the same university or institution

We consider the following situations a conflict of interest:

- The referee has published with the authors or one of the co-authors in the last three years
- The referee has worked on or financially supported research projects where the author or one of the co-authors was involved in the last three years
- The referee is from the same institution as the author or one of the co-authors
- The referee is related to the author or one of the authors (e.g. spouse, child, etc.)

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Manuscript Preparation

General Considerations

- **Research manuscripts** should comprise:
    - Front matter: Title, Author list, Affiliations, Abstract, Keywords
    - Research manuscript sections: Introduction, Materials and Methods, Results, Discussion, Conclusions.
    - Back matter: Supplementary Materials, Acknowledgments, Author Contributions, Conflicts of Interest, References.
- **Review manuscripts** should comprise the front matter, literature review sections and the back matter. The template file can also be used to prepare the front and back matter of your review manuscript. It is not necessary to follow the remaining structure. Structured reviews and meta-analyses should use the same structure as research articles and ensure they conform to the PRISMA guidelines.
- **Case reports** should include a succinct introduction about the general medical condition or relevant symptoms that will be discussed in the case report; the case presentation including all of the relevant de-identified demographic and descriptive information about the patient(s), and a description of the symptoms, diagnosis, treatment, and outcome; a discussion providing context and any necessary explanation of specific treatment decisions; a conclusion briefly outlining the take-home message and the lessons learned.
- **Graphical abstract:** Authors are encouraged to provide a graphical abstract as a self-explanatory image to appear alongside with the text abstract in the Table of Contents. Figures should be a high quality image in any common image format. Note that images displayed online will be up to 11 by 9 cm on screen and the figure should be clear at this size.
- **Abbreviations** should be defined in parentheses the first time they appear in the abstract, main text, and in figure or table captions and used consistently thereafter.
- **SI Units** (International System of Units) should be used. Imperial, US customary and other units should be converted to SI units whenever possible
- **Accession numbers** of RNA, DNA and protein sequences used in the manuscript should be provided in the Materials and Methods section. Also see the section on Deposition of Sequences and of Expression Data.
- **Equations:** If you are using Word, please use either the Microsoft Equation Editor or the MathType add-on. Equations should be editable by the editorial office and not appear in a picture format.
- **Research Data and supplementary materials:** Note that publication of your manuscript implies that you must make all materials, data, and protocols associated with the publication available to readers. Disclose at the submission stage any restrictions on the availability of materials or information. Read the information about Supplementary Materials and Data Deposit for additional guidelines.
- **Preregistration:** Where authors have preregistered studies or analysis plans, links to the preregistration must be provided in the manuscript.

- **Guidelines and standards:** MDPI follows standards and guidelines for certain types of research. See http://www.mdpi.com/editorial_process for further information.

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Front Matter

These sections should appear in all manuscript types

- **Title:** The title of your manuscript should be concise, specific and relevant. It should identify if the study reports (human or animal) trial data, or is a systematic review, meta-analysis or replication study. When gene or protein names are included, the abbreviated name rather than full name should be used.
- **Author List and Affiliations:** Authors' full first and last names must be provided. The initials of any middle names can be added. The PubMed/MEDLINE standard format is used for affiliations: complete address information including city, zip code, state/province, country, and all email addresses. At least one author should be designated as corresponding author, and his or her email address and other details should be included at the end of the affiliation section. Please read the criteria to qualify for authorship.
- **Abstract:** The abstract should be a total of about 200 words maximum. The abstract should be a single paragraph and should follow the style of structured abstracts, but without headings: 1) Background: Place the question addressed in a broad context and highlight the purpose of the study; 2) Methods: Describe briefly the main methods or treatments applied. Include any relevant preregistration numbers, and species and strains of any animals used. 3) Results: Summarize the article's main findings; and 4) Conclusion: Indicate the main conclusions or interpretations. The abstract should be an objective representation of the article: it must not contain results which are not presented and substantiated in the main text and should not exaggerate the main conclusions.
- **Keywords:** Three to ten pertinent keywords need to be added after the abstract. We recommend that the keywords are specific to the article, yet reasonably common within the subject discipline.

Research Manuscript Sections

- **Introduction:** The introduction should briefly place the study in a broad context and highlight why it is important. It should define the purpose of the work and its significance, including specific hypotheses being tested. The current state of the research field should be reviewed carefully and key publications cited. Please highlight controversial and diverging hypotheses when necessary. Finally, briefly mention the main aim of the work and highlight the main conclusions. Keep the introduction comprehensible to scientists working outside the topic of the paper.
- **Materials and Methods:** They should be described with sufficient detail to allow others to replicate and build on published results. New methods and protocols should be described in detail while well-established methods can be briefly described and appropriately cited. Give the name and version of any software used and make clear whether computer code used is available. Include any pre-registration codes.

- **Results:** Provide a concise and precise description of the experimental results, their interpretation as well as the experimental conclusions that can be drawn.
- **Discussion:** Authors should discuss the results and how they can be interpreted in perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible and limitations of the work highlighted. Future research directions may also be mentioned. This section may be combined with Results.
- **Conclusions:** This section is mandatory, and should provide readers with a brief summary of the main conclusions.
- **Patents:** This section is not mandatory, but may be added if there are patents resulting from the work reported in this manuscript.

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Back Matter

- **Supplementary Materials:** Describe any supplementary material published online alongside the manuscript (figure, tables, video, spreadsheets, etc.). Please indicate the name and title of each element as follows Figure S1: title, Table S1: title, etc.
- **Acknowledgments:** All sources of funding of the study should be disclosed. Clearly indicate grants that you have received in support of your research work and if you received funds to cover publication costs. Note that some funders will not refund article processing charges (APC) if the funder and grant number are not clearly and correctly identified in the paper. Funding information can be entered separately into the submission system by the authors during submission of their manuscript. Such funding information, if available, will be deposited to FundRef if the manuscript is finally published.
- **Author Contributions:** Each author is expected to have made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data; or the creation of new software used in the work; or have drafted the work or substantively revised it; AND has approved the submitted version (and version substantially edited by journal staff that involves the author's contribution to the study); AND agrees to be personally accountable for the author's own contributions and for ensuring that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and documented in the literature.
  For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "X and Y conceived and designed the experiments; X performed the experiments; Y analyzed the data; Y wrote the paper." **Authorship must include and be limited to those who have contributed substantially to the work. Please read the section concerning the criteria to qualify for authorship carefully.**
- **Conflicts of Interest:** Authors must identify and declare any personal circumstances or interest that may be perceived as inappropriately influencing the representation or interpretation of reported research results. If there is no conflict of interest, please state "The authors declare no conflict of interest." Any role of the funding sponsors in the

design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript, or in the decision to publish the results must be declared in this section. If there is no role, please state "The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results".

- **References:** References must be numbered in order of appearance in the text (including table captions and figure legends) and listed individually at the end of the manuscript. We recommend preparing the references with a bibliography software package, such as EndNote, ReferenceManager or Zotero to avoid typing mistakes and duplicated references. We encourage citations to data, computer code and other citable research material. Include the digital object identifier (DOI) for all references where available. If available online, you may use reference style 9. below.
- Citations and References in Supplementary files are permitted provided that they also appear in the main text and in the reference list.

In the text, reference numbers should be placed in square brackets [ ], and placed before the punctuation; for example [1], [1–3] or [1,3]. For embedded citations in the text with pagination, use both parentheses and brackets to indicate the reference number and page numbers; for example [5] (p. 10). or [6] (pp. 101–105).

The reference list should include the full title, as recommended by the ACS style guide. Style files for Endnoteand Zotero are available.

