AN INVESTIGATION OF POSSIBLE CONTRIBUTING RISK FACTORS RELATED TO DIET AND LIFESTYLE WHICH MAY CAUSE HYPERTENSION IN MALE EMPLOYEES OF HOTAZEL MANGANESE MINES (NORTHERN CAPE PROVINCE, SOUTH AFRICA)

by
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Thesis presented in partial fulfilment of the requirements for the degree
Master of Nutrition at the Stellenbosch University

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March 2016

DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for any qualification.

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ABSTRACT

Introduction

Occupational health nurses employed by Life Health Services noticed a high prevalence of hypertension among employees that were hypertension free at the start of employment at Hotazel Manganese Mines. Of the 804 employees eligible for participation in the study, 369 already suffered from hypertension at commencement of employment.

Objectives

This study investigated nutrition and lifestyle as risk factors for the perceived high prevalence of hypertension among the male mineworkers. Risk factors relating to diet were investigated (excessive salt consumption, a reduced intake of potassium, magnesium, calcium, high saturated fat and energy intake; overall unhealthy diet and alcohol consumption) and lifestyle (physical inactivity, stress, smoking and obesity). Findings assisted in developing a set of recommendations to help prevent and manage the development of hypertension in employees of HMM.

Methodology

An analytical unmatched case-control study type was used. The eligible sample consisted of 408 permanent male employees who were hypertension free at the start of employment. Proportionate random sampling methods were initially used to select participants from three mines (N=88). Participants were selected using the South African Heart and Stroke Foundation's classification for hypertension. Anthropometric data was obtained from each participant's medical file as well as their blood pressure at the start of employment and yearly measurements thereafter. Participants completed self-administered questionnaires pertaining to their physical activity, stress and demographic information. The researcher administered the quantified food frequency questionnaire (including questions on extra salt addition, alcohol intake and smoking) during individual interviews and analysed the nutritional content using the Foodfinder nutritional analysis software. Statistical analysis was performed using various methods and a p-value of <0.05 was regarded as statistically significant.

Results

Fifty eight per cent (n=26) of the participants developed hypertension during employment at Hotazel Manganese Mines (hypertensive cases) and 42% (n=19) remained normotensive (controls) during an average of 11 years of employment. The cases have, on average, worked significantly longer ($p<0.01$) than the controls (14 years compared to six years respectively) and were also significantly older (p=0.03) than the controls (42 years and 36 years respectively). Body mass index (BMI) increased on average with 3 kg/m^2 during employment and the cases (n=26) had a significantly higher increase in BMI during employment (p=0.004). Coloured participants in more senior positions were significantly more likely to develop hypertension than the coloured participants employed in lower levels (p=0.01). White participants working at Mamatwan mine were more likely to develop hypertension (p=0.01). No significant difference was found between the two groups in terms of the amount of time it took the cases to develop hypertension during employment (on average three years), the level of physical activity, stress levels, alcohol consumption, smoking, supplement usage, addition of extra salt, consumption of sodium, magnesium, potassium and calcium, saturated fat and energy intake. Mean energy and saturated fat intake was higher than the recommended dietary allowances.

Conclusion

Duration of employment, increased age and BMI increase was associated with the risk of developing hypertension in this study. Lifestyle interventions should be introduced to improve the health and well-being of the employees.

OPSOMMING

Inleiding

Beroepgesondheidsverpleegkundiges werksaam by Life Gesondheidsdienste het waargeneem dat die voorkoms van hipertensie toeneem onder die werknemers sedert hulle by Hotazel Mangaanmyne begin werk het. Uit die 804 werknemers wat geskik was vir die studie, het 369 alreeds hipertensie gehad tydens indiensname by Hotazel Mangaanmyne.

Doelwitte

Die studie het gepoog om vas te stel of voeding- en lewenstyl moontlike risikofaktore kon wees vir die oënskynlike hoë voorkoms van hipertensie onder mynwerkers. Risiko faktore wat verband hou met diëet (oormatige sout lae kalium, magnesium, kalsium, hoe versadigde vette en energie, ongesonde diëet en alkohol inname) en lewenstyl (fisiese onaktiwiteit, spanning, rook, en vetsug) is ondersoek. Aanbevelings om hipertensie onder die werknemers te voorkom en te bestuur is gemaak volgens die bevindinge.

Metodologie

’n Analitiese ongepaarde geval en kontrole studietipe is gebruik. Die werknemers wat in aanmerking gekom het vir seleksie het bestaan uit 408 permanente manlike werknemers wat sonder hipertensie was tydens indiensname. Proporsionele ewekansige steekproeftrekking is aanvanklik gebruik om werknemers by drie myne te kies. Deelnemers is geselekteer volgens die Suid-Afrikaanse Hart- en Beroerte Stigting se klassifikasie van hipertensie. Elke deelnemer se antropometriese data en bloeddrukwaardes tydens indiensname en elke jaar daarna, is uit die mediese lêers verkry. Die deelnemers het vraelyste oor hulle fisiese aktiwiteit, spanningsvlakke en sosio-demografie ingevul. ’n Gekwantifiseerde voedselfrekwensie vraelys is deur die navorser tydens individuele onderhoude gebruik (insluitende vrae oor ekstra sout toevoeging, alkohol inname en rookgewoontes). Die voedingsinligting is geanaliseer met behulp van die Foodfinder voedingsanalise sagteware. Statistiese analise is uitgevoer deur die gebruik van verskeie metodes en ’n p-waarde van $p<0.05$ is aanvaar as statisties beduidend.

Resultate

Tydens ’n gemiddelde dienstydperk van 11 jaar by Hotazel Mangaan Myn, het 58% (n=26) van die deelnemers hipertensie ontwikkel (hipertensiewe gevalle) en 42% (normotensiewe kontrole) het nie. Die hipertensiewe gevalle het beduidend langer gewerk ($p<0.01$) as die normotensiewe kontrole (14 jaar teenoor 6 jaar onderskeidelik) en was ook beduidend ouer ($p=0.03$) as die normotensiewe kontrole (42 jaar teenoor 36 jaar onderskeidelik).

Liggaamsmassa indeks (LMI) het gedurende die dienstydperk met 3 kg/m^2 toegeneem en die gevalle (n=26) het ’n beduidende hoër toename in LMI gehad gedurende die dienstydperk (p=0.004). Die kleurling deelnemers in meer senior posisies was beduidend meer waarskynlik om hipertensie te ontwikkel as die kleuringdeelnemers in laer posisies (p=0.01). Wit deelnemers werksaam op Mamatwan myn was meer waarskynlik om hipertensie te ontwikkel (p=0.01). Daar was geen beduidende verskil tussen die twee groepe in terme van dienstydperk voordat die gevalle hipertensie ontwikkel het (gemiddeld drie jaar), die vlak van fisiese aktiwiteit, spanningsvlakke, alkohol inname, rookgewoontes, gebruik van diëetaanvullings, byvoeging van ekstra sout en hoeveelheid natrium, magnesium, kalium, kalsium, versadigde vet en energie ingeneem nie. Die gemiddelde energie-inname asook versadigde vet-inname was meer as die aanbevole daaglikse toelae.

Gevolgtrekking

Die tydperk van indiensname, ’n toename in ouderdom en ’n toename in LMI was geassosieer met die ontwikkeling van hipertensie in hierdie studie. Leefstyl intervensies moet ingestel word om gesondheid en algemene welstand van die werknemers van Hotazel Mangaanmyn te bevorder.

AKNOWLEDGEMENTS

Thank you to Sr Hannetjie van der Merwe for initiating the idea for this study and to Dr Ewert Bohnen for supporting the case for this study. Also, thank you to Navarre Kruger for helping to get the necessary approval from head office. Special thanks to the mine managers of each of the Hotazel Manganese Mines for providing suitable space to administer or complete the questionnaires and granting each selected participant time to attend their session. Thank you to Prof Marietjie Herselman and Mrs Maritha Marais for their patience and continued support and valuable input throughout the study and to Prof Daan Nel for help with the statistical analysis. Lastly I would like to thank my husband for his continuous support, understanding and help with our twin girls while I completed my studies.

Contributions by principal researcher and fellow researchers

The principal researcher (Catharina Maidment) developed the idea and the protocol. The principal researcher planned the study, undertook data collection (with a research assistant), captured the data for analysis, analysed the data with the assistance of a statistician (Prof DG Nel), interpreted the data and drafted the thesis. Prof MG Herselman and Mrs ML Marais (Supervisors) provided input at all stages and revised the protocol and thesis. Editing of the final thesis was done by Lize Vorster.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	analysis of variance
Armcor	African Metal Corporation
BHPB	Broken Hill Proprietary Billiton
BIRD	Biomedical Informatics Research Division
BMI	body mass index
CSIR	Council for Scientific and Industrial Research
DASH	Dietary Approaches to Stop Hypertension
DBP	diastolic blood pressure
DEAK	Dietary Assessment and Education Kit
ECG	electrocardiogram
HMM	Hotazel Manganese Mines
HUNT	Nord-Trϕndelag Health Study
IPAQ	International Physical Activity Questionnaire
ISMAUK	International Stress Management Association United Kingdom
MRC	Medical Research Council
MUST	Malnutrition Universal Screening Tool
NHANES	American National Health and Nutrition Examination Survey
NIRU	National Intervention Research Unit
MHSAct	Mine Health and Safety Act
PA	physical activity
QFFQ	Quantified Food Frequency Questionnaire
SA	Republic of South Africa
SANHANES	South African National Health and Nutrition Examination Survey
SBP	systolic blood pressure
SD	standard deviation
UK	United Kingdom
USA	Unites States of America
WHO	World Health Organisation

LIST OF DEFINITIONS

	Definition
Automated blood pressure reading	Blood pressure reading taken using an automated machine where the upper arm cuff is inflated by using an electrically driven pump and it automatically deflates after reaching the user –adjustable or preset inflation pressure. It has a pressure sensor and a digital display as well as an upper arm cuff[1,2]
Body Mass Index	Calculated by dividing an individual's weight in kilograms with their square height in meters. This calculation provide a value that classifies a person's weight in one of the following three categories; underweight, normal or healthy weight, overweight and obese[3]
Calcination	Also called calcining - it is a thermal treatment process applied to ores and other solid materials to bring about a thermal decomposition, phase transition, or removal of a volatile fraction. The calcination process normally takes place at temperatures below the melting point of the product materials[4]
Case	A patient with the disease or outcome of interest. In this study employees who developed hypertension during employment at HMM[5]
Cohort	A group of people who are followed over time and share similar characteristics among its members[6]
Confidence interval	A range of values calculated from the sample data between which it is believed the true population value lies[7]
Conscious ambulatory blood pressure reading	Blood pressure measurement taken as individual is living their normal daily life, through a small digital blood pressure monitor on a belt around the individual's waist. The digital monitor is connected to a cuff around the individuals arm. Blood pressure is taken for up to 24 hours[8]
Content validity	Tests the effectiveness of a test to accurately calculate all the fundamental parts of a variable[9]
Controls	In this study employees who did not develop hypertension after a period of time in employment at HMM[5]
Current employees	An employee of Hotazel Manganese Mines at the present time[10]

DASH diet principles	A flexible and healthy plan based on research by the National Heart, Lung and Blood Institute (NHLBI) that lowers high blood pressure and improves blood lipid levels. It is high in potassium, calcium, magnesium, fibre and protein (due to its emphasis on fruit and vegetables) and it also includes fat free and low fat dairy products, whole grains, fish, poultry, beans, nuts, seeds and vegetable oils. Sugary beverages, sweets, sodium and red meats are limited[11]
Diastolic	Diastolic pressure is the pressure during relaxation of the heart between each contraction or heart beat[12]
Dizygotic twins	Two babies born from one single pregnancy and developed from 2 individual ova, released from the ovary simultaneously and fertilized at the same time. These twins can be of the same sex or opposite sexes and differ in terms of their physical, physiological and mental characteristics[13]
Electrocardiogram	A test that checks the electrical activity of a person's heart[14]
Face validity	The level of understanding of a question or test by those familiar with the subject or to those that have a good understanding of the culture and language of the participants[9]
Gold standard	A test by which other similar tests are measured, it is not the ideal test merely the best available test, it serves as a basis for comparison[15]
Hypertension	An increase in an individual's blood pressure over 140/90 mm HG [12]
Pre-Hypertension/elevated blood pressure	Blood pressure higher than normal blood pressure (<120/80 mm HG to 129/84 mm HG)[12] but not yet hypertensive.
Malnutrition	A condition where the intake of energy, protein and other nutrients intake is not sufficient or in excess leading to under nutrition or obesity[16]
Manual blood pressure reading	Blood pressure reading using a manual blood pressure monitor (sphygmomanometer) and where the upper arm cuff is inflated by hand and a stethoscope is used to listen to the Korotkoff sounds while the cuff is being deflated[17,18]

Matched case control study	A study where the controls for the cases are selected to share certain characteristics like age, sex, ethnicity etc.[19]
Mendelian Randomization	A method (used in epidemiological studies) of using measured variation in genes of known function to examine the causal effect of a modifiable exposure on a disease in non-experimental studies. This design has a strong control for reverse causation and confounding [20]
Monozygotic twins	Two babies born from one single pregnancy and developed from one fertilized ovum that splits into equal halves during embryonic development and developing into two separate foetuses. These twins are always from the same sex, have the same genetic constitution and blood group and closely resembles one another in physiological, physical and mental characteristics[21]
New Employees	Individuals who recently joined an organisation. In the context of this study, Hotazel Manganese Mines[22]
Occupational Health Nurse	Occupational health nurses are speciality practitioners that provide a range of healthcare services to organizations and their employees. Their focus are the safety, support and restoration of health of all employees and a safe and healthy work setting[23]
Pilot study	A small study that tests certain parts of the main study before commencement of the main study. It tests the methods used, help to determine the sample size and detect if field training has been done to the appropriate standard[24]
Probability (p value)	It refers to the level of possibility or likelihood that a hypothesis are accepted or rejected (an event occurring)[25]
Reliability	The level of comparison between results of a test repeated more than once[26]
Systolic	Systolic blood pressure is the pressure in the arteries when the heart is contracting[12]
Unmatched case control study	A study where the controls are selected randomly from a suitable non affected population[6]

CHAPTER 1: REVIEW OF RELATED LITERATURE

1.1 BACKGROUND INFORMATION

The Town Hotazel is located on the border of the Northern Cape and the North West province of South Africa.[27] It is home to Mamatwan Manganese Mine (open cast) and its sinter complex and Wessels Mine (underground), with its exclusive train terminal.