References should be described as follows, depending on the type of work:

 Journal Articles:
1. Author 1, A.B.; Author 2, C.D. Title of the article. *Abbreviated Journal Name* **Year**, *Volume*, page range, DOI. Available online: URL (accessed on Day Month Year).
 Books and Book Chapters:
2. Author 1, A.; Author 2, B. *Book Title*, 3rd ed.; Publisher: Publisher Location, Country, Year; pp. 154–196; ISBN.
3. Author 1, A.; Author 2, B. Title of the chapter. In *Book Title*, 2nd ed.; Editor 1, A., Editor 2, B., Eds.; Publisher: Publisher Location, Country, Year; Volume 3, pp. 154–196; ISBN.
 Unpublished work, submitted work, personal communication:
4. Author 1, A.B.; Author 2, C. Title of Unpublished Work. status (unpublished; manuscript in preparation).
5. Author 1, A.B.; Author 2, C. Title of Unpublished Work. *Abbreviated Journal Name* stage of publication (under review; accepted; in press).
6. Author 1, A.B. (University, City, State, Country); Author 2, C. (Institute, City, State, Country). Personal communication, Year.
 Conference Proceedings:
7. Author 1, A.B.; Author 2, C.D.; Author 3, E.F. Title of Presentation. In *Title of the Collected Work* (if available), Proceedings of the Name of the Conference, Location of Conference, Country, Date of Conference; Editor 1, Editor 2, Eds. (if available); Publisher: City, Country, Year (if available); Abstract Number (optional), Pagination (optional).

 Thesis:
8. Author 1, A.B. Title of Thesis. Level of Thesis, Degree-Granting University, Location of University, Date of Completion.
 Websites:
9. Title of Site. Available online: URL (accessed on Day Month Year).
Unlike published works, websites may change over time or disappear, so we encourage you create an archive of the cited website using a service such as WebCite. Archived websites should be cited using the link provided as follows:
10. Title of Site. URL (archived on Day Month Year).
See the Reference List and Citations Guide for more detailed information.

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Preparing Figures, Schemes and Tables

- File for Figures and schemes must be provided during submission in a single zip archive and at a sufficiently high resolution (minimum 1000 pixels width/height, or a resolution of 300 dpi or higher). Common formats are accepted, however, TIFF, JPEG, EPS and PDF are preferred.
- *IJERPH* can publish multimedia files in articles or as supplementary materials. Please contact the editorial office for further information.
- All Figures, Schemes and Tables should be inserted into the main text close to their first citation and must be numbered following their number of appearance (Figure 1, Scheme I, Figure 2, Scheme II, Table 1, *etc.*).
- All Figures, Schemes and Tables should have a short explanatory title and caption.
- All table columns should have an explanatory heading. To facilitate the copy-editing of larger tables, smaller fonts may be used, but no less than 8 pt. in size. Authors should use the Table option of Microsoft Word to create tables.
- Authors are encouraged to prepare figures and schemes in color (RGB at 8-bit per channel). There is no additional cost for publishing full color graphics.

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Supplementary Materials, Data Deposit and Software Source Code

Data Availability

In order to maintain the integrity, transparency and reproducibility of research records, authors must make their experimental and research data openly available either by depositing into data repositories or by publishing the data and files as supplementary information in this journal.

Computer Code and Software

For work where novel computer code was developed, authors should release the code either by depositing in a recognized, public repository or uploading as supplementary information to the publication. The name and version of all software used should be clearly indicated.

Supplementary Material

Additional data and files can be uploaded as "Supplementary Files" during the manuscript submission process. The supplementary files will also be available to the referees as part of the peer-review process. Any file format is acceptable, however we recommend that common, non-proprietary formats are used where possible.

Unpublished Data

Restrictions on data availability should be noted during submission and in the manuscript. "Data not shown" should be avoided: authors are encouraged to publish all observations related to the submitted manuscript as Supplementary Material. "Unpublished data" intended for publication in a manuscript that is either planned, "in preparation" or "submitted" but not yet accepted, should be cited in the text and a reference should be added in the References section. "Personal Communication" should also be cited in the text and reference added in the References section. (see also the MDPI reference list and citations style guide).

Remote Hosting and Large Data Sets

Data may be deposited with specialized service providers or institutional/subject repositories, preferably those that use the DataCite mechanism. Large data sets and files greater than 60 MB must be deposited in this way. For a list of repositories specialized in scientific and experimental data, please consult databib.org or re3data.org. The data repository name, link to the data set (URL) and accession number, doi or handle number of the data set must be provided in the paper. The journal Data also accepts submissions of data set papers.

Deposition of Sequences and of Expression Data

New sequence information must be deposited to the appropriate database prior to submission of the manuscript. Accession numbers provided by the database should be included in the submitted manuscript. Manuscripts will not be published until the accession number is provided.

- *New nucleic acid sequences* must be deposited in one of the following databases: GenBank, EMBL, or DDBJ. Sequences should be submitted to only one database.
- *New high throughput sequencing (HTS) datasets* (RNA-seq, ChIP-Seq, degradome analysis, …) must be deposited either in the GEO database or in the NCBI's Sequence Read Archive.
- *New microarray data* must be deposited either in the GEO or the ArrayExpress databases.The "Minimal Information About a Microarray Experiment" (MIAME) guidelines published by the Microarray Gene Expression Data Society must be followed.
- *New protein sequences* obtained by protein sequencing must be submitted to UniProt (submission tool SPIN).

All sequence names and the accession numbers provided by the databases should be provided in the Materials and Methods section of the article.

References in Supplementary Files

Citations and References in Supplementary files are permitted provided that they also appear in the reference list of the main text.

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Research and Publication Ethics

Research Ethics

Research Involving Human Subjects

When reporting on research that involves human subjects, human material, human tissues, or human data, authors must declare that the investigations were carried out following the rules of the Declaration of Helsinki of 1975 (https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/), revised in 2008. According to point 23 of this declaration, an approval from an ethics committee should have been obtained before undertaking the research. At a minimum, a statement including the project identification code, date of approval and name of the ethics committee or institutional review board should be cited in the Methods Section of the article. Data relating to individual participants must be described in detail, but private information identifying participants need not be included unless the identifiable materials are of relevance to the research (for example, photographs of participants' faces that show a particular symptom). Editors reserve the right to reject any submission that does not meet these requirements.

Example of an ethical statement: "All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of XXX (Project identification code)."

A written informed consent for publication must be obtained from participating patients who can be identified (including by the patients themselves). Patients' initials or other personal identifiers must not appear in an image. For manuscripts that include any case details, personal information, and/or images of patients, authors must obtain signed informed consent from patients (or their relatives/guardians) before submitting to an MDPI journal. Patient details must be anonymized as far as possible, e.g., do not mention specific age, ethnicity, or occupation where they are not relevant to the conclusions.

You may refer to our sample form and provide an appropriate form after consulting with your affiliated institution. Alternatively, you may provide a detailed justification of why informed consent is not necessary. For the purposes of publishing in MDPI journals, a consent, permission, or release form should include unlimited permission for publication in all formats (including print, electronic, and online), in sublicensed and reprinted versions (including translations and derived works), and in other works and products under open access license. To respect patients' and any other individual's privacy, please do not send signed forms. The journal reserves the right to ask authors to provide signed forms if necessary.

Ethical Guidelines for the Use of Animals in Research

The editors will require that the benefits potentially derived from any research causing harm to animals are significant in relation to any cost endured by animals, and that procedures followed are unlikely to cause offense to the majority of readers. Authors should particularly ensure that their research complies with the commonly-accepted '3Rs':

- Replacement of animals by alternatives wherever possible,
- Reduction in number of animals used, and
- Refinement of experimental conditions and procedures to minimize the harm to animals.

Any experimental work must also have been conducted in accordance with relevant national legislation on the use of animals for research. For further guidance authors should refer to the Code of Practice for the Housing and Care of Animals Used in Scientific Procedures [1].

Manuscripts containing original descriptions of research conducted in experimental animals must contain details of approval by a properly constituted research ethics committee. As a minimum, the project identification code, date of approval and name of the ethics committee or institutional review board should be cited in the Methods section.

IJERPH endorses the ARRIVE guidelines (www.nc3rs.org.uk/ARRIVE) for reporting experiments using live animals. Authors and reviewers can use the ARRIVE guidelines as a checklist, which can be found at www.nc3rs.org.uk/ARRIVEchecklist.

1. Home Office. Animals (Scientific Procedures) Act 1986. Code of Practice for the Housing and Care of Animals Used in Scientific Procedures. Available online: http://www.official-documents.gov.uk/document/hc8889/hc01/0107/0107.pdf.

Research Involving Cell Lines

Methods sections for submissions reporting on research with cell lines should state the origin of any cell lines. For established cell lines the provenance should be stated and references must also be given to either a published paper or to a commercial source. If previously unpublished *de novo* cell lines were used, including those gifted from another laboratory, details of institutional review board or ethics committee approval must be given, and confirmation of written informed consent must be provided if the line is of human origin.

An example of Ethical Statements:

The HCT116 cell line was obtained from XXXX. The $MLH1^{+}$ cell line was provided by XXXXX, Ltd. The DLD-1 cell line was obtained from Dr. XXXX. The DR-GFP and SA-GFP reporter plasmids were obtained from Dr. XXX and the Rad51K133A expression vector was obtained from Dr. XXXX.

Research Involving Plants

Experimental research on plants (either cultivated or wild) including collection of plant material, must comply with institutional, national, or international guidelines. We recommend that authors comply with the Convention on Biological Diversity and the Convention on the Trade in Endangered Species of Wild Fauna and Flora.

For each submitted manuscript supporting genetic information and origin must be provided. For research manuscripts involving rare and non-model plants (other than, e.g., *Arabidopsis thaliana, Nicotiana benthamiana, Oriza sativa*, or many other typical model plants), voucher specimens must be deposited in an accessible herbarium or museum. Vouchers may be requested for review by future investigators to verify the identity of the material used in the study (especially if taxonomic rearrangements occur in the future). They should include details of the populations sampled on the site of collection (GPS coordinates), date of collection, and document the part(s) used in the study where appropriate. For rare, threatened or endangered species this can be waived but it is necessary for the author to describe this in the cover letter.

Editors reserve the rights to reject any submission that does not meet these requirements.

An example of Ethical Statements:

Torenia fournieri plants were used in this study. White-flowered Crown White (CrW) and violet-flowered Crown Violet (CrV) cultivars selected from 'Crown Mix' (XXX Company, City, Country) were kindly provided by Dr. XXX (XXX Institute, City, Country).

Arabidopis mutant lines (SALKxxxx, SAILxxxx,…) were kindly provided by Dr. XXX , institute, city, country).

Publication Ethics Statement

IJERPH is a member of the Committee on Publication Ethics (COPE). We fully adhere to its Code of Conductand to its Best Practice Guidelines.

The editors of this journal enforce a rigorous peer-review process together with strict ethical policies and standards to ensure to add high quality scientific works to the field of scholarly publication. Unfortunately, cases of plagiarism, data falsification, image manipulation, inappropriate authorship credit, and the like, do arise. The editors of *IJERPH* take such publishing ethics issues very seriously and are trained to proceed in such cases with a zero tolerance policy.

Authors wishing to publish their papers in *IJERPH* must abide to the following:

- Any facts that might be perceived as a possible conflict of interest of the author(s) must be disclosed in the paper prior to submission.
- Authors should accurately present their research findings and include an objective discussion of the significance of their findings.
- Data and methods used in the research need to be presented in sufficient detail in the paper, so that other researchers can replicate the work.
- Raw data should preferably be publicly deposited by the authors before submission of their manuscript. Authors need to at least have the raw data readily available for presentation to the referees and the editors of the journal, if requested. Authors need to ensure appropriate measures are taken so that raw data is retained in full for a reasonable time after publication.
- Simultaneous submission of manuscripts to more than one journal is not tolerated.

- Republishing content that is not novel is not tolerated (for example, an English translation of a paper that is already published in another language will not be accepted).
- If errors and inaccuracies are found by the authors after publication of their paper, they need to be promptly communicated to the editors of this journal so that appropriate actions can be taken. Please refer to our policy regarding publication of publishing addenda and corrections.
- Your manuscript should not contain any information that has already been published. If you include already published figures or images, please obtain the necessary permission from the copyright holder to publish under the CC-BY license. For further information, see the Rights and Permissions page.
- Plagiarism, data fabrication and image manipulation are not tolerated.
    - **Plagiarism is not acceptable** in *IJERPH* submissions.

      Plagiarism includes copying text, ideas, images, or data from another source, even from your own publications, without giving any credit to the original source.

      Reuse of text that is copied from another source must be between quotes and the original source must be cited. If a study's design or the manuscript's structure or language has been inspired by previous works, these works must be explicitly cited.

      If plagiarism is detected during the peer review process, the manuscript may be rejected. If plagiarism is detected after publication, we may publish a correction or retract the paper.

    - **Image files must not be manipulated or adjusted in any way** that could lead to misinterpretation of the information provided by the original image.

      Irregular manipulation includes: 1) introduction, enhancement, moving, or removing features from the original image; 2) grouping of images that should obviously be presented separately (e.g., from different parts of the same gel, or from different gels); or 3) modifying the contrast, brightness or color balance to obscure, eliminate or enhance some information.

      If irregular image manipulation is identified and confirmed during the peer review process, we may reject the manuscript. If irregular image manipulation is identified and confirmed after publication, we may correct or retract the paper.

  Our in-house editors will investigate any allegations of publication misconduct and may contact the authors' institutions or funders if necessary. If evidence of misconduct is found, appropriate action will be taken to correct or retract the publication. Authors are expected to comply with the best ethical publication practices when publishing with MDPI.

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Reviewer Suggestions

During the submission process, please suggest three potential reviewers with the appropriate expertise to review the manuscript. The editors will not necessarily approach these referees. Please provide detailed contact information (address, homepage, phone, e-mail address). The proposed referees should neither be current collaborators of the co-authors nor have published with any of the co-authors of the manuscript within the last five years. Proposed reviewers should be from different institutions to the authors. You may identify appropriate Editorial Board members of the journal as potential reviewers. You may suggest reviewers from among the authors that you frequently cite in your paper.

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English Corrections

To facilitate proper peer-reviewing of your manuscript, it is essential that it is submitted in grammatically correct English. Advice on some specific language points can be found here.

If you are not a native English speaker, we recommend that you have your manuscript professionally edited before submission or read by a native English-speaking colleague. This can be carried out by MDPI's English editing service. Professional editing will enable reviewers and future readers to more easily read and assess the content of submitted manuscripts. All accepted manuscripts undergo language editing, however **an additional fee will be charged** to authors if very extensive English corrections must be made by the Editorial Office: pricing is according to the service here.

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Preprints and Conference Papers

IJERPH accepts articles that have previously been made available as preprints provided that they have not undergone peer review. A preprint is a draft version of a paper made available online before submission to a journal.

MDPI operates *Preprints*, a preprint server to which submitted papers can be uploaded directly after completing journal submission. Note that *Preprints* operates independently of the journal and posting a preprint does not affect the peer review process. Check the *Preprints* instructions for authors for further information.

Expanded and high quality conference papers can be considered as articles if they fulfil the following requirements: (1) the paper should be expanded to the size of a research article; (2) the conference paper should be cited and noted on the first page of the paper; (3) if the authors do not hold the copyright of the published conference paper, authors should seek the appropriate permission from the copyright holder; (4) authors are asked to disclose that it is conference paper in their cover letter and include a statement on what has been changed compared to the original conference paper. *IJERPH* does not publish pilot studies or studies with inadequate statistical power.

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Qualification for Authorship

Each author is expected to have made substantial contributions to the conception or design of the work; acquisition, analysis, or interpretation of data; the creation of new software used in the work; and/or writing or substantively revising the manuscript. In addition, all authors must have approved the submitted version (and any substantially modified version that involves the author's contribution to the study); AND agrees to be personally accountable for the author's own contributions and for ensuring that questions related to the accuracy or integrity of any part of the work, even those in which the author was not personally involved, are appropriately investigated, resolved, and documented in the literature. Note that acquisition of funding, collection of data, or general supervision of the research group do not, by themselves, justify authorship.Those who contributed to the work but do not qualify for authorship should be listed in the acknowledgements.