The name Hotazel came from the observation of one of the founders, Dirk Roos that "this place is as hot as hell". In the 1950s, geologists found that the area beneath Hotazel town was almost solid manganese. Mining started in 1958 and Hotazel town was built to house the workers. The mine was run by SA Manganese and African Metals Corporation (Armcor). In 1975 the two companies merged to form Samancor.[27,28] Hotazel Manganese Mines (HMM) consist of Wessels mine, Mamatwan mine (with sinter plant) and the administrative offices are housed in the town itself.

Drilling at the area today known as Wessels mine exposed manganese as early as 1951. Mamatwan mine was opened in 1964 to provide ore with a high manganese-to-iron ratio. It was only in 1966 that the true extent of the manganese fields was discovered when deeper drilling was undertaken.[27,28] For both Wessels- and Mamatwan mines, the manganese ore is broken by blast and drill methods. On Wessels mine, the blasted ore is then loaded with large, earth moving vehicles and transported to satellite crushers where it is stored before being cleaned, sorted into grade and size and loaded onto trains or blended to meet customer requirements. In the case of Mamatwan mine, the ore is transported to the sinter plant (commissioned in 1988[28]) where it is calcined and partially reduced resulting in a product that is chemically stable and physically strong.

Hotazel Manganese Mines used to form part of BHP Billiton (BHPB), the world's largest resources company, but in May 2015, HMM demerged from BHPB and South32 was formed sharing the same values as BHPB. South32, like BHPB, has a zero-harm policy, meaning zero harm to their employees, zero harm to the environment and producing the best quality product.[28, 29]

Employees at HMM perform very high-risk jobs, requiring them to be alert and in good health. Some employees operate very large earth-moving vehicles and explosives are used in the underground mine (Wessels mine) as well as the open cast mine (Mamatwan mine). Furthermore, employees working at the sinter plant, located on Mamatwan mine where the manganese is melted, are exposed to high temperatures.

Management of South32 are aware of these strenuous working conditions and provide a range of nutritional supplements (Addendum 1) to all employees to provide for additional energy requirements. The range of supplements consists of milkshakes, Tropicana dairy style drinks, diabetic milkshakes, traditional style drinks, cold drinks, porridges and soups.

1.2 CURRENT HEALTH TESTING PROCEDURES AT HMM ACCORDING TO RELEVANT LEGISLATION

The Department of Mineral Resources in South Africa is responsible for the safe mining of minerals (natural resources) and healthy working conditions.[30] All the mines in South Africa are required to comply with the Mine Health and Safety Act of 1996 (MHSAct),[31] in which it is stated that employers should ensure the health and safety of their employees in the workplace and the health and safety of those working with heavy machinery. One of the eight duties of the employer, as set out in the MHSAct, is to “provide such information, instructions, training and supervision as may be necessary to ensure, as far as is reasonably practicable, the health and safety at work of his employees”.[31]

In compliance with the MHSAct, all new and current employees are subjected annually to a medical examination to ensure that they are medically fit for work. The health services for HMM are run by the Life Occupational Health Group.[32] The occupational health nurses are responsible for these medical examinations. New employees who will mainly do office work undergo the following tests: eyesight (using the Snellin eye chart); hearing (audio machine), blood pressure, height, weight, urine (testing for glucose, protein, leucocytes, blood and pH), pulse rate and body mass index (BMI) is calculated.[33]

New employees, who will be responsible for driving heavy vehicles or operating heavy machinery, undergo an authorater test, which includes additional tests for night vision, colour blindness, depth perception, and a drugs test. In addition, those employees who will be responsible for driving vehicles carrying passengers will receive an electrocardiogram (ECG).

At the start of employment all employees undergo a lung test and x-rays to look for signs of lung disease and tuberculosis. If no sign of lung disease has been found after the initial tests, the test and x-rays are repeated every three years. If any lung problems are found at the time of the initial test, those employees have to undergo a test annually and the occupational nurse will refer the employee to a doctor or specialist for treatment.

Blood pressure is closely monitored and deemed extremely important by HMM and Life Health Services as the symptoms of uncontrolled hypertension include dizziness, headaches, nausea, vision loss, memory loss, stroke, heart attack and renal failure.[34] Any of these symptoms can have serious consequences in a mining setup were heavy vehicles and machinery are used on a daily basis. Hypertension is one of the most common illnesses in the developed countries, but goes largely undetected and is often called the silent killer because sufferers can be asymptomatic for years and then suddenly suffer a fatal heart attack or stroke.[35]

The occupational health nurses at HMM use two types of blood pressure instruments: Aneroid Sphygmomanometer (conventional manual blood pressure measurement) and a Micro-life digital meter (automated blood pressure measurement). Blood pressure is first measured with the Micro-life digital meter as it is quicker and easier to use. If elevated blood pressure is indicated, the occupational nurse will retest the individual's blood pressure with the Aneroid Sphygmomanometer and the second measurement will then be used. If the individual has normal blood pressure when tested initially, that measurement will be used and it would not be retested with the Aneroid Sphygmomanometer.

A Canadian study (2010) that researched the conventional versus the manual automated blood pressure measurements in a primary care setting, found robust evidence for the use of automated blood pressure measurements. Manual blood pressure readings, taken in the primary care setting and taken before participants were enrolled in the Canadian study, were significantly higher than the ambulatory blood pressure readings taken at home (the gold standard for defining blood pressure status).[36] Routine manual, primary care setting, systolic blood pressure readings, also related poorly to the conscious ambulatory, home blood pressure readings. It was found that the replacement of manual blood pressure readings with automated readings almost completely eliminated the difference between the routine manual primary care setting, systolic blood pressure readings and the conscious ambulatory home blood pressure readings.[36]

The occupational health nurses at HMM weighs each employee during their annual medical check-up with a Seca scale that measures weight and height. The scale is calibrated annually by RAM, a reputable service provider. Height is measured once at the start of employment and then carried over every year. BMI values are then calculated by dividing weight in kilograms by the square of the height in meters.[37] The Malnutrition Universal Screening Tool (MUST) (Addendum 2) is used to determine BMI. The MUST tool is divided into five steps and the occupational health nurses at Hotazel clinic only use the BMI Score and BMI chart in step 1 to interpret the score. The other steps are not used as they are not interested in calculating the overall risk of malnutrition. A BMI of less than 18.5 is classified as underweight; 18.5 to 24.9 as normal; 25 to 29.9 as overweight and above 30 as obese.[38]

If the occupational nurse found an employee developed hypertension since his last test, thus having a blood pressure reading of 150 mm HG/100 mm HG or higher as set by the Life Practice doctor, the nurse will place him under restriction by declaring him unfit to work (depending on his job title) and refer him to the doctor. This individual has to return weekly for blood pressure tests until his blood pressure is under control (diastolic blood pressure <100). Thereafter, he needs to return for monthly blood pressure tests for the duration of his employment at HMM. The restriction will only be lifted if his doctor or specialist declares him fit to work and the relevant medical problem is under control. The diastolic cut-off of a 100 mm HG was established at the discretion of the Life Practice Doctor. If a lower value was used (such as 80-90 mm HG) a much higher number of workers would have been diagnosed with hypertension, therefore putting pressure on the staff and resources to follow up on each individual.

1.3 BACKGROUND OF THE RESEARCHER

The researcher graduated with a Bachelor of Science in Consumer Sciences: Food and Nutrition at Stellenbosch University (1999-2002) and also obtained a Diploma in Culinary Arts from the Institute of Culinary Arts in Stellenbosch (2003-2005). She immigrated to the United Kingdom in 2005 and has been working as a chef in London for the last ten years with the last four years in new product development for companies such as Fortnum and Mason and Sainsbury's. Growing up in Hotazel town and with both parents working for Hotazel Manganese Mines, the researcher wanted to focus her thesis on a topic that could benefit the employees of Hotazel Manganese Mines.

The planned time period for research was four years with six months dedicated to data collection. Logistically, it was very difficult to live in a different country from where the research took place and this lead to delays in data gathering and impacted on the time it took to complete the research.

1.4 HYPERTENSION: AN OVERVIEW

According to the South African Heart and Stroke Foundation, about one in four South Africans between the ages of 15 and 64 years suffer from hypertension.[12] Hypertension is defined as systolic blood pressure over diastolic blood pressure (SBP/DBP) greater than 140/90. The South African Heart and Stroke Foundation uses the criteria indicated in Table 1.1 to classify blood pressure with a blood pressure of 120/80 mm HG being considered ideal and blood pressure higher than 180/110 mm HG as severely hypertensive.[12]

Table 1.1: Guide to blood pressure levels according to the South African Heart and Stroke Foundation.[12]

Blood pressure classification	Systolic blood pressure (mm HG)/diastolic blood pressure (mm HG)
Normal	120/80 to 129/84
High normal	130/85 to 139/89
Hypertension: Mild	140/90 to 159/99
Hypertension: Moderate	160/100 to 179/109
Hypertension: Severe	>180/110

Most cases of hypertension in young male adults result from an increase in diastolic blood pressure as the heart needs to pump harder mostly due to increased body weight, whereas in the elderly males' hypertension is mostly related to increases in systolic blood pressure due to the stiffening of arteries.[39]

Hypertension can be divided into primary and secondary hypertension. Primary hypertension is not curable and the aetiology cannot be determined but is mostly believed to be multi-factorial, whereas secondary hypertension is curable and normally the cause of another underlying disease. If hypertension is left untreated, it can lead to congestive heart failure, end stage renal disease, peripheral vascular disease and premature death.[40]

1.5 HYPERTENSION: THE RISK FACTORS

Hypertension is a multi-factorial disease and the development can be hard to understand. According to Beevers et al, "the development of hypertension reflects a complex and dynamic interaction between genetic and environmental factors"[41] and that is why, in some primal communities where obesity is rare and salt consumption very low, hypertension is almost unheard of and the risk of developing hypertension also does not increase with age.[41]

For the purpose of this study, the investigator will only look at those individuals who developed high blood pressure after they started to work on the mines, regardless of whether they have suffered from any illness associated with hypertension.