More detailed guidance on authorship is given by the International Council of Medical Journal Editors (ICMJE).The journal also adheres to the standards of the Committee on Publication Ethics (COPE) that "all authors should agree to be listed and should approve the submitted and accepted versions of the publication. Any change to the author list should be approved by all authors including any who have been removed from the list. The corresponding author should act as a point of contact between the editor and the other authors and should keep co-authors informed and involve them in major decisions about the publication (e.g. answering reviewers' comments)." [1]. We reserve the right to request confirmation that all authors meet the authorship conditions.

1. Wager, E.; Kleinert, S. Responsible research publication: international standards for authors. A position statement developed at the 2nd World Conference on Research Integrity, Singapore, July 22-24, 2010. In Promoting Research Integrity in a Global Environment; Mayer, T., Steneck, N., eds.; Imperial College Press / World Scientific Publishing: Singapore; Chapter 50, pp. 309-16.

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Editorial Procedures and Peer-Review

Initial Checks

All submitted manuscripts received by the Editorial Office will be checked by a professional in-house *Managing Editor* to determine whether they are properly prepared and whether they follow the ethical policies of the journal, including those for human and animal experimentation. Manuscripts that do not fit the journal's ethics policy or do not meet the standards of the journal will be rejected before peer-review. Manuscripts that are not properly prepared will be returned to the authors for revision and resubmission. After these checks, the *Managing Editor* will consult the journals' *Editor-in-Chief*, *Associate Editor*, or *Guest Editor* (or an *Editorial Board member* in case of a conflict of interest) to determine whether the manuscript fits the scope of the journal and whether it is scientifically sound. No judgment on

the significance or potential impact of the work will be made at this stage. Reject decisions at this stage will be verified by the *Editor-in-Chief*.

Peer-Review

Once a manuscript passes the initial checks, it will be assigned to at least two independent experts for peer-review. A single-blind review is applied, where authors' identities are known to reviewers. Peer review comments are confidential and will only be disclosed with the express agreement of the reviewer.

In the case of regular submissions, in-house assistant editors will invite experts, including recommendations by an academic editor. These experts may also include *Editorial Board members* and Guest Editors of the journal. In the case of a special issue, the *Guest Editor* will advise on the selection of reviewers.

Potential reviewers suggested by the authors may also be considered. Reviewers should not have published with any of the co-authors during the past five years and should not currently work or collaborate with any of the institutions of the co-authors of the submitted manuscript.

Editorial Decision and Revision

All the articles, reviews and communications published in MDPI journals go through the peer-review process and receive at least two reviews. The in-house editor will communicate the decision of the academic editor, which will be one of the following:

- *Accept after Minor Revisions*:
  The paper is in principle accepted after revision based on the reviewer's comments. Authors are given five days for minor revisions.
- *Reconsider after Major Revisions*:
  The acceptance of the manuscript would depend on the revisions. The author needs to provide a point by point response or provide a rebuttal if some of the reviewer's comments cannot be revised. Usually, only one round of major revisions is allowed. Authors will be asked to resubmit the revised paper within a suitable time frame, and the revised version will be returned to the reviewer for further comments.
- *Reject and Encourage Resubmission*:
  If additional experiments are needed to support the conclusions, the manuscript will be rejected and the authors will be encouraged to re-submit the paper once further experiments have been conducted.
- *Reject*:
  The article has serious flaws, and/or makes no original significant contribution. No offer of resubmission to the journal is provided.

All reviewer comments should be responded to in a point-by-point fashion. Where the authors disagree with a reviewer, they must provide a clear response.

Author Appeals

Authors may appeal a rejection by sending an e-mail to the Editorial Office of the journal. The appeal must provide a detailed justification, including point-by-point responses to the reviewers' and/or Editor's comments. The *Managing Editor* of the journal will forward the manuscript and related information (including the identities of the referees) to the Editor-in-Chief, Associate Editor, or Editorial Board member. The academic Editor being consulted will be asked to give an advisory recommendation on the manuscript and may recommend acceptance, further peer-review, or uphold the original rejection decision. A reject decision at this stage is final and cannot be reversed.

In the case of a special issue, the *Managing Editor* of the journal will forward the manuscript and related information (including the identities of the referees) to the *Editor-in-Chief* who will be asked to give an advisory recommendation on the manuscript and may recommend acceptance, further peer-review, or uphold the original rejection decision. A reject decision at this stage will be final and cannot be reversed.

Production and Publication

Once accepted, the manuscript will undergo professional copy-editing, English editing, proofreading by the authors, final corrections, pagination, and, publication on the www.mdpi.com website.

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Clinical Trials Registration

Registration

Authors are strongly encouraged to pre-register clinical trials with an international clinical trials register or and to cite a reference to the registration in the Methods section. Suitable databases include clinicaltrials.gov, the EU Clinical Trials Register and those listed by the World Health Organisation International Clinical Trials Registry Platform.

CONSORT Statement

IJERPH requires a completed CONSORT 2010 checklist and flow diagram as a condition of submission when reporting the results of a randomized trial. Templates for these can be found here or on the CONSORT website (http://www.consort-statement.org) which also describes several CONSORT checklist extensions for different designs and types of data beyond two group parallel trials. At minimum, your article should report the content addressed by each item of the checklist. Meeting these basic reporting requirements will greatly improve the value of your trial report and may enhance its chances for eventual publication.

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Appendix D
Ethical

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
POTCHEFSTROOM CAMPUS

Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Faculty of Health Sciences
Tel: 018-299 2092
Fax: 018-299 2088
Email: Minrie.Greeff@nwu.ac.za

To whom it may concern

5 December 2013

Dear Prof. Monyeki

Ethics Application: NWU-00125-13-S1 "Physical activity and selected health risk factors among local government employees in Vhembe District, Limpopo Province"

Thank you for amending your application, all ethical concerns have now been addressed and ethical approval is granted.

Yours sincerely

Prof. Minrie Greeff
Ethics Sub-committee Vice Chairperson

Original details: [illegible]
5 December 2013

File reference: NWU-00125-13-S1

APPENDIX E
Letter to Vhembe District

P.O.BOX

THOHOYANDOU

0950

27 JUNE 2013

THE MUNICIPAL MANAGER

P.O.BOX

THOHOYANDOU

0950

Dear sir/madam

Re: Permission to do research in the Vhembe District municipalities

I hereby respectfully request permission to conduct/undertake a research project as stated above. Please find attached of the concise outline of the motivation and details of the proposal.

I hope that my request will receive your positive response

Yours faithfully

T.Muluvhu

APPENDIX F
Information Leaflet, Informed Consent, Data Proforma and Questionnaires

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

School of Biokinetics, Recreation and Sport Science
Private Bag x6001,
Potchefstroom
2520
South Africa

INFORMATION LEAFLET, INFORMED CONSENT, DATA PROFORMA AND QUESTIONNAIRES

PROJECT TITLE: Physical activity and selected health risk factors among local government employees in Vhembe District, Limpopo Province

Primary investigators: Prof. M.A. Monyeki and Mr T. Muluvhu [Biokineticists and a lecturer at Tshwane University of Technology]
Study leader: Prof M.A. Monyeki, PHASReC; School of Biokinetics, Recreation and Sport Science, Potchefstroom Campus of the North-West University, Potchefstroom
Co-study leader: Prof. G.L. Strydom [Biokineticists]

Dear Potential research participant,

You are invited to participate in a research study that forms part of my formal MSc-studies. It is envisaged that this degree will be taken at the North-West University as University of Venda does not offer this at present.This information leaflet will help you to decide if you would like to participate. Before you agree to take part, you should fully understand what is involved. You should not agree to take part unless you are completely satisfied with all aspects of the study.

WHAT IS THE STUDY ALL ABOUT?

Physical inactivity is a global, public health concern affecting all people in different walks of life, including employees (Lee & Paffenbarger; 2000:293-299, Allman_Farinell *et al.,* 2010:14). It is also well documented that physical inactivity is positively associated with other health risk indicators which include obesity, dyslipidaemia and hypertension (Ehrman *et al.,* 2009). The higher the prevalence of health risks in an individual, the greater the risk for morbidity and mortality (Loock *et al.,* 2011:624-635).

Research on high level employees in the South African corporate sector indicates that the working environment is not always beneficial for good health of employees (Boshoff, 2000:256), and that almost 97% of the management already shows some definite risk factors for the

development of coronary heart diseases (Jacobs, 1991). Van Zyl (1995) found that 62% of employees in middle management positions has elevated total cholesterol. Those findings are not surprising, especially when considering the low levels of participation in physical activities typical of this population. In support of this, Uys and Coetzee (1989:4) found that only 12% of male managers in South Africa considered physical activity a priority in their schedule while Dreyer (1991) reported that only 14.3% of male managers participated in regular and adequate physical activity to render any significant health benefits. The presence of lifestyle-related chronic diseases and indeed their associated risk factors may contribute to a decline in workplace productivity and hence in economic loss and may lead to a decline in quality of life of employees. Therefore, employers should be mindful of the health status of their employees (Sealy *et al.,* 2010).

It is against this background that the following research questions are posed: What is the physical activity; some selected risk factors of chronic diseases and lifestyle profiles of local government employees in Vhembe District of Limpopo Province? And what is the relationship between physical activity and selected risk factors of chronic diseases among local government employees in Vhembe District of Limpopo Province? Answers to these questions may provide the professionals working in the field of endeavour and companies with scientifically researched information regarding the importance of physical activity and its beneficial effects. Additionally, the results will provide biokineticists with valuable information in the design of physical activity training programs, hence strategic programs geared towards the management of chronic diseases of lifestyle through the use of physical activity. The objectives of this research are to determine: 2.1) The physical activity, some selected risk factors of chronic diseases (hypertension, hyperlipidaemia, diabetes and obesity) and lifestyle profiles of local government employees in Vhembe District, and 2.2) The relationship between physical activity and some selected risk factors of chronic diseases (hypertension, hyperlipidaemia, diabetes and obesity) among local government employees in Vhembe District.

WHAT WILL YOU BE REQUIRED TO DO IN THE STUDY?

1) The procedures that will be performed on/with the research participants,

Upon agreeing to take part in the study you will be requested to complete an inform consent. Subsequently, you will be taken through to complete demographic questionnaire (i.e. name, age, gender, occupation, locality, medical history). You will also be requested with the help of the researchers to complete an International Physical Activity Questionnaire made out of 27 questions which seeks to gather information on the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport. The long form of the IPAQ will be requiring about 20 minutes to complete. The IPAQ assessed moderate and vigorous physical activity in four life domains: job-related work done outside the home (paid jobs, farming, volunteer work, and course work), house and yard work

(outside and inside the home), recreation, and transportation (to locations such as work by bicycle or automobile, train, or other motor vehicle) among young and middle-aged adults (Craig et al. 2003). It includes a separate measurement of time spent sitting at a desk, visiting friends, reading, or watching television. Walking will be assessed as part of occupation, transportation, and recreational activities but its intensity was not measured. Moderate physical activity is described as activities that made you breathe somewhat harder than normal; vigorous physical activity was described as activities that made you breathe much harder than normal. Physical activity was measured in a frequency-by-duration format on a per week basis. The long form of the IPAQ instrument is available online at http://www.ipaq.ki.se website.

The **Lifestyle Questionnaire** by Belloc and Breslow (1972) will be used to determine the lifestyle index (LSI) of the respondents. This questionnaire is based on the 7 basic healthy lifestyles as described by Belloc and Breslow (1972:46-64). The respondents will indicate which of the following lifestyles they are following: not smoking, moderate physical activity 2-3 times per week, moderate or no alcohol intake, 7-8 hours sleep per night, manage a moderate body weight, eat breakfast daily and taking 3 meals per day. For the purpose of this study, the respondents will be classified into those following a bad lifestyle (<3), moderate (4-5) and good lifestyle (>6) (Kriel, 2004).

The Coronary Risk Index Questionnaire by Björstrom and Alexiou (1978) will be used to determine the risk of the participants to develop coronary heart disease. The questionnaire contains 14 risk factors which carry a certain weight depending on the presence or severity of the risk factor. For instance, non-smoking is weighted 0 while smoking more than 30 cigarettes is weighted 10. The weight of the 14 risk factors are calculated and express a coronary risk index (CRI). A total CRI of ≤21 is described as a low risk, while an index of 22-30 and ≥ 31 will be described as moderate and high-risk respectively.

Anthropometric measurements

Standing height will be measured to the nearest 0.1 cm, using a stadiometer. Body mass will be measured using a portable calibrated scale and recorded to the nearest 0.5 kg according to standard procedures of ISAK (Stewart et al. 2011).. Body mass index (BMI) will be calculated as body mass (kg) divided by height (m) squared (kg/m^2). Waist and hip circumferences will be measured using a standard tape measure and in accordance with procedure recommended by the American College of Sports Medicine (ACSM, 2010). In performing these measurements you will be requested to take out your shoes and minimise your clothes; for example by requesting you to taking out jackets and anything heavy in your pockets.

Cholesterol and glucose screening

Total blood cholesterol and glucose levels will be determined after a fasting period of ten hours using capillary blood sample obtained using finger prick. The sample will be placed on the PTS

panels glucose and lipids test strips and analysed using cardiocheck®PA Analyser (Polymer technology systems, Inc., USA).

Blood pressure
Blood pressure will be measured by using an automated sphygmomanometer (Omron, Health care, Inc., USA). You will be requested to be seated for 10 minutes; and the blood pressure will be determined according to the protocol as suggested by ACSM (2010).

Cut-off points
The American College of Sports Medicine has identified thresholds above which individuals will be at increased risk for cardiovascular diseases (ACSM, 2010), these thresholds that will be utilised to describe risk include the following:

- Obesity – BMI ≥ 30kg/m² or waist girth > 102 cm for males and > 88 cm for females.
- Blood pressure – systolic blood pressure ≥ 140 mmHG and for diastolic blood pressure ≥ 90 mmHG or patient on hypertension treatment.
- Total cholesterol- ≥ 5.18 mmol/l or patient using lipid lowering drugs.
- Impaired fasting glucose - ≥ 5.5 mmol/l or patient using diabetic medication

The project will take place at your own workplace at a venue to be arranged with you council management and will be given to you a day before the actual measurements. Measurements will be performed separately for men and women.

NB: There will be no total or full blood sample (e.g. 10ml via venipunctures from the vein in the fold of the elbow) will be drawn from you.

ARE THERE ANY CONDITIONS THAT MAY EXCLUDE YOU FROM THE STUDY?

You will not be eligible to participate in this study if you currently suffer from any of the following conditions extremely sick. Also, if you are below 25 and 66 years old and not leaving in Vhembe District around Thulamela, Makhado, Musina and Mutale Municipalities, you will be excluded from the study.

CAN ANY OF THE STUDY PROCEDURES RESULT IN PERSONAL RISK, DISCOMFORT OR INCONVENIENCE?

Questionnaires: The study and procedures involve no foreseeable physical discomfort or inconvenience to you or your family. Due to the personal nature of the questions, you may experience some emotional discomfort. The information to be provided by you will be keep confidential in the sense that your name will not be used but the research ID number.

Finger prick: These devices are used to collect a drop of blood for sampling. Most finger-pricking devices resemble a ball point pen and contain a sharp, spring loaded lancet which momentarily pierces the skin. These have both a disposable lancet and disposable plastic tip

surrounding the lancet, so that all parts, which come into contact with the patient's skin, can be discarded to minimise the risk of transmission of disease. Both lancet and plastic tip should be safely disposed of after use. Each will be used to one individual and not shared among you as a means to control risk transmission of diseases. The device is used in hospital clinics, laboratories and rest homes.

We will at all cost minimise the risk/ discomfort or inconvenience by ensuring that the measurements are performed according to prescribed procedures and the study protocol.

WHAT ARE THE POTENTIAL BENEFITS THAT MAY COME FROM THE STUDY?