Risk factors for the development of hypertension include the following:

1.5.1 Pre-hypertension

Pre–hypertension is also referred to as high normal or above optimal blood pressure, therefore, (according to the South African Heart and Stroke Foundation) 130/85 mm HG to 139/89 mm HG.[12] In a follow-up study of the Framingham heart study that investigated the association between blood pressure category and the development of cardiovascular disease, it was found that individuals with a high normal blood pressure at baseline was more likely to suffer from a cardiovascular event than those individuals with normal blood pressure.[42] The results indicated that elevated blood pressure was a marker for increased risk of cardiovascular disease, but it did not indicate whether this was solely due to the increase in blood pressure as individuals with high normal blood pressure usually also had other risk factors for cardiovascular disease (like increased age and obesity). Research done for the Framingham heart study indicated that individuals with high normal blood pressure are two to three times more likely to develop hypertension later in life than those with normal blood pressure.[42]

For this study, pre-hypertension was defined according to the classification of the South African Heart Foundation with a systolic pressure of 130-139 mm HG and diastolic pressure as 85-89 mm HG (or both).[12]

1.5.2 Family history of hypertension

Separate genes and genetic factors have been linked with the development of hypertension, but it is difficult to determine the exact contribution of each separate gene. For the development of hypertension in an individual person, multiple genes are more likely to be a contributory factor.[43] A comparison of parents with their monozygotic and dizygotic twin children, and their other and adopted children, suggest that genetic factors are responsible for at least 30% of variations in blood pressure in different populations.[43]

1.5.3 Ethnicity

Individuals from African descent have been found to be more prone to developing hypertension than those from Caucasian descent. Studies in the United States (US) and the United Kingdom reported a higher prevalence and lower awareness of hypertension in black people versus whites.[44] As indicated by data from the American National Health and Nutrition Examination Survey (NHANES), a sample of the civilian US population indicated that at least 33% of blacks have hypertension and that the black ethnicity is an independent predictor of hypertension.[45]

In South Africa, hypertension is a widespread problem and there is a high prevalence in urban areas. It is also frequently under-diagnosed and associated with severe complications. Black South Africans have a stroke mortality rate (one of the consequences of hypertension) twice that of white South Africans.[46] Various contributory factors could explain the difference in mortality rate between black and white South Africans based on genetic and physiological differences.[46] These factors include lower plasma rennin levels (black hypertensives are more likely than white hypertensives to have low plasma rennin levels), higher sodium sensitivity, abnormalities and changes in epithelial sodium channels in blacks, a greater than anticipated rise in systolic blood pressure in blacks for any given body mass due to polymorphism of the promoter region of the angiotensinogen gene, increased peripheral vascular resistance and increased obesity prevalence in blacks.[46,47]

Clinical measurements of blood pressure in the South African National Health and Nutrition Examination Survey (SANHANES-1 2012), indicated that the white and coloured ethnic groups had the highest mean systolic blood pressures (130 mm HG and 132 mm HG respectively) compared to that of blacks (128.1 mm HG) and the same was seen for the diastolic blood pressure of the white (74 mm HG) and coloured (76 mm HG) ethnicities (74 mm HG in Blacks).[47] This finding, of a higher systolic and diastolic blood pressure in white and coloured ethnicities versus the black ethnicities, is contradictory with NHANES[45] and a South African study investigating the role of obesity in the prevalence of hypertension in South African women.[46,47,48]

1.5.4 Excessive salt consumption

The World Health Organisation's (WHO) daily recommended intake for salt is 5 g of salt a day (2000 mg sodium), roughly a teaspoon.[49] Experts in South Africa estimate that some South Africans could have intakes of 40 g or more. Most of the salt ingested is hidden in food products and most individuals are, therefore, not aware of the high salt content of their diet.[50] Commercial products high in sodium and regularly consumed are listed in Table 1.2.[51]

Table 1.2: List of commonly consumed commercial food products high in sodium

Food product	Sodium (mg) content per 100 grams of edible food[52]
Milk	Fresh full cream – 49
Hard cheese i.e. cheddar	Cheddar - 620
Breakfast cereals	All bran flakes - 804; Cornflakes – 1 211
Bread	Bread/rolls brown - 451; Bread/rolls white - 490
Boerewors and other sausages (cooked)	Boerewors (sausages) - 805; Pork (sausages) – 1 294; Droëwors - (dried sausages) 1 141
Processed and cured meats	Polony – 1 019; Ham – 1 365; Salami – 1 860; Bacon – 1 596
Soup powders (average reconstituted with water)	431
Stock cubes/bouillon	Beef - 326; Chicken - 608
Hard brick margarine	1 730
*Aromat53	22 533
Potato chips	1 000
Pretzels54	1 357
Salted popcorn	1 940
Savoury biscuits: Tucs, bacon kips	9 83
Take aways 55,56	KFC (drumsticks and thighs) - 380/850; Burger steers (King Steer, beef) - 1539
Baked beans	397
French fries (cooked)	163

*58 g salt per 100 g aromat[53]
**Table salt contains 38 850 mg sodium per 100 g[52] that is 3 497 mg in one level teaspoon (9 g)[57]

Salt intake has a consistent and direct effect on blood pressure variations. The human body excretes less than one gram of salt per day, less than ten times the current average intake in the industrialised world, [58] thus leading to the conclusion that the chronic exposure to a high salt diet is a major contributing factor in the development of hypertension and other cardiovascular diseases in the human population.[58] This may be due to the kidneys' inability to excrete large amounts of salt.

Epidemiological evidence suggests that there is a clear absence of hypertension in populations that consume less than three grams of dietary salt per day and a clear occurrence of hypertension in populations that consume more than 20 g of dietary salt per day. It is, however, difficult to establish the occurrence of hypertension in populations whose salt intake ranges between three grams and 20 g of dietary salt per day. This may be due to the differences in day-to-day salt intake.[58] It was clear that in populations consuming a salt intake larger than three grams per day, hypertension prevalence rose with age and this occurrence was more distinct when salt intake was higher.[58]

In about 40 tribes from South America, Africa, the Pacific and the Arctic, not exposed to Western society, a daily salt intake of less than three grams per day was recorded. In these tribes blood pressure did not rise with age and this observation was not due to a peaceful existence and a lack of influences and stresses from Western civilisation as some of the tribes studied led a life of chronic warfare and tension like the Yanomamo Indians.[58]

Similarly, civilisations in Northern Kashmir were also unexposed to Western influences of industrialisation, diet and economy but they consumed a diet high in salt mainly due to a custom of adding various amounts of salt to their tea. Mean dietary salt intake in three villages varied between 9.9 g–10.1 g per day with an individual intake ranging between 4–21 g per day per individual. Both diastolic and systolic blood pressure correlated significantly with individual salt intake with an increased blood pressure as salt intake increased Therefore, the main finding was that habitual salt intake controls blood pressure.[58]

Close observation using sophisticated techniques found a weak link between sodium intake and hypertension in the general population. However, some individuals displayed large blood pressure changes with the sodium consumption of meals.[59] Some experts believed that excessive salt consumption will only raise blood pressure in individuals that are salt sensitive, thus suggesting a genetic link in these individuals.[59] But as only ten per cent of the American population are deemed to be salt sensitive, and far more than ten per cent of American adults have hypertension, it is apparent that salt sensitivity cannot be the only factor responsible for increased blood pressure.[60]

1.6 POTENTIAL ROLE OF OTHER NUTRITIONAL FACTORS: MAGNESIUM, POTASSIUM, CALCIUM AND LIPIDS

Potassium, magnesium, calcium and lipids are deemed nutrients beneficial for hypertension management. Table 1.3 shows the recommended dietary intake of the above nutrients.

Table 1.3: Recommended daily dietary allowances of magnesium, potassium, calcium and lipids for males 18 years to <70 years.

Nutrient	Age (years)	Average recommended dietary allowances per day (mg)	Tolerable upper intake level (mg)
Magnesium[61,62,63]	14-18	410	
	19-30	400	***350
	31->50	420	
Potassium[64]	>18	2000	****3700
**Calcium[65,65]	14-18	1300	
	19-50	1000	2500
	>50	1200	
Total Lipids*[66]	> 18	65g (20-35% of total energy intake)	N/A
Total saturated* fat[66]	> 18	20g (10% of total energy intake)	N/A

N/A-Not applicable
*Based on a 2000 kcal diet (9200kJ)
**Adequate intake for calcium set because there is not enough information to set and recommended dietary allowance for calcium[67]
***For supplements only[68]
****Safe upper limit or guidance limit. Not enough evidence to set a tolerable upper intake level[69]

1.6.1 Magnesium

Magnesium may play a role in regulating blood pressure by acting as a vasodilator[70] and could, by reducing inflammation, protect against hypertension-related vascular disease.[71] In a study of 30,000 US male professionals, investigating the different nutritional risk factors and the incidence of high blood pressure, it was found that magnesium on its own had a significant association with lower risk of hypertension after adjusting for age, weight, alcohol consumption and energy consumption.[71] Magnesium-rich foods (Table 1.4)[72] are also mostly rich in potassium and dietary fibre and therefore, it is difficult to determine the independent effect of magnesium on blood pressure.[70,73] However, the Dietary Approaches to Stop Hypertension (DASH) study provides strong evidence that a diet rich in magnesium is a good lifestyle modification for individuals with hypertension and those with pre-hypertension.[74]

Table 1.4: List of food sources rich in magnesium

Food source	Amount of magnesium (mg) per 100g[52]
Bran breakfast cereals	182
Green beans cooked	25
Cucumber	11
Celery	11
Cantaloupe	11
Kale	18
Spinach (cooked)	87
Bell peppers	10
Bran rice (cooked)	43
Wheat	32
Oats (cooked)	40
Dark chocolate	100
Nuts: almonds	286
Brazil	225
Seeds: flax[75]	392
pumpkin	262
sunflower	354

1.6.2 Potassium

The positive effects of potassium on blood pressure were first illustrated in rats (genetically engineered to have high blood pressure) and showed a great reduction in their blood pressure when fed a diet rich in potassium.[76] Further research indicated that the blood pressure lowering effect of potassium in rats were also true in humans. How, exactly, potassium lowers blood pressure still needs to be explained by scientists. It is thought that potassium makes blood vessels less sensitive to hormones that cause blood vessel contractions and, therefore, less contraction leads to less pressure. Another theory suggests that the effects of potassium might be related to vessel relaxation.[71,76] Potassium can be found in a wide range of fruit, vegetables and wholewheat products (Table 1.5).[77,78] The DASH diet is high in fruit and vegetables and some of its blood pressure lowering effects could be contributed to its high potassium content[74,76]

Table 1.5: List of food sources rich in potassium

Food source	Amount of potassium (mg) per 100g of edible food[52]
Dried herbs: chervil[79]	4.7
Basil	3.4
Oregano	0.8-1.9
Coriander	4.4
Dried fruit: apricots	1378
Raisins	751
Prunes	745
Currants	892
Avocado[80]	485
Potatoes (baked skin and flesh)	418
Strawberries	166
Mushrooms	370
Bananas	396
Beans: haricot	1140
Lentils (cooked)	270
Mackerel	194
Sardines in oil (drained solids)	397
Tuna canned in oil (drained solids)	207
Tomatoes	222
Fresh full cream milk	152
Yogurt (low fat fruit)	194
Seeds/nuts	262-392
Turkey (roasted with skin)	280
Beef (regular pan-fried)	332

1.6.3 Calcium

The DASH study indicated that a combination diet that included calcium rich and low-fat dairy products (Table 1.6)[81] had a greater effect of lowering blood pressure than a diet in which only fruit and vegetables were consumed.[74] This indicated that calcium plays a crucial role in lowering blood pressure and several epidemiologic and randomised controlled studies indicated an inverse association between dairy intake and blood pressure.[82] In a cohort of 21 553 Dutch adults, blood pressure was not clearly related to the overall consumption of dairy products. This finding could be contributed to the overall high consumption of dairy products and the effect of dairy intake on blood pressure may therefore be more pronounced in individuals with low habitual dairy intake.[83] The way in which dairy products lowers blood pressure still needs to be explained, but it is thought that calcium, magnesium and potassium play a role with the anti-hypertensive peptides that are formed during the digestion of milk proteins.[82, 83]

Table 1.6: List of food sources rich in calcium

Food source	Amount of calcium (mg) in 100g of edible food[52]
Milk and all milk products:	119
Cheese: cheddar	721
Yogurt	152
Broccoli (raw)	48
Cabbage (raw)	47
Celery(raw)	23
Beans: haricot (uncooked)	155
Peas/petit pois (fresh frozen cooked)	22
Soy products (beans dried cooked)	102
Fortified cereals[84]	457

1.6.4 Lipids

The recommended total fat intake of adults is 20-35% of total energy intake with total saturated fat intake not exceeding more than ten percent of overall energy intake.[66]

The occurrence of certain lipids in the blood stream may contribute to high blood pressure. These lipids include cholesterol, triglycerides and fatty acids. When cholesterol builds up in the arteries, it restricts blood flow, which increases blood pressure. Unused calories are converted into triglycerides[85] and a high number of triglycerides in the blood stream can cause the hardening of the arteries, leading to reduced elasticity. The heart then needs to work much harder to pump the blood, which in turn raises blood pressure.[86] Fatty acids consist of a lipid bound to an alcohol group.

There are two types of fatty acids: saturated and unsaturated. Saturated fatty acids, as found in animal products like meat and dairy products, increase the build-up of cholesterol in the bloodstream, whereas unsaturated fatty acids like omega-3 found in nuts and vegetable oils may help to lower blood pressure.[74,85,86]

In a two-year follow-up study, fruit and vegetable intake were inversely associated with saturated fat intake. When the effect of low fat dairy products versus whole fat dairy products was assessed, the results indicated a 54% reduction in the incidence of hypertension in participants who consumed lower fat dairy products.[87] This may indicate that less dietary fat could be beneficial to hypertension reduction. A review of dietary advice to reduce cardiovascular risk indicated that where reduced fat intake (total and saturated fatty acids) was advised, there was a reduction in diastolic and systolic blood pressure.[88] Although saturated fat reduction is advised for the lowering of hypertension, the Omniheart study looked at three different diets that was, like the DASH diet, lower in saturated fat and high in fruit, vegetable, fibre and minerals.[89] All diets lowered systolic blood pressure, but the diet with increased unsaturated fat predominately monounsaturated fats lowered blood pressure even more.[89]

1.7 LIFESTYLE-RELATED RISK FACTORS

Individuals with continuous high blood pressure levels are at risk of developing cardiovascular diseases such as strokes, heart attacks and aneurysms. The development of hypertension and the link with cardiovascular disease relies on a variety of factors and most possibly include both physiological/genetic and environmental components.[42] For the purpose of this study, the investigator investigated those individuals who developed high blood pressure after they started to work on the mines, regardless of whether they have suffered from any illness associated with hypertension. The following lifestyle-related risk factors will be discussed: obesity and BMI, alcohol consumption, physical activity, smoking, stress and age.