The benefits of participating in this study are:

- You will make a contribution towards establishing a profile of physical inactivity and risk factors of life amongst employees in the Vhembe District Municipality.
- You will receive personal information on your physical activity classification, cholesterol; glucose and cardiovascular disease risk classification; and lifestyle and coronary risk profile.
- You will be invited to attend an information session presented by a Biokineticists, Physical Activity Epidemiologist; nutritionist and sport scientist.

WILL YOU RECEIVE ANY FINANCIAL COMPENSATION OR INCENTIVE FOR PARTICIPATING IN THE STUDY?

Please note that you **will not** be paid to participate in the study. However, you will receive refreshments after completion of the study protocol.
You will receive a once-off cash payment of R50-00 at the end of the interview session.

WHAT ARE YOUR RIGHTS AS A PARTICIPANT IN THIS STUDY?

Your participation in this study is entirely voluntary. You have the right to withdraw at any stage without any penalty or future disadvantage whatsoever. You don't even have to provide the reason/s for your decision. Your withdrawal will in no way influence your continued care and relationship with the health care team. Note that you are not waiving any legal claims, rights or remedies because of your participation in this research study.

(The formulation of the above paragraph should be adapted to suit the context of each specific study)

HOW WILL CONFIDENTIALITY AND ANONYMITY BE ENSURED IN THE STUDY?

(Possible formulations for this section, depending on the type of study, follow below.)

All information obtained during the course of this study is strictly confidential. The study data will be coded so that it will not be linked to your name. Your identity will not be revealed while the study is being conducted or when the study is reported in scientific journals. All the data sheets that have been collected will be stored in a secure place of the North-West University. Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. The information received during the project will only be used for research purposes and will not be released for any employment-related performance evaluation, promotion and/or disciplinary purposes.

IS THE RESEARCHER QUALIFIED TO CARRY OUT THE STUDY?

The researcher is a qualified Biokineticists who has extensive industrial experience and knowledge about doing research. Furthermore, the team involved in the study is made out of the experts in the field of Biokineticists, Physical Activity Epidemiology who have track record in field research. The primary researcher comes from the same geographical region as you. This means that he/she deeply understands your cultural context and can fluently speak the local languages. The field workers will be students from the University of Venda who also understand the language and cultural practice in the area.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

Yes. The Ethic Committee of North-West University have approved the formal study proposal (NWU-00125-13-51). All parts of the study will be conducted according to internationally accepted ethical principles.

WHO CAN YOU CONTACT FOR ADDITIONAL INFORMATION REGARDING THE STUDY?

The primary investigator, Mr T. Muluvhu, can be contacted during office hours at on her cellular phone at 0734325234. The study leader, Prof M.A. Monyeki, can be contacted during office hours at Tel (018) 2991790. Should you have any questions regarding the ethical aspects of the study, you can contact the chairperson of the NWU Research Ethics Committee, Prof. M. Greeff, during office hours at Tel (018 2992092, E-mail minrie.greeff@nwu.ac.za. Alternatively, you can report any serious unethical behaviour at the office of the Vice-Rector: Research and Planning at 018 299 2607.

DECLARATION: CONFLICT OF INTEREST

This research study will be jointly be under the collaborative discretions between NWU and UNIVEN. Any financial support towards the study will be from the two universities. No publication prohibitions, conditions or limitations were placed on the researcher.

A FINAL WORD

Your co-operation and participation in the study will be greatly appreciated. Please sign the informed consent below if you agree to participate in the study. In such a case, you will receive a copy of the signed informed consent from the researcher and an original copy will be kept locked until the entire duration of the study (i.e. writing of the report).

Research Project: Physical activity and selected health risk factors among local government employees in Vhembe District, Limpopo Province

CONSENT

I hereby confirm that I have been adequately informed by the researcher about the nature, conduct, benefits and risks of the study. I have also received, read and understood the above written information. I am aware that the results of the study will be anonymously processed into a research report. I understand that my participation is voluntary and that I may, at any stage, without prejudice, withdraw my consent and participation in the study. I had sufficient opportunity to ask questions and of my own free will declare myself prepared to participate in the study.

Research participant's name: _____ (Please print)

Research participant's signature: _____

Date: _____

Researcher's name: _____ (Please print)

Researcher's signature: _____

Date: _____

Research Project: Physical activity and selected health risk factors among local government employees in Vhembe District, Limpopo Province

VERBAL CONSENT

(Applicable when participants cannot read or write)

I hereby declare that I have read and explained the contents of the information sheet to the research participant. The nature and purpose of the study were explained, as well as the possible risks and benefits of the study. The research participant has clearly indicated that he/she is aware of the right to withdraw from the study at any time, for any reason and without jeopardizing his/her relationship with the research team. I hereby certify that the research participant has verbally agreed to participate in this study.

Research participant's name: _____ (Please print)

Researcher's name: _____ (Please print)

Researcher's signature: _____

Date: _____

ANTHROPOMETRIC AND PHYSIOLOGICAL MEASUREMENTS

Participants Number				
Age				
		1	2	Average
	Height (cm)			
	Weight (kg)			
	Waist circumference (cm)			
	Blood pressure			
	Cholesterol and Glucose			

QUESTIONNAIRES

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE (October 2002)

LONG LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

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

Background on IPAQ

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

Using IPAQ

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

Translation from English and Cultural Adaptation

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

Further Developments of IPAQ

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

More Information

More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective.* Research Quarterly for Exercise

and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

   ☐ Yes

   ☐ No → ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous/ hard** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

   _____ **days per week**

   ☐ No vigorous job-related physical activity → ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous/ hard** physical activities as part of your work?

   _____ **hours per day**
   _____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

_____ **days per week**

☐ No moderate job-related physical activity → ***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ **days per week**

☐ No job-related walking → ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**
_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a bus, car etc.?

_____ **days per week**

☐ No traveling in a motor vehicle → ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a bus, car or other kind of motor vehicle?

_____ **hours per day**

_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

    _____ **days per week**

    ☐ No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

    _____ **hours per day**
    _____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

    _____ **days per week**

    ☐ No walking from place to place → ***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

    _____ **hours per day**
    _____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous/ hard** physical activities like heavy lifting, chopping wood, shoveling, or digging **in the garden or yard**?

    _____ **days per week**

    ☐

No vigorous activity in garden or yard → ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous/ hard** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

☐ No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

☐ No moderate activity inside home → ***Skip to PART 4: RECREATION, SPORT AND LEISURE TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**
_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

☐ No walking in leisure time → ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**
_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

☐ No vigorous activity in leisure time → ***Skip to question 24***

23. How much time did you usually spend on one of those days doing **vigorous / hard** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

☐ No moderate activity in leisure time → ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?
_____ **hours per day**
_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**
_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

1. Demographic information

1.1 Surname: _____ Initials: _____

Gender: Male [2] Female [1] [ ]
Mark appropriate box with ✓

1.2 What was your age at your last birthday? (Full years) [ ]

1.3 Name of your company:

1.4 Your residential address:

1.5 What is your current job description?

Management level: Top level [1] Middle level [2] [ ]

Race / Ethnic group*: [ ]

Religious group*: [ ]

* For the purpose of this study, this information is needed to determine the origin of certain dietry and lifestyle practices/patterns.

Mark the appropriate box with a ✓

1.6 What is your company's primary field of activity? ☐

Civil service	1
Motor industry	2
Steel and engineering	3
Finance	4
Academic	5
Building industry	6
Mining	7
Electricity	8
Other: ***Please indicate***	9

1.7 How long have you been in your current position? ☐

< 6 months	1
6 – 12 months	2
1 – 2 years	3
2 – 5 years	4
5 – 10 years	5
> 10 years	6

1.8 In your opinion, are you sufficiently educated/trained to do your current job efficiently? ☐

Not at all	1
To a certain extent	2
Definitely	3

c1.9 What is your highest academic qualifications? ☐

Grade 11	1
Grade 12	2
Diploma (1 year study)	3
Diploma (2 year study)	4
Diploma (3 year study)	5
Diploma (> 3 year study)	6
Degree (3 year study)	7
Post-graduate degree (Hons., M.A., M.Sc., etc.)	8
3 year and diploma	9
Other	10

1.10 What is your nationality? ☐

Mark the appropriate box with a ✓

2. Physical activity index

2.1 **Do you participate in sport or any other kind of physical activity or physical recreation on a regular basis?** ☐

Yes* 1 No 2

* **If yes,** please complete the table below. Please indicate how tired you get from participating **(intensity)**, for how long you participate **(duration)** and how many times you participate per week **(frequency)**.