1.7.1 Obesity and BMI

Consuming more calories than physiological needs, physical inactivity, genetics and family history, certain medication, health conditions, emotional factors, smoking, age, pregnancy and lack of sleep has been identified as risk factors for obesity.[90] To prevent obesity, the recommended energy intake for moderately active men is 2 500 calories (10 500 kJ) (Table 1.7).[91] Less than seven per cent of the total calorie intake should come from saturated fat and less than one per cent from trans fats.[92] It is also recommended that cholesterol intake should be limited to less than 300 mg per day.[92]

Table 1.7: Recommended daily energy intake (in kilojoules) for males 14 years and over and for different levels of physical activity.

	Level of Activity		
Age (years)	**Sedentary (kcal)**	**Moderate (kcal)**	**Active (kcal)**
14-18	9 240 (2 200)	10 080–11 760 (2 400–2 800)	11 760–13 440 (2 800–3 200)
19-30	10 080 (2 400)	10 920–11 760 (2 600–2 800)	12 600 (3 000)
31-50	9 240 (2 200)	10 080–10 920 (2 400–2 600)	11 760–12 600 (2 800–3 000)
>50	8 400 (2 000)	9 240–10 080 (2 200–2 400)	10 080–11 760 (2 400–2 800)

*1 calorie =4.2 kJ[93]

Obesity is associated with an increased risk of hypertension and diabetes.[94,95] A direct link between BMI and hypertension across a range of BMI levels (normal to slightly overweight and obese) was found.[77] A body mass index of 27 and greater and excess abdominal fat with a waist circumference of more than 86 cm in women and 99 cm in men, is both associated with an increase in the risk for developing hypertension.[43] In a prospective cohort study of 13 563 healthy non-hypertensive male individuals, 4 920 developed hypertension after a median of 14.5 years with an increase in baseline BMI even in the "normal" BMI range.[96]

1.7.2 High alcohol consumption

The South African department of Health advises the sensible consumption of alcohol. Therefore, no more than three standard drinks (Table 1.8) for men per day and two standard drinks for women is recommended.[97]

Table 1.8: The South African Department of Health's guide to a standard drink

Type of drink	Quantity of a standard drink	Approximate number of units per standard drink [9,99,100]
Beer (4.5% alcohol)	1 can/340 ml	1.3-1.7
Spirit	1 tot/25 ml	1
Dry red wine (14% alcohol)	1 glass/175 ml	2.3
Dry white 12 % alcohol	1 glass/125 ml	1.4
Fortified wine 17.5- 20% alcohol	1 small glass/50 ml	0.9-1

Alcohol provides seven calories per gram of alcohol/ethanol and can contribute to weight gain.[101] Table 1.9 shows the calorie content of popular alcoholic drinks.

Table 1.9: Popular alcoholic drinks and their energy intake in kilojoules (kJ) and calories (kcal)[101,102]

Drink	Kilojoules (kJ)*	Calorie (kcal)
175 ml of 12% wine	530	126
568 ml 5% strength beer	903	215
50 ml 17% cream liqueur	496	118
50 ml fortified wine	273	65

*4.2 kj in 1 calorie[93]

Alcohol can possibly affect blood pressure by stimulating the production of the adrenocorticoid hormone.[42] Studies where individuals' blood pressure were measured and they were questioned about their drinking habits, indicated that alcohol consumption might influence blood pressure. However, as hypertension is a multi-factorial disease, establishing a causal link between alcohol and blood pressure is very difficult due to confounding factors.[103] Chen et al used "Mendelian randomisation" (a method used in epidemiological studies) of using measured variation in genes of known function to examine the causal effect of a modifiable exposure on a disease in non-experimental studies.[103] This design has a strong control for reverse causation and confounding to get past the hurdle of confounding by using the inactive variant of aldehyde dehydrogenase 2 (ALDH2).[103] People who inherited the variant of this gene from both parents had an ALDH2 *2*2 genotype, making them flushed and nauseated when they ingest alcohol. As this variant is inherited from the parents, confounding cannot play a role. Findings indicated that men with genotype *1*1 (highest alcohol intake) and those with genotype *1*2 (moderate alcohol intake) were 2.42 and 1.72 times more likely, respectively, to have hypertension than those with genotype *2*2. No effect was found between ALDH2 variant and hypertension in women.[103, 104]

1.7.3 Physical activity

Dietary modification is essential in managing hypertension but without regular exercise the benefits might be brief.[105] The South African guidelines for healthy eating also advise at least 30-45 minutes of physical activity each day.[97] Physical activity does not necessary mean joining the gym but could include simple activities like doing housework, mowing the lawn and taking the stairs instead of the elevator.[97] Exercise increases blood pressure acutely, but individuals who undertake regular exercise are normally found to have lower blood pressure than those individuals who do not exercise regularly. This may be because individuals who exercise normally follow a healthier lifestyle, i.e. smoke less and eat healthier.[43] In contrast to the previous statement it was also found that individuals who exercised regularly had lower blood pressure, regardless of their BMI.[105] This might be due to regular exercise's positive effect on the sympathetic nervous system, inflammatory indicators and lipid profile, therefore, improving endothelial function.[105] Observational studies have shown that the occurrence of a heart attack and stroke may be reduced by regular physical activity. An inverse association between systolic and diastolic blood pressure and physical activity was found in the British Regional Heart Study.[42]

1.7.4 Smoking

The seventh report (2003) of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension from the US Department of Health and Human Services, stated that smoking should be ceased to improve overall cardiovascular health.[107] Smoking is a major risk factor for cardiovascular disease and is linked with the increase in ankle-to-arm systolic blood pressure, which in turn is a major indicator for peripheral atherosclerosis[106] (hardening and narrowing of arteries).[107]

1.7.5 Stress

Most research focused on the effect of psychosocial stress on blood pressure but in almost all cases, other stressors like poverty, unemployment and poor education along with lifestyle risk factors for hypertension like obesity, high salt intake and physical inactivity were found.[42] Studies have found a small link between environmental stress and hypertension, but due to confounding factors such as other stressors and lifestyle, no causal link could be established.[42]

1.7.6 Age

The age-related increases of SBP are responsible for both the incidence and prevalence of hypertension, which increases significantly with age. In the US almost half of the persons aged 60–69 years were diagnosed with hypertension and in over three-quarters of persons older than 70 years.[44] A South African study indicated high hypertension numbers among adults fifty years and older, with the prevalence of hypertension 77.3% (74.4% for men and 79.6% for women).[108] Results from the 1998 Demographic and Health Survey indicated a significant increase in systolic blood pressure in men and women with increased age and diastolic blood pressure also increased until the ages of 35-44 years, after which it declined slightly.[109] A study (2012) on gold miners in South African gold mines indicated an increase in the prevalence of hypertension with increased age from 16% in 18–29 year-olds to 83% in the 60–69 year age group (also see 1.8 below).[110]

1.8 PREVALENCE OF HYPERTENSION OF EMPLOYEES IN THE SOUTH AFRICAN MINING INDUSTRY

In a study (2003) performed for the Council for Scientific and Industrial Research (CSIR)—mining technology, the impact of housing and nutrition on the occupational health and safety of employees were reported.[111] A correlation was found between nutrition and occupational diseases and while hypertension was discussed, it was in relation to the prevalence of hypertension in modern African populations versus African populations a generation ago.[111] The study also focussed on the black employees of the mines, evaluating the nutritional intake of those living in hostels versus those not living in the hostels. Ten mines representative of all the commodities in the South African Mining industry were selected as the sample for the study.[111] The study gives valuable insight into nutrition and occupational health in a mine setting, but does not answer the question of hypertension and the risk factors relating to diet and lifestyle.

In another study (2012) on hypertension in gold miners at the Gauteng Harmony Goldmine operations, the study sample was drawn from individuals who attended Harmony health centres. The prevalence of hypertension was 39.5% (N=1696) with 40.5% in males and 30% in females.[110] A large number of the participants were found to be black, middle-aged men and women. This study focused on pharmacological blood pressure control and did not examine non-pharmacological blood pressure controls like lifestyle interventions.[110]

1.9 MOTIVATION FOR THE CURRENT STUDY

The health services for HMM are run by the Life Occupational Health Group. Through the annual medical examinations required by the OHSAct, health staff made the observation from the annual blood pressure recordings that there was an increase in the number of male employees diagnosed with hypertension. Symptoms of hypertension include headaches, drowsiness, confusion and visual disturbance, thus making it extremely dangerous for such employees doing these high-risk jobs. Except for the obvious safety risks, a great deal of revenue is lost each year through employee absenteeism due to illnesses, which could possibly be prevented with the right guidance and information.

HMM is situated in the Northern Cape province of South Africa well known for its cattle farming industry. A large number of employees grew up in the area. The population is largely white (Afrikaans) and black (Tswana) with a much smaller coloured and Indian community. Apart from the increased energy requirements, there are other factors that also cause a concern about the habitual diet of this population group. Individuals living in Hotazel tend to consume large amounts of red meat as it is readily available at a reasonable price. In contrast, due to the remoteness of the mines and towns servicing the mines, fresh fruit and vegetables are expensive and not readily available.

The staple foods for the white population consist mainly of starch (potatoes and white rice) and red meat— the so called “Boerekos” (preferred food of farmers), while maize porridge is the staple of the black community. The mining environment is highly stressful as constant production targets need to be met with tight deadlines. Social gatherings for the employees are held on a frequent basis and are normally in the form of a barbeque where alcohol is served.

The motivation for this study was to determine whether nutrition and lifestyle are risk factors for the perceived high prevalence of hypertension among the mineworkers. For the purpose of this study, the researcher will investigate those risk factors relating to diet (excessive salt consumption, potassium, magnesium, calcium, lipids, overall unhealthy diet and alcohol consumption) and also those relating to lifestyle (physical inactivity, stress, smoking, obesity (high BMI >25).

In addition, findings of the study will provide the employees with information. Life Health Services will also be able to use the findings to provide support on how to live and eat more healthily to the employees of HMM.

1.10 CONCEPTUAL FRAMEWORK OF METHODOLOGY

The conceptual framework (Figure 1.1) outlines the methods used to determine if there is a difference in risk factors between the hypertensive cases and normotensive controls. From the cohort of HMM employees, certain inclusion and exclusion criteria were used to obtain the study sample. The exclusion and inclusion criteria were selected by taking the aims of the study and the structure of the sample population into account (Refer to section 2.4).

Using historical medical data, the sample population was investigated since the start of their employment at HMM. The investigator administered questionnaires relating to risk factors for the development of hypertension: diet, physical activity, stress and demographic influences (the study outcomes). The sample population was divided into cases (those who developed hypertension after employment at the mine) and controls (those who did not develop hypertension) and the outcomes of the cases and controls were compared. This will enable the investigator to formulate preventative strategies, taking the difference in risk factors between the cases and controls into account in order to prevent the possible development of hypertension in individuals that were previously hypertension free.

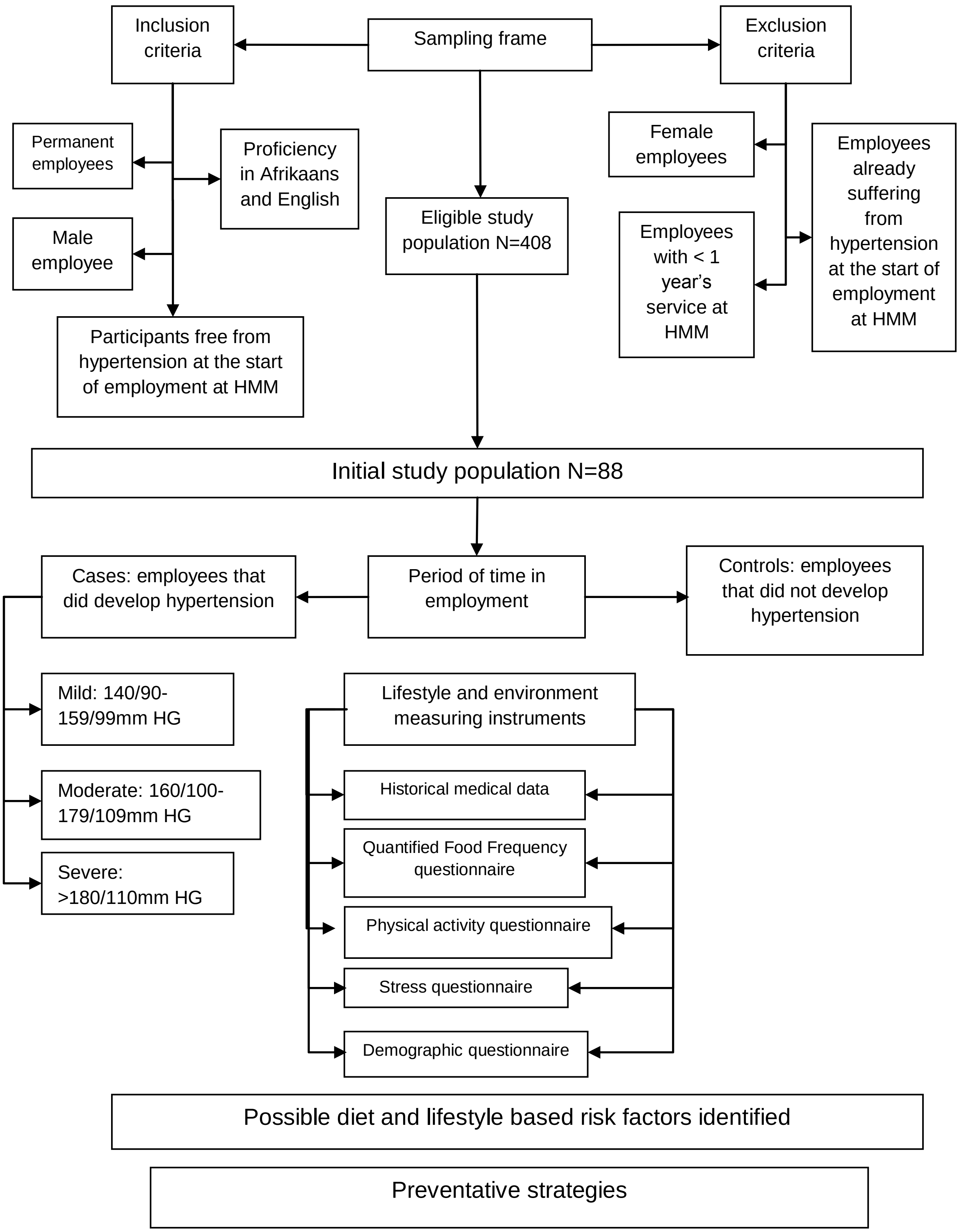


Figure 1.1: Conceptual framework of the study methodology including measuring instruments of the risk factors associated with hypertension