Example:

Walking		✓					✓						✓		

Summer															
Activity	**Intensity**					**Duration**				**Frequency**					
	1 = Not tired	**2** = Slightly tired	**3** = Tired	**4** = Very tired	**5** = Exhausted	**1** = < 10 min	**2** = 10 - 19 min	**3** = 20 - 30 min	**4** = > 30 min	**1** = 1 x month	**2** = few times/month	**3** = 1 - 2 x week	**4** = 3 - 5 x week	**5** = Almost daily	
	1	2	3	4	5	1	2	3	4	1	2	3	4	5	
Winter															

Mark the appropriate box with a ✓

3. Lifestyle

3.1 Daily habits

For each of the following statements mark the choice (Yes or No) that indicates your habits.

	Yes	No	
1. Do you eat 3 meals a day at regular times with no in-between snacking?	1	0	
2. Do you eat breakfast every day?	1	0	
3. Do you participate in moderate exercise two or three times a week?	1	0	
4. Do you get adequate sleep (7 – 8 hours a night)?	1	0	
5. Are you a non-smoker*?	1	0	
6. Have you been able to maintain your body weight at a moderate level during the last 10 years?	1	0	
7. Do you consume little or no alcohol?	1	0	

* For the purpose of this study, ex-smokers who have stopped smoking for more than 1 year qualify as non-smokers.

3.2 Nutritional evaluation

3.2.1 Eating behaviour pattern

Indicate if the following is a reflection of your eating behaviour (Sometimes or Never).

	1 = Sometimes	2 = Never
1. Have you ever been on a weight reduction diet?		
2. When watching TV, do you usually snack on different snack foods?		
3. Do you tend to eat when you are bored?		
4. Is your appetite usually reduced when you are emotionally upset?		
5. Have you ever used appetite suppressants to help you control your weight?		
6. Do you usually have cravings for starchy or sugary foods?		
7. Do you tend to eat less when under stress?		
8. Do you usually choose rich or creamy foods?		
9. Do you tend to eat more when emotionally upset?		
10. Do you usually wake up at night for something to eat?		

Mark the appropriate box with a ✓

3.2.2 Weekly food intake

Indicate how often you eat the following foods:

	< 1 per week	1 - 3 per week	> 3 per week
	1	2	3
1. Dark green and leafy vegetables, e.g. spinach, green beans, peas, etc.			
2. Dark yellow and orange vegetables and fruit, e.g. pumpkin, carrots and paw paw.			
3. Citrus fruits, e.g. orange, grapefruit, lemon, etc.			
4. Eggs			
5. Red meat, e.g. beef, pork, mutton, veal, etc.			
6. Fish or chicken			
7. Broccoli, cabbage, brussels sprouts, cauliflower			
8. Dairy products like cheese, milk and yoghurt			
9. Legumes, lentils, dried beans and baked beans			
10. Snack foods, e.g. chips, nuts, biltong, pies, etc.			
11. Sweets, chocolates, cakes, sweetened cooldrinks, sweet biscuits			

Mark the appropriate box with a ✓

4. Illness and coronary risk profile

4.1 Risk factors for coronary heart disease

Complete the table below by marking the appropriate space. Read from left to right.

Age	10 – 20 years	1	21 – 30 years	2	31 – 40 years	3	41 – 50 years	4	51 – 60 years	6	61+ years	8	
Hereditary*: Parents and family	No family history of CVD	1	1 with CVD over 60 yrs	2	2 with CVD over 60 yrs	3	1 death from CVD under 60 yrs	4	2 deaths from CVD under 60 yrs	6	3 deaths from CVD under 60 yrs	7	
Weight	5 kg under standard weight	0	Standard weight	1	5 – 10 kg overweight	2	11 – 15 kg overweight	3	16 – 20 kg overweight	5	21+ kg overweight	7	
Smoking	No smoking	0	Occasional cigar/pipe	1	< 10 cigarettes per day	2	11 – 20 cigarettes per day	4	21 – 30 cigarettes per day	6	> 30 cigarettes per day	10	
Exercise	Intensive occupational and recreational exercise	0	Moderate occupational and recreational exercise	1	Sedentary occupational and intensive recreation	2	Sedentary occupation and moderate recreation	4	Sedentary occupation and light recreation	6	Sedentary occupation and no exercise or recreation	8	
Cholesterol	< 5.2 mmol.ℓ^{-1}	1	Don't know	2	5.2 – 6.0 mmol.ℓ^{-1}	3	6.1 – 6.6 mmol.ℓ^{-1}	4	6.7 – 7.3 mmol.ℓ^{-1}	5	7.4+ mmol.ℓ^{-1}	7	
Systolic bloodpressure	111 – 130 mm Hg.	0	131 – 140 mm Hg.	1	Don't know	2	141 – 160 mm Hg.	3	161 – 180 mm Hg.	5	> 180 mm Hg.	7	
Diastolic bloodpressure	80 – 85 mm Hg.	0	86 – 90 mm Hg.	1	Don't know	2	91 – 95 mm Hg.	4	96 – 100 mm Hg.	7	> 101 mm Hg.	9	
Gender	Female	1	Female over 45 yrs	2	Male	4	Bald male	5	Bald, short male	6	Bald, short, stocky male	7	
Stress	No stress	1	Occasional mild stress	2	Frequent mild stress	3	Frequent moderate stress	4	Frequent high stress	5	Constant high stress	7	
Present CVD* symptoms	None	0	Occasional tachycardia** and/or irregular rhythm	2	Frequent tachycardia** and /or irregular rhythm	4	Dyspnea on exertion***	6	Occasional angina***	8	Frequent angina****	10	
Past personal history of CVD*	Completely benign	0	CVD symptoms not medically confirmed	2	History of CVD symptoms, examined by doctor	4	Mild CVD, no present symptoms	6	CVD under symptoms	8	Hospitalised for CVD	10	
Diabetes	No family history	0	Positive family history	1	Diagnosed pre-diabetic	3	Diabetes: dietary control	5	Diabetes: oral control	7	Diabetes: insulin control	9	
Gout	No family history	0	Family history	1	Elevated uric acid. No symptoms.	2	New onset gout: early detected	3	Repeated chromic gouty attacks	5	Gout with renal and ostea complications	8	

* CVD = Cardiovascular disease (example: heart disease, heart attack, bypass, etc.)
** Tachycardia = Fast heartbeat (e.g. seen in normal persons after climbing stairs)
*** Dyspnea = Difficulty in breathing ("out of breath").
**** Agina = Pain in the chest

Circle the number/s

4.2 Illness rating scale

Circle the number indicating all the illnesses that you have experienced during the last year.