1.11 IMPACT OF FINDINGS

Staff of Life Occupational Healthcare currently provides guidance and information to those workers already suffering from hypertension, but no preventative strategies are in place. Assessing the risk factors will provide valuable knowledge and will assist Life Health Services in the planning and implementation of possible prevention strategies for hypertension and hypertension-related illnesses. Ultimately, these preventative measures could be included in the company's health and safety measures to ensure the well-being of each employee. The investigator aimed to provide recommendations for the staff of Life Health Services in order to provide support to all employees of Hotazel Manganese Mines regarding healthy eating (based on the principles of the DASH diet) and a healthy lifestyle.

CHAPTER 2: METHODOLOGY

2.1 AIMS AND OBJECTIVES

The main aim of this study was to investigate possible contributing risk factors related to diet and lifestyle that might cause hypertension in male employees of Hotazel Manganese Mines. The primary and secondary objectives of this study are discussed below.

2.1.1 Primary objectives

The primary objectives of this study were:

- To determine the incidence and classification of hypertension in employees after being employed for more than 12 months.
- To determine the average time for developing hypertension in employees who previously had normal blood pressure.
- To determine the possible risk factors associated with development of hypertension with the focus on nutrition and lifestyle:
    - BMI at the start of employment at HMM
    - Change in BMI since the start of employment at HMM
    - Level of activity
    - Level of work-related stress
    - Energy consumption
- To determine the consumption of saturated fat, magnesium, potassium, calcium, sodium and alcohol.
- To compare the results of Mamatwan and Wessels mines and Hotazel town to determine if the incidence of hypertension is more prominent at one or the other and linking possible reasons to the phenomenon.
- To determine if individuals that added extra salt to their food developed hypertension versus those who did not.
- To determine if there was a difference in the results of those individuals who regularly used nutritional supplements versus those who did not.

2.1.2 Secondary objectives

The secondary objectives of this study were:

- To determine if there was a difference in the incidence of hypertension between different job positions and employment duration.

- To compile a set of recommendations to help prevent the development of hypertension in employees of HMM.

2.2 HYPOTHESIS

The following null-hypotheses were tested statistically:

1. There is no significant difference in the incidence and classification of hypertension in male employees of the different Hotazel Manganese Mines.
2. There is no significant difference between the hypertensive case and normotensive control groups regarding diet, lifestyle, period of employment, job positions.
3. There is no significant difference between individuals who added extra salt to their meals and those who did not in terms of the incidence of hypertension.
4. There is no significant difference between individuals who took additional nutritional supplements and those who did not in terms of the incidence of hypertension.

2.3 STUDY PLAN

2.3.1 Study design

An analytical unmatched case control study design was used. Case control studies "provide evidence of strong associations between disease (hypertension) and risk factors (diet, lifestyle)".[112] An eligible cohort of male employees of HMM without hypertension at the start of employment qualified for participation in the study. The sample turned out to be much smaller than originally anticipated and therefore, the study was changed from matched (as originally planned) to an unmatched case control study (see section 2.3.3 sample selection).

All new employees at HMM undergo a health check before they start employment at HMM. By using this historical data, the investigator aimed to determine which of the participants were free of hypertension before they started working at HMM. As dictated by law, all employees must also undergo a yearly health check where blood pressure is measured and BMI calculated and logged in each patient's medical file. Medical files were checked for all employees before applying the selection criteria, to determine whether they were hypertension free at the start of employment. Only employees who were hypertension free at the time of employment could be selected for participation. The hypertensive cases were those in the study population that developed hypertension after a period of time in employment at HMM whilst the normotensive controls were those who did not develop hypertension.

2.3.2 Study participants

The sampling frame consisted of all permanent employees of HMM. There were 1 076 permanent employees working at HMM (including Mamatwan and Wessels Mines situated just outside of Hotazel town and HMM offices in Hotazel town) at the time of the study. Participants were resident in one of the hostels in Hotazel town or in one of the nearby towns (Kuruman or Kathu). The participants consisted of male and female employees and the main languages of communication were Afrikaans and English. Employees must hold at least a National Senior Certificate but educational levels vary depending on the type of position. Wessels and Mamatwan mines tended to have a higher percentage of employees with the basic educational level due to the nature of the jobs on these mines—performing manual labour. Hotazel offices, on the other hand, tended to have a larger percentage of employees educated to diploma or degree level, as most of the administrative jobs were based here (such as information technology, accounting and human resources).

2.3.3 Sample selection

A list of all employees were provided by the Human Resources Department of HMM offices in Hotazel town on 3 March 2012 and the sampling frame consisted of all permanent employees (n=1 076). Table 2.1 shows the gender distribution on each of the mines. After excluding all the females (see exclusion criteria), 927 males remained.

Table 2.1: Gender distribution of employees (n=1076) at three different mines of Hotazel Manganese Mines

Place of work	Female	Male	Total
Hotazel town	59	83	**142**
Mamatwan mine(including sinter)	39	309	**348**
Wessels mine	51	535	**586**
Total	**149**	**927**	**1 076**

The duration of employment of all the male employees at HMM is shown in Table 2.2. After all employees with less than one year employment were excluded, 804 male employees remained eligible for participation in the study.

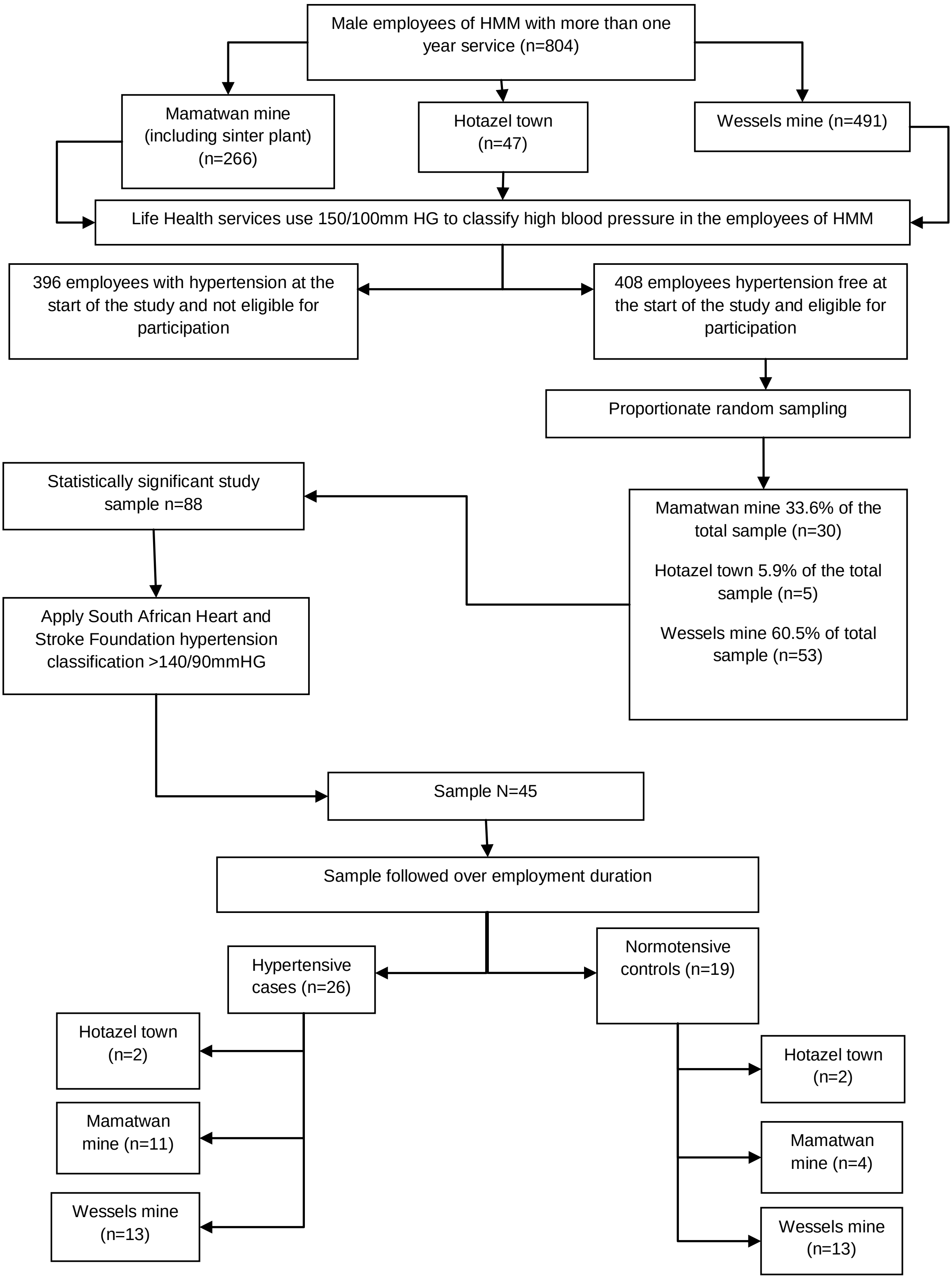
Table 2.2: Male employees (n=927) of Hotazel Manganese Mines and the number of years' service

Place of work	Less than one year service	One year and more service	Total
Hotazel town	36	47	**83**
Mamatwan mine (including sinter)	43	266	**309**
Wessels mine	44	491	**535**
Total male employees	**123**	**804**	**927**

The investigator supplied a list of the 804 male employees to staff at the Life Health Clinic who, in turn, indicated that 396 already suffered from hypertension or hypertension-related disease or had no available blood pressure measurement at the start of employment. They were, therefore, excluded from the study, leaving 408 employees from which the study sample was drawn.

2.3.4 Sample size

The original number of participants needed in order to have statistically significant results (N=88) was selected from the sample population. However, due to the way the nurses at Life Health Services gave preference to the diastolic blood pressure reading when classifying hypertension (see section 1.2) the initial sample drawn was skewed. The investigator therefore reclassified the sample (N=88) using the South African Heart and Stroke Foundation's classification for hypertension. After the reclassification only 45 of the original sample drawn did not have hypertension when they started working at HMM. This came to light after all the data was collected and it was not possible at the time to select more participants and do further data gathering. Table 2.3 explains the process followed by the researcher to select the original sample of N=88 and thereafter the process followed to obtain the final sample of N=45.



* Detailed explanation of sampling for Wessels mine is explained in the text.

Figure 2.1: Flow diagram of the process followed to select the sample N=45

Initially, the selection of participants was drawn by using the "RAND ()" Excel function at Mamatwan mine and Hotazel town for the original sample of N=88. In the case of Wessels mine this selection method could no longer be used and participants were therefore randomly selected from the original list of 408 (using the cut-offs of Life Health Services) and according to availability. This was due to a large percentage of the individuals selected who could not attend during the time allocated by the investigator, due to the structure of the mine and the specific jobs they performed. Also at the time of data gathering, representatives of South Africa's Department of Minerals and Resources were visiting Wessels mine, which further contributed to the mine manager of Wessels mine not being able to release the original Wessels sample drawn to be interviewed by the investigators. The Heart and Stroke Foundation classification was applied (after exclusion criteria were applied) to the sample of N=88, leaving a total sample of 45 participants. Those individuals who developed hypertension after they started working at HMM are called the hypertensive cases (n=26) and those who did not develop hypertension, the normotensive controls (n=19).

Using a total sample size of 45 and a confidence interval of 95% for estimating an unknown proportion, showed an error percentage of 14.5. With a total sample size of only 45 and with 90% power, a power analysis for two groups for analysis of variance with 5% significance, detected an effect size of 0.75 for the cases and 0.6 for the controls (combined effect size of 0.67). Effect size is "the standardised magnitude of differences between two groups", thus how much of a difference exist between two variables or groups. Cohen classified effect size into three groups; small (d=0.2), medium (d=0.5) and large (d≥0.8).[113] When setting sample sizes, the intention is to set these such that one can distinguish the smallest possible effect size with 90% power at a significance of 5%. The larger the sample size, the smaller the effect size that can be distinguished. This means that, according to Cohen, effect sizes of a medium magnitude can be distinguished in this study.