1. Dandruff
2. Warts
3. Cold sore, cancer sore
4. Corns
5. Hiccups
6. Bad breath
7. Sty
8. Common cold
9. Farsightedness
10. Nosebleed
11. Sore throat
12. Nearsightedness
13. Sunburn
14. Constipation
15. Astigmatism
16. Laryngitis
17. Ringworm
18. Headache
19. Scabies
20. Boils
21. Heartburn
22. Acne
23. Abscessed tooth
24. Colour blindness
25. Tonsillitis
26. Diarrhoea
27. Carbuncle
28. Chickenpox
29. Menopause
30. Mumps
31. Dizziness
32. Sinus infection
33. Bed sores
34. Increased menstrual flow
35. Fainting
36. Measles
37. Painful menstruation
38. Infection of middle ear
39. Varicose veins
40. Psoriasis
41. No menstruation
42. Hemorrhoids
43. Hay fever
44. Low blood pressure
45. Eczema
46. Drug allergy
47. Bronchitis
48. Hyperventilation
49. Shingles
50. Glandular fever
51. Infected eye
52. Bursitis
53. Whooping cough
54. Lumbago
55. Fibroids of the uterus
56. Migraine
57. Hernia
58. Frostbite
59. Goitre
60. Abortion
61. Ovarian cyst
62. Heatstroke
63. Gonorrhoea
64. Irregular heart beats
65. Overweight
66. Anemia
67. Anxiety reaction
68. Gout
69. Snake bite
70. Appendicitis
71. Pneumonia
72. Depression
73. Frigidity
74. Burns
75. Kidney infection
76. Inability for sexual intercourse
77. Hyperthyroid
78. Asthma
79. Glaucoma
80. Sexual deviation
81. Gallstones
82. Arthritis
83. Starvation
84. Syphilis
85. Accidental poisoning
86. Slipped disk
87. Hepatitis
88. Kidney stones
89. Peptic ulcer
90. Pancreatitis
91. High blood pressure
92. Smallpox
93. Deafness
94. Collapsed lung
95. Shark bite
96. Epilepsy
97. Chest pain
98. Nervous breakdown
99. Diabetes
100. Blood clot in blood vessels
101. Hardening of the arteries
102. Emphysema
103. Tuberculosis
104. Alcoholism
105. Drug addiction
106. Coma
107. Cirrhosis of the liver
108. Parkinson's disease
109. Blindness
110. Mental retardation
111. Blood clot in the lung
112. Manic depressive psychosis
113. Stroke
114. Schizophrenia
115. Muscular dystrophy
116. Congenital heart defects
117. Tumor in the spinal cord
118. Cerebral palsy
119. Heart failure
120. Heart attack
121. Brain infection
122. Multiple sclerosis
123. Bleeding in brain
124. Uremia
125. Cancer
126. Leukemia

Mark the appropriate box with a ✓

5. Stress

Indicate how your behaviour matches the following statements.

	Often	A few times a month	Rarely
	2	1	0
1. I have indigestion			
2. I have difficulty finding enough time to relax			
3. I smoke when I feel tense			
4. I sleep badly			
5. I find it difficult to concentrate on what I am doing because of worrying about other things			
6. I feel anxious			
7. I eat more when I a anxious			
8. I have headaches			
9. People at work make me feel tense			
10. I have aches and pains in my neck or shoulders			
11. Even if I find time, it is hard for me to relax			
12. People at home make me feel tense			
13. I drink alcoholic beverages when I feel tense			
14. My day is made up of may deadlines			
15. I can't turn off my thoughts for long enough at night or weekends to feel relaxed/refreshed the next day			
16. I take tranquillisers (or drugs) to relax			
17. I feel my heart beating fast			
18. My legs feel wobbly			
19. I perspire without even exercising			
20. I get angry/irritated quickly			
21. I am impatient and become frustrated with others			
22. I do things in a hurry			
23. I talk quickly			
24. I worry that there are so many things that I can do nothing about			
25. I cannot sit still for long			

Mark the appropriate box with a ✓

6. Emotional well-being

How often do you have any of the following experiences? Please use the following scale.

	Never 1	Once 2	Rarely 3	Sometimes 4	Often 5	Usually 6	Always 7
1. Being tired							
2. Feeling depressed							
3. Having a good day							
4. Being physically exhausted							
5. Being emotionally exhausted							
6. Being happy							
7. Feeling "wiped out"							
8. Feeling burnout"							
9. Being unhappy							
10. Feeling rundown							
11. Feeling trapped							
12. Feeling worthless							
13. Being weary							
14. Being troubled							
15. Feeling disillusioned and resentful about people							
16. Feeling weak							
17. Feeling hopeless							
18. Feeling rejected							
19. Feeling optimistic							
20. Feeling energetic							
21. Feeling anxious							

32 – B = C ÷ A = D/21

32 - ☐ = ☐ ÷ ☐ = ☐ /21

Mark the appropriate box with a ✓

7. Happiness, well-being and quality of life

Read each statement and decide how often the feeling was present over the past few weeks. Please use the following response scale.

	Not at all 1	Occasionally 2	Sometimes 3	Often 4	All the time 5
1. My life is on the right track					
2. I wish I could change some part of my life					
3. My future looks good					
4. I feel as though the best years of my life are over					
5. I like myself					
6. I feel there must be something wrong with me					
7. I can handle any problem that comes up					
8. I feel like a failure					
9. I feel loved and trusted					
10. I seem to be left alone when I don't want to be					
11. I feel lose to people around me					
12. I have lost interest in other people and don't like them					
13. I feel I can do whatever I want to					
14. My life seems to be in a rut					
15. I have energy to spare					
16. I can't be bothered doing anything					
17. I smile and laugh a lot					
18. Nothing seems very much fun anymore					
19. I think clearly and creatively					
20. My thoughts go round in useless circles					

☐ - ☐ = ☐

Mark the appropriate box with a ✓

8. Company culture

Rate the following statements with regard to the way they match your experience at work each day.

	Doesn't fit my job at all	Fits my job in some way	Fits my job more or less	Strongly fits the way it is at work
	0	1	2	3
1. People feel free to take risks and experiment at work				
2. Creativity is affirmed daily				
3. A few key advisors take responsibility for projects as opposed to the assignment of projects to committees				
4. People feel that they make a powerful difference and are involved in experiences that prove it				
5. Salaries meet basic needs and also provide incentives				
6. People are rewarded and recognized for excellent performance				
7. Conflicts are resolved with win/win solutions or are mediated by non affected third parties				
8. People are constructively confronted when negative behaviour occurs				
9. People avoid blame placing and finger pointing as a method of problem solving				
10. The decision-making process is highly participatory				
11. People emphasize co-operation over competition among members of the organization				
12. People set their own work objectives and work method				
13. People's beliefs are congruent with their actions				
14. People understand how their work relates to the goals or values of the organization				
15. People seek out the ideas and opinions of others				
16. Leaders follow up on problems and new ideas swiftly				
17. Leaders show a balanced concern between the quality of work that has to be done and the people who are doing it.				
18. Leaders are actively involved in providing quality services and they model the behaviour they expect of others				
19. Some meetings focus on nothing but individual and/or group achievements				
20. Support for and caring of associates is strongly emphasized				
21. People are concerned about the success of the work group				
22. The work environment is relaxing and families are included in some of the organization's programmes				
23. Fitness facilities and programmes are available and their use is encouraged				
24. The organization provides the necessary staff, programmes or other resources to assist people under stress or who are experiencing personal problems.				
25. Change and/or efforts focus on measurable results				
26. Quality is something upper management not only talks about but also does something about				
27. Management acts quickly and decisively on quality improvement suggestions				

APPENDIX G
Acceptance letter for the published article 1 in the Asian Journal of Scientific Research

SCIENCE ALERT
www.scialert.com
PO Box 126208 Deira Dubai, UAE

Jul 28, 2017

Prof. M.A. Monyeki,

Subject: Acceptance Letter for Article No. 85626-AJSR-ANSI

It's a great pleasure for us to inform you that below mentioned manuscript has been accepted for publication in Asian Journal of

Scientific Research as Research Article on the recommendation of the reviewers.

Title: Relationship between Selected Metabolic Risk Factors and Waist to Height Ratio among Employees in Vhembe District Municipality of Limpopo Province, South Africa

Author's Name: TAKALANI C. MULUVHU, M.A. MONYEKI, G.L STRYDOM and A.L. TORIOLA

Receiving Date: June 22, 2017

Regards

M. Imran Pasha
Publication Manager

APPENDIX H
Certificate of Proof Reading

Lesley Suzanne Wyldbore

PO Box 130211 Bryanston 2021
e-mail: lesleywyldbore@gmail.com

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20 April 2018

To Whom It May Concern

I, Lesley Wyldbore, do herewith confirm that I have conducted an English language and grammar edit on the PhD thesis by Takalani Clearance Muluvhu entitled:

Physical activity and metabolic risk factors in relation to lifestyle behaviour among employees in the Vhembe District municipality of Limpopo Province

Yours sincerely

Lesley Wyldbore
+27(0) 83 639-1960
+44(0) 74 8154 5738