2.4 INCLUSION AND EXCLUSION CRITERIA

2.4.1 Inclusion criteria

- All permanent male employees were eligible for participation in the study regardless of race and social status.
- Participants should have been free from hypertension (BP <140/90 mm HG) before they took up employment at Hotazel Manganese Mines.
- Participants must have been able to read, write and understand English or Afrikaans as these were indicated by the HMM employee list as the main

languages used. English or Afrikaans was also the languages used in the questionnaires to be completed in this study.

- Participants must have provided written, informed consent.

2.4.2 Exclusion criteria

- Female employees were excluded as they only contributed to 14% of the permanent work force, mostly did office jobs and the occupational health nurses only noticed an increase in blood pressure in male employees.
- All permanent employees who had less than one year's service at HMM.
- All employees who already suffered from hypertension at the start of their employment at HMM.
- All permanent employees whose blood pressure was not taken at the start of employment.
- All employees suffering from hypertension-related diseases e.g. diabetes, heart disease, stroke, aneurisms, kidney disease and tachycardia.

2.5 METHODS OF DATA COLLECTION

2.5.1 Approval from the mining company

Approval was obtained from BHPB head office through the Superintendent for Health and Safety (BHPB) in charge of the health services of HMM. The researcher also supplied a letter from the Life Occupational Doctor at the time, explaining the perceived incidence of hypertension and the need for an investigation. Further written approval (Addendum 3) was obtained through email (the researcher resides in the UK) from the General Manager of HMM at the time of commencement of the study. Written approval had to be obtained again thereafter from the acting General Manager due to a change in management. The written approval entitled the researcher and research assistant to use the facilities on each mine and to obtain the relevant information from Life Occupational Health group as well as the human resources department of Hotazel Manganese Mines. After the written approval was obtained, the researcher also emailed each mine manager of her intention to gather data and to establish which dates would be convenient for both the researcher and the mine managers. The dates that were agreed upon with each mine manager are shown in Table 2.3.

Table 2.3: Time schedule for data gathering on each of the Hotazel Manganese Mines

Period of data gathering	Mine
March 2012	Pilot
March 2012	Hotazel
March 2012	Mamatwan
25 July - 3 August 2012	Wessels

Data was collected in two stages: Collecting medical data and completing a set of questionnaires. First, the relevant medical data was extracted from the existing medical data collected by the occupational nurses of Life Occupational Health group on an ongoing basis. A research assistant, a qualified occupational nurse, captured the relevant data as it was made available to her over several weeks prior to the commencement of the study. The researcher used the extracted data to determine which employees where hypertension free at the start of employment at Hotazel Manganese Mines and therefore, eligible for participation in the study. The researcher could then draw the sample needed for statistically significant results and supply a list of the employees selected to the mine managers of each mine before data gathering started. Before the commencement of the second part of the study, informed consent was obtained from each individual as described in 2.11 (Addendum 4).

The following instruments (described in detail under 2.6) were used to gather data on blood pressure, BMI, demographic parameters, nutrition, physical activity and stress levels:

- Historical medical data
- Quantified Food Frequency Questionnaire (QFFQ)(Addendum 5)
- International Physical Activity Questionnaire (Addendum 6)
- Work-related Stress Questionnaire (Addendum 7)
- Demographic questionnaire (Addendum 8)

All the questionnaires were completed in the same session and during working hours (7am to 4pm), to enhance participant compliance. After completion, all questionnaires were checked for completeness by the investigator and research assistant and filed until data capturing was performed.

The clinics on each mine could not be used for the data gathering as originally planned. The interview locations had to be easily accessible for the employees, quiet and large enough for the researcher and research assistant to fill out questionnaires simultaneously, without interrupting or disturbing one another. The interview locations also had to have desk space for the employees to complete the self-administered questionnaires. The Life Occupational Health nurses consulted patients during the day and no quiet space was available to the investigators to use in the clinics. Various locations were therefore arranged with the management of each mine, according to the availability of a suitable venue, which also suited the relevant participants best.

The International Physical Activity Questionnaire (Addendum 6), Work Related Stress Questionnaire (Addendum 7) and demographic questionnaire (Addendums 8) took between ten and 20 minutes each to complete and were, as far as possible, self-administered. The researcher or research assistant read through the self-administered questionnaires with each participant in their language of choice (Afrikaans or English). Thereafter, any questions they might have had were answered and queries clarified. Each participant was then left to complete the questionnaire on their own. Some participants found the questionnaires difficult to understand and in these cases the investigator or research assistant facilitated filling in the questionnaire using simple language, more readily understood by the participant without influencing the participant in any way. Using historical medical data and data gathered from the diet and lifestyle-based questionnaires, the investigator determined the variables or risk factors present in the hypertensive cases versus the normotensive controls.

2.6 TYPES OF INSTRUMENTS USED FOR DATA COLLECTION

2.6.1 Historical medical data

The investigator supplied the research assistant with a list of employees selected for the study sample after all exclusion criteria have been applied and after randomisation. The medical files of all employees are kept at the Occupational Health Clinic at Hotazel. The research assistant extracted the selected files and recorded each participant's blood pressure level from the start of their employment and for each year of employment. Due to the annual medical examinations, each medical file contained the blood pressure measurement and a BMI value for each year of service. Data was recorded by the research assistant not on the original data capture sheet, but on an Excel spreadsheet to support statistical analysis and to determine the incidence of hypertension in employees, the average time it took to develop hypertension, the level of hypertension of each participant and a possible increase in BMI after being employed by HMM. Where systolic and diastolic blood pressure fell into two different categories (normal or hypertensive), the abnormal (hypertensive) category was used to classify the patient's blood pressure.

2.6.2 Demographic questionnaire

The demographic questionnaire contained closed-ended questions on each participant's age, marital status, place of living, qualifications, job description, level of responsibility and years of employment at HMM (Addendum 8). Participants were able to complete this questionnaire in either Afrikaans or English. This data was used to determine if there was a difference in results between the above-mentioned demographic bands, as set out in the aims.

2.6.3 Quantified Food Frequency Questionnaire (QFFQ)

A QFFQ was used to determine the usual daily dietary intake of each participant.[115] This type of questionnaire determines the frequency of consumption of a food item or food group during a particular time period and gives qualitative descriptive information regarding the typical food intake patterns.[114] “Food frequency questionnaires are the method of choice of epidemiologists to determine the interrelationship between nutrient intakes of individuals and other indices of health status or disease measured in the same person.”[114]

Participants were asked to reflect on the food and drinks they most frequently consumed in the past six months. The most frequently consumed foods and the usual portion sizes were recorded on the QFFQ recording sheet (Addendum 5). The QFFQ was administered in Afrikaans or English by the researcher or research assistant to each individual participant in a one-to-one interview at each participant’s place of work and took 60-90 minutes to complete. A systematic approach (detailed below) was followed by the researcher and research assistant to obtain the dietary intake of each participant (Addendum 9).

Step 1:

To assist the participants in indicating, as closely as possible, the correct foods eaten over the past six months, the investigator used food flash cards of The Dietary Assessment and Education Kit (DEAK).[114] The DEAK was developed by the Unit for Chronic Diseases and Lifestyle at the Medical Research Council (MRC) to assist with valid and reliable dietary assessments. The guide includes food flash cards for food frequency assessments and education purposes; the food photo manual that includes food photographs for the identification of food items and master copies of examples of the QFFQ.[115]

The researcher and research assistant used the food flash cards and the food photo manual and asked the participants to make two piles: one with the food and drink items they consumed during the past six months and another pile for those they did not consume at all. The unconsumed pile was then removed. The participants were then ask to make a further two piles, one with the food and drink items they consumed regularly during the past six months (every day, once a week) and those that they consumed less often during the past six months (once a fortnight, once a month, once every three months or once in the last six months).

Step 2:

The researcher and research assistant then started with the first pile of regularly-consumed items and systematically worked through each card asking the participant how much of the item was consumed and captured the data in column D of the QFFQ. Information about the frequency of consumption was captured in columns E and F of the QFFQ. Column D of the QFFQ was used to add extra information about the food or drink item, for example the type of tea consumed or if skimmed, full-fat or semi-skimmed milk was used. To quantify the amounts consumed the researcher and research assistant used the food quantities manual and the food photo manual to show the participants an example of a regular portion size for a specific item.[57, 115]

The researcher and research assistant also had visual aids (teaspoons; dessertspoons; cups in sizes 125ml and 500ml; small, medium and large bowls; and match boxes) at hand to quantify the portion sizes. By quantifying the portion size of the food item consumed, it is possible to calculate energy and nutrients and obtain information on the habitual dietary intake of an individual.[57, 114,115]

Step 3:

The same method as in step two was repeated for the less frequently-consumed food and drink items and the data captured in column G of the QFFQ.

Step 4:

Lastly, each participant was asked about their extra salt consumption, nutritional supplement consumption and how much they smoked. Selected aspects of the DASH diet were included[116] to make it more applicable to factors related to hypertension, such as questions on additional salt intake, consumption of nutritional supplements available to HMM employees, and smoking. Supplement intake from the "Back to Basics" range provide by the mine to the employees, was recorded and quantified.

2.6.4 International Physical Activity Questionnaire

The short version of the International Physical Activity Questionnaire (IPAQ) was used to assess physical activity (Addendum 6) and consisted of a set of seven closed-ended questions. The IPAQ was translated into Afrikaans by the investigator using the translation guidelines on the IPAQ website.[11, 118]

Due to time and financial constraints, the questionnaire was translated into Afrikaans only once and then translated back into English to compare with the original English version.

The IPAQ included questions on the days during a week each participant undertook vigorous and moderate exercise and the amount of time during each day they spend doing these, including activities at work. It also included questions on days during the week they walked for more than 10 minutes and the total amount of time they spend walking. The last question asked about the time spent sitting on a weekday.

2.6.5 International Stress Management Association United Kingdom (ISMA^{UK}) stress questionnaire

A questionnaire of the ISMA^{UK} was used to assess stress in the participants (Addendum 7). No specific stress test for South Africa could be found and the ISMA^{UK} is the world's largest stress management organisation (with one member in South Africa) and was, therefore, used to calculate the likelihood of stress in the participants.[119] The ISMA^{UK} is a registered charity and the lead professional body for stress management, well-being and performance in the UK and a branch of the parent organisation—ISMA^{USA}. ISMA, as a company, promotes sound knowledge and best practice in preventing and reducing stress in the workplace.[120]

ISMA was developed in 1973 by Edmund Jacobsen, MD. PHD, alongside F.J McGuigan and Professor Marigold Edwards in the Unites States as the Association for the Advancement of Tension Control.[120] They modelled the title on the American Association for the Advancement of Science and the association was an interdisciplinary endeavour including fields of dentistry, education, medicine, physical therapy, psychology and speech pathology. ISMA underwent many changes as the International Stress and Tension Control Association and then finally to the International Stress Management Association.[120]

The questionnaire consisted of 20 closed-ended questions. It was changed from just two answers (yes and no) to five different answers: not at all, rarely, sometimes, often and very often. This was done to get a clearer picture on the indication of stress at the work place as just a yes or no option did not include those participants that "sometimes" felt stressed. No was represented by "not at all" and yes with "very often".

Completing the work-related stress questionnaire involved circling one answer from a possible five answers. Each participant was also given a stress score by assigning a point for each "very often" answer. This questionnaire does not diagnose stress in individuals but gives a mere indication of how each individual relates to stress. The questionnaire was translated into Afrikaans by the researcher, translated back into English (Addendum 7) and compared with the original English version.

2.7 VALIDITY AND RELIABILITY OF THE QUESTIONNAIRES

2.7.1 Quantified Food Frequency Questionnaire

2.7.1.1 Content validity

Nel and Steyn used raw data of existing dietary databases from the following studies undertaken from 1983 to 2000 to develop and validate the QFFQ used in this study (Lebowa study, Dikhale study, Black Risk Factor Study (BRISK), Coronary Risk Factor Study (Coris), Transition, Health and Urbanisation in South Africa (THUSA), Weight and Risk Factor Study (WRSF) and the First-Year Female Student Project).[121]Before the development of this QFFQ, there was no nationwide survey of the dietary intake of South African adults.[12] The QFFQ was used by Stadler in a similar setting in 2006[122] with 62% black participants and has been compiled from a range of studies—some of which had only black participants (Lebowa study, BRISK, Dikhale).[121] The QFFQ was also used in the Prospective Urban Rural Epidemiology (PURE) Study investigating the association of different dietary fatty acids with blood lipids in healthy South African men and women.[123] This ensured content validity for use for white and black participants in South Africa.

2.7.1.2 Face validity

Face validity for the QFFQ used in this study was tested during the pilot study. Participants understood the content and purpose of the questionnaire and its purpose. The content of the questionnaire was kept the same after the pilot study. However, the font size of the questionnaire was changed to make it easier and quicker for the researcher to complete.

2.7.1.3 Reliability

The researcher and research assistant was the only people to administer the QFFQ and this helped to ensure reliability. They used a standard set of sketches, food flash cards[115] and the food quantities manual[57] to determine portion sizes and followed a systematic approach in obtaining each participants dietary intake.

2.7.2 International Physical Activity Questionnaire (IPAQ)

2.7.2.1 Content validity

Before the IPAQ, no standard method existed to measure physical activity (PA). The concern was that the IPAQ might over-report PA, therefore, validity was tested for the NORD-Trøndelag Health Study (HUNT) population of men.[118] It has been validated for 12 countries, of which South Africa is one.[118]

2.7.2.2 Face validity

Face validity was tested during the pilot study. Some of the participants found it difficult to distinguish between the different levels of physical activity. This was overcome by the researcher and research assistant administering the questionnaire in simple language more readily understood by the participants.

2.7.2.3 Reliability

Development of the IPAQ commenced in Geneva in 1998 and extensive reliability and validity tests have been undertaken in twelve countries during 2000. The reliability of results were good for vigorous and fair for moderate activities. The IPAQ has been developed as a cross–national assessment tool for PA.[118]

2.7.3 International Stress Management Association (United Kingdom) questionnaire

2.7.3.1 Content validity

The goal of ISMA is to facilitate the acquisition and dissemination of scientifically sound knowledge about stress management and encourages the public and practitioners to use approaches, which have been scientifically validated.[119,120] Detail pertaining to how the ISMA stress questionnaire was validated, was not available

2.7.3.2 Face validity

Face validity was tested in the pilot study. The pilot study included a very small number of participants not completely representative of the study population. Some participants struggled with the level of language used and this was overcome by the researcher and research assistant administering the questionnaire to the participants in a language they understood and questions were answered and queries clarified The content of the questionnaire and the format was clear and easy to use and no changes were made to the content and format of the stress questionnaire after the pilot study.

2.7.3.3 Reliability

Results on reliability testing of the ISMA[UK] stress questionnaire were not available.

2.8 PILOT STUDY

A pilot study was conducted on 19 March 2012 to test the research instruments and the process of data collection. The pilot study was performed on the first day of data gathering and commencement of the main study started on day two (20 March 2012).

In order to assess feasibility, nine male employees who have worked at HMM for more than one year (three each from Wessels mine, Mamatwan mine and Hotazel town offices) were randomly selected using the same method described under the section on sample selection. The investigator, however, could not guarantee a sample that reflected all the employees regarding social status, education level and language as only four of the nine individuals selected were interviewed. This was due to the unwillingness of selected participants to participate. The final selection was as follows: two on Mamatwan mine, one Wessels mine and one Hotazel offices. The pilot study was conducted at each of the participants' place of work.

Questionnaires were adapted according to the findings in the pilot study. Font sizes of the QFFQ were enlarged to make data capturing easier. The International Physical Activity questionnaire and ISMAUK questionnaires had to be changed from self-administered to researcher-administered (see sections 2.7.2.2 and 2.7.3.2). The demographic questionnaire did not need any changes. Special attention was given to the length of time it took to complete each questionnaire.

Data gathered during the pilot study were included in the main study as no changes were made to the actual content of the questionnaires, nor the number of questions. The researcher decided to include the data from the pilot study in the main study due to the low response rate and the subsequent small sample remaining

2.9 STANDARDISATION

The research assistant is a qualified occupational health nurse and was an employee of Life Health Services during the data gathering phase of the study. The researcher (due to locality) could not access the medical data and therefore, needed the research assistant to collect the data needed.

Standardisation of the investigator and research assistant, in terms of data collection procedures, was done before the commencement of the pilot study. The investigator discussed each of the questionnaires (demographic, QFFQ, Physical Activity and Work Related Stress questionnaire) in detail with the research assistant to make sure the research assistant knew what was expected. The researcher and research assistant practised the interview steps (Addendum 18)[114] for the QFFQ described under "Types of instruments used for data collection" (section 2.4.1.3) to ensure both understood the interview steps and to clarify any discrepancies. During the pilot study, all discrepancies or queries of the investigators were clarified amongst themselves, such as quantities of food consumed by the participants and not precisely represented by any of the visual aids described in section 2.6.3.

2.10 STATISTICAL METHODS

2.10.1 Data capturing and coding

2.10.1.1 Quantified Food Frequency Questionnaire

The Medical Research Council (MRC) Food Quantities Manual was used to convert household measures to weight, in order to use Foodfinder nutritional analysis software to analyse the nutritional values of food intakes. This was done because the nutrition composition is given per weight of cooked food, for example per 100g.[57]

All food items had a code that corresponds with the codes used in the computer programme for nutritional analysis. Foodfinder 3 for Windows was used to analyse the data and was developed by the Nutritional Intervention Research Unit (NIRU) and Biomedical Informatics Research Division (BIRD) of the South African Medical Research Council (MRC).[124] It has been developed to accommodate South African food sources and dietary habits. The nutritional composition of items not currently included in the programme (for example nutritional supplements) were added to ensure completeness of the database. From the nutritional data analysis, the total energy intake of each participant, as well as saturated fat, sodium, magnesium, potassium, calcium and alcohol intake was used.

2.10.1.2 ISMAUK stress questionnaire

Level of stress was calculated by allocating one point for every “very often” answer (yes) and zero points for every “not at all” (no) answer. A total score of four or less indicated an unlikelihood the participants might suffer from stress and/or stress-related illness; 5-13 points indicated that participants were more likely to suffer from stress-related illness and might need stress management; 14 and more indicated that participants were very prone to suffer from stress and/or stress-related illness and will need professional help.[119] Data collected from this stress questionnaire was analysed statistically to determine if there was a link between a high stress questionnaire score and elevated blood pressure.

2.10.1.3 International Physical Activity Questionnaire

Level of activity was calculated by using the IPAQ scoring protocol. Both continuous and categorical indicators of physical activity were calculated and the continuous indicator presented as median MET minutes per week (METS are used to express the volume of activity weighted by the energy required to complete and). MET minutes were calculated by multiplying each MET level (3.3 for walking, four for moderate activities and eight for vigorous activity) with the minutes of activity and days per week and as expressed as MET minutes/week.[117, 118] The total MET minutes per week was calculated by adding up the walk MET minutes, Moderate MET minutes and Vigorous MET minutes to give a total MET minutes for all activities. Categorical indicators were expressed as low, medium and high activity levels and presented as interquartile ranges for the population.[117, 118]

2.10.2 Statistical analysis of data

MS Excel was used to capture the data and STATISTICA, data analysis software system was used to analyse the data.[125] Descriptive statistics (graphs and tables) was used to record the categorical variables i.e. classification of hypertension, level of physical activity and level of stress. Summary statistics were used to describe the variables. Distributions of variables were presented with histograms and frequency tables. Medians or means were used as the measures of central location and standard deviations and quartiles as indicators of spread. Means were reported with standard deviation (mean (SD)) throughout the results (chapter 3).

The relationships between continuous response variables and nominal input variables were analysed using appropriate analysis of variance (ANOVA). The effect of possible confounding factors was investigated with subsequent analysis of covariance (ANACOVA) by treating these factors as covariates. Levene's test for the homogeneity of variances was used to test the null-hypothesis that population variances are equal or homogeneous, which is an assumption of ANOVA.

If the residuals from ANOVA are not normally distributed or when ordinal response variables were compared to a nominal input variable, non-parametric ANOVA methods were used. Hypothesis testing for completely randomised designs were done by using the Mann-Whitney test.

The relation between two nominal variables was investigated with contingency tables and likelihood ratio chi-square tests. More specifically, the risks for hypertension (yes or no) originating either from dichotomous nominal factors (yes or no) or continuous factors, will be determined respectively with contingency tables, i.e. also called categorical data analysis and logistic regression, where appropriate. To investigate the statistical difference between ethnic groups, the Cochrane-Mantel-Hansel test was done. This was also done for nutritional supplements and salt. A p-value of less than 0.05 represents statistical significance in hypothesis testing and 95% confidence intervals were used to describe the estimation of unknown parameters

2.11 ETHICS AND LEGAL ASPECTS

Ethical approval (S12/03/075) was obtained from the Health Research Ethics Committee of the University of Stellenbosch (see Addendum 10). The researcher and research assistant adhered to the declaration of Helsinki at all times, of which the fundamental principle is respect for the individual, their right to self-determination and their right to make informed decisions regarding participation in the research.[126]

Approval for the study was obtained from the General Manager of HMM (Addendum 3) allowing the research assistant to access the relevant files and collect the data needed to determine which employees were eligible for the study (i.e. free of hypertension at the start of employment). Written informed consent was obtained from each participant selected for the study (Addendum 4) at the time of data gathering. For this purpose, an information and consent form was distributed to each selected individual. These forms fully explained the study, the methods used and the motivation for the study. At the commencement of each interview, participants were given information about the study, why it was being performed and how it would impact them; they were then asked whether they would like to proceed with the questionnaires. If they affirmed this, they were given a consent form to sign and a copy to keep.

The information leaflet explicitly stated that participation was absolutely voluntary, all information was kept confidential, and only the information relevant to the study was used. Anonymity was assured by allocating a unique participant code to each participant. This code was used on all the relevant forms. Only the investigator and research assistant had access to the information gathered and participants selected in order to ensure confidentiality during data analysis and dissemination of findings. All the information was used for the sole purpose of the study and to make recommendations that can be used by the Life Health Professionals of HMM to improve overall well-being of HMM employees. Where the stress questionnaires indicated, on average, high stress levels in an employee, the Life Health Professionals would be alerted and could take immediate action with those employees at risk. The process of obtaining consent used in this study was approved by the ethics committee.

2.12 REPORTING OF RESULTS

Results of the study will be considered for publication in a peer reviewed scientific journal and presentation at a national and/or international nutrition/dietetics-related congress.

CHAPTER 3: RESULTS

3.1 SOCIO-DEMOGRAPHIC CHARACTERISTICS OF THE STUDY PARTICIPANTS (N=45)

The socio-demographic characteristics of the study participants are shown in Table 3.1. Of the total study participants (N=45), 9% (n=4) of participants worked in Hotazel town, 33% (n=15) on Mamatwan mine and 58% (n=26) on Wessels mine. More than half of the study sample came from Wessels mine as this was the biggest mine with the most employees. Non-supervisory roles (levels four and five) were held by 73% (n=33) of all the participants and 26% (n=12) held supervisory roles (levels two and three). Most of the participants (47%, n=21) worked for less than five years at Hotazel Manganese Mines with only six per cent (n=3) having more than 25 years' service. Most participants (62%, n=28) did level four jobs, i.e. miners, artisans and administrators. Only one (2%) superintendent (level two positions) participated in the study. Level five positions (operators, cleaners and general helpers) were held by 11% (n=5) of the participants. Results on marital status showed that 64% (n=29) were married and 29% single (n=13). Sixty per cent (n=27) of the participants lived in a mine house with only 2% (n=1) living in homes they owned.

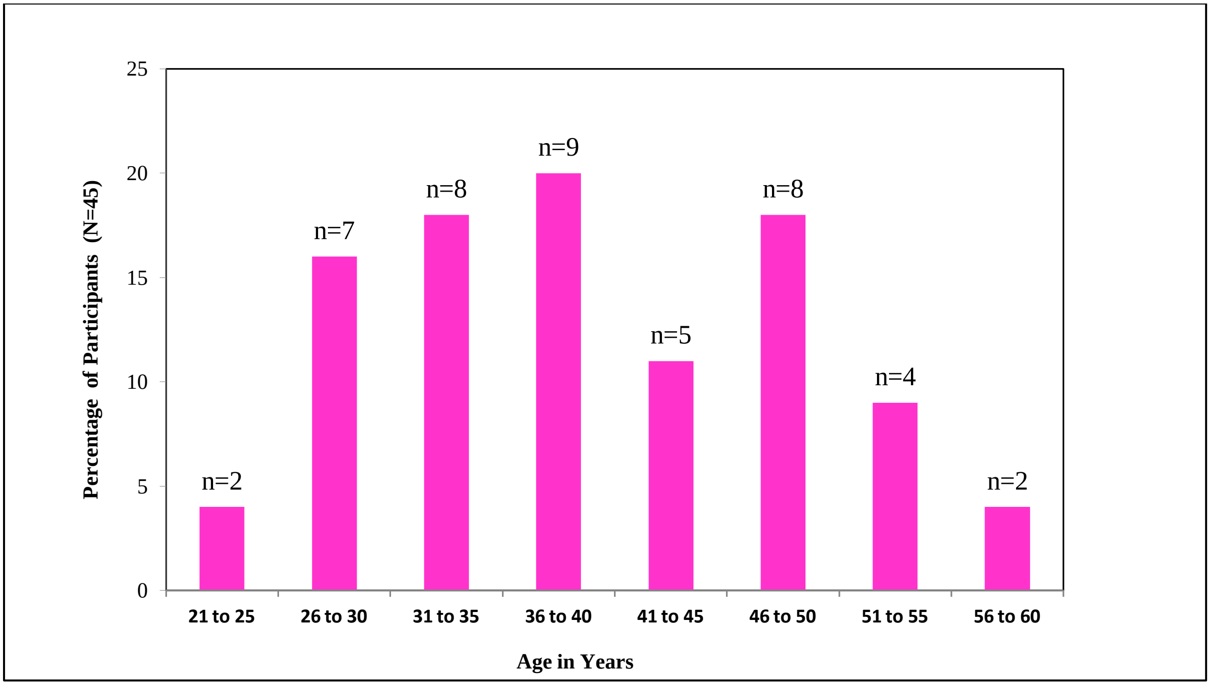
Of the three ethnic groups comprising the study population, the majority of participants (51%, n=26) was black. The largest group of participants were 30-40 years old with 38% (n=17) of participants falling into this age group. The second largest age group (29%; n=13) was 40-50 years old. Only 13% (n=6) were older than 50 years. The qualification held by most participants was grade 12 (29%, n=13) with only two per cent (n=1) having no qualification at all.

Table 3.1: Socio-demographic characteristics of the study participants employed by Hotazel Manganese Mines (N=45)

Demographic variable	n	%
Ethnicity		
Black	26	58
White	10	22
Coloureds	9	20
Age group		
20-30	9	20
30-40	17	38
40-50	13	29
50-60	6	13
Residence		
House	27	60
Mine hostel	4	9
Other	9	20
Single quarters	4	9
House own	1	2
Job position		
Level 2 Superintendents	1	2
Level 3 Specialists, supervisors, safety officer, shift boss	11	24
Level 4 Miners, artisans, administrators	28	63
Level 5 Operators, cleaners, helpers	5	11
Marital status		
Married	29	65
Divorced	1	2
Partner	2	4
Single	13	29
Level of education		
No qualification	1	2
Grade 9	5	11
Grade 10	5	11
Grade 11	4	9
Grade 12	13	29
Diploma/degree	8	18
Post graduate degree	2	4
Other	7	16

3.1.1 Effect of age

Age in the study participants (N=45) (presented in a bar chart in Figure 3.1) peaked at 35–40 years (n=9, 20%) with only two (4%) participants being younger than 25 years and six (13%) older than 50 years.



*The ANOVA test found a statistically significant difference (p=0.03) between the mean age of the hypertensive cases and the normotensive controls.
**Levene's test found the variances homogenous (p=0.64)

Figure 3.1: Age of the study participants employed by Hotazel Manganese Mines (N=45)

The effect of age on the development of hypertension in the study participants (N=45) was investigated as the participants could not be matched for age due to the small sample size. A normal probability plot indicated that the residuals was normally distributed and Levene's test showed that the variances were homogeneous (p=0.64). A parametric ANOVA test was, therefore, performed and found that the hypertensive cases (n=26) (42 years (SD 9, CI 39-46)) was significantly older (p=0.03) than the normotensive controls (n=19) 36 years (SD 9, CI 32-40). Mean age for the study participants (N=45) was 40 (SD 9, CI 37-42) years.

3.2 THE INCIDENCE AND CLASSIFICATION OF HYPERTENSION IN THE STUDY PARTICIPANTS AFTER BEING EMPLOYED FOR MORE THAN 12 MONTHS

Only participants (N=45) that were hypertension free (BP<140/90) at the start of their employment were included in the study and of those, 69% (n=31) had normal blood pressure at the start of employment (120/80 mm HG—129/84mm HG). Thirty one per cent (n=14) had a blood pressure classification of high normal (130/85 mm HG -139/89mm HG).

During employment, 26 of the 45 participants developed hypertension (i.e. the hypertensive cases). Of these, 96% (n=25) had mild hypertension (140/90—159/99 mm HG) and four per cent (n=1) a moderate hypertension classification (160/100—179/109 mm HG).

In terms of ethnicity and hypertension, five white participants out of nine developed hypertension (56%), 15 out of 26 black participants (58%) and six out of the 10 coloured participants. A chi square test found no statistical association (p=0.98) between the ethnicity of the participants in this study and the development of hypertension.

3.2.1 Systolic and diastolic blood pressure

Systolic and diastolic blood pressure of the study participants (N=45) before and after commencement of employment at HMM has been compared to visualise any possible shifts in systolic and diastolic blood pressure. For the study participants as a whole, systolic blood pressure at the start of employment peaked at 125-130 mm HG with 27% (n=12) of participants falling into this category. During employment, systolic blood pressure peaked at 135-140 mm HG with 35% (n=16) of the participants now falling into this category. Figure 3.2 shows a clear shift in the number of participants with higher systolic blood pressure readings during employment, with no participants classified with a systolic blood pressure higher than 140 mm HG at the start of employment compared to 16% (n=7) during employment.

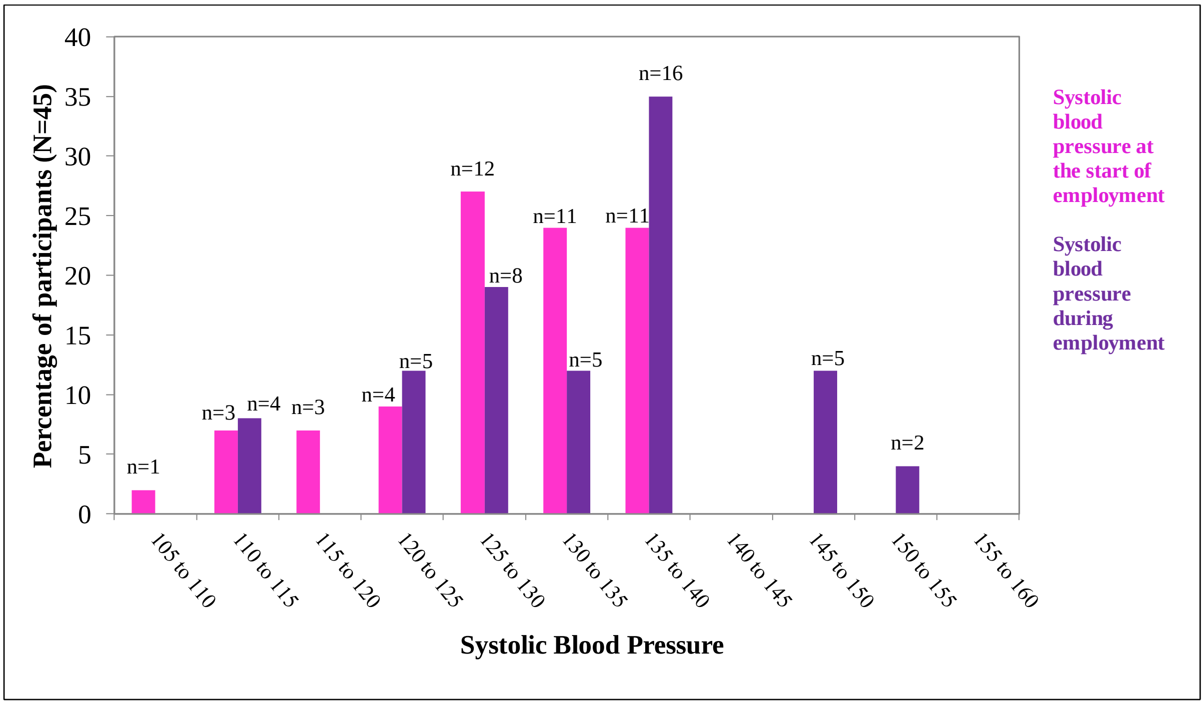


Figure 3.2: Systolic blood pressure in the study participants employed by Hotazel Manganese Mines (N=45).

Sixty six percent (n=30) of the study participants (N=45) had a diastolic blood pressure between 80-89 mm HG at the start of employment at HMM and the rest had lower readings (Figure 3.3). During employment, diastolic pressure also peaked at 80-90 mm HG with 54% (n=24) of participants falling into this category.

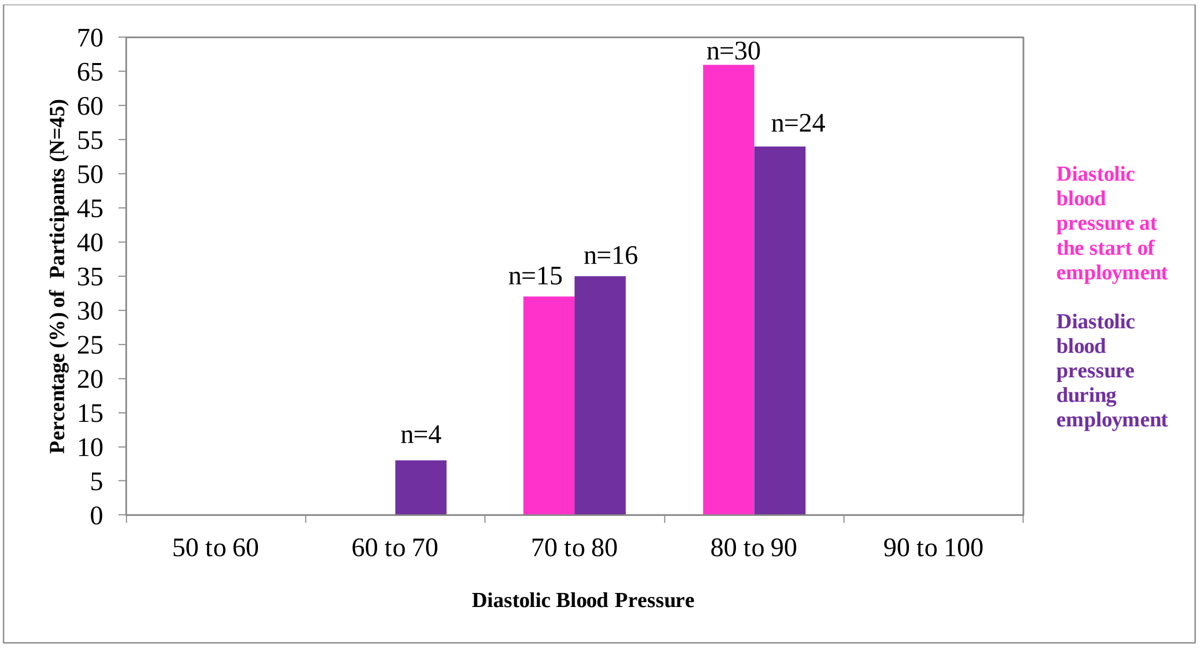


Figure 3.3: Diastolic blood pressure in the study participants employed by Hotazel Manganese Mines (N=45)

Differences in the incidence and classification of hypertension between the participants from different mines could not be tested statistically due to the small sample size. The null hypothesis, "There is no significant difference in the incidence and classification of hypertension in male employees of the different Hotazel Manganese Mines," therefore remains unanswered.

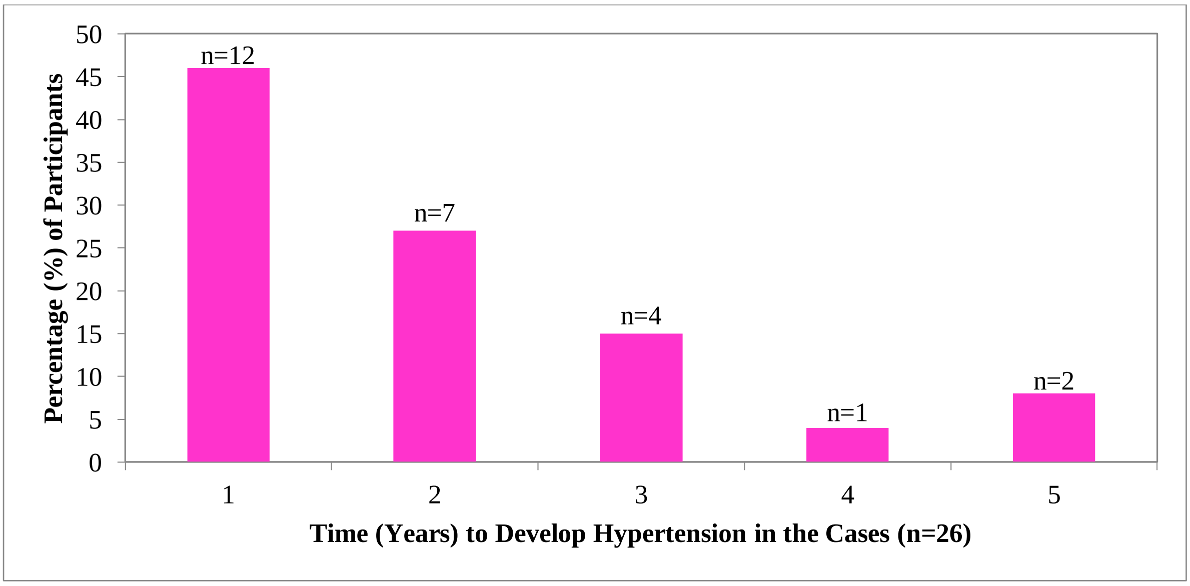
3.2.2 Development of hypertension during employment

More than half of the participants developed hypertension (58%, n=26) and served as the hypertensive cases after being employed for more than 12 months. Those who did not develop hypertension (42%, n=19) were the normotensive controls.

3.3 THE TIME IT TOOK FOR THE CASES TO DEVELOP HYPERTENSION

Forty six per cent (n=12) of the hypertensive cases (n=26) developed hypertension between 1½ and 2½ years of employment and only eight per cent (n=2) took more than 5½ years to develop hypertension (Figure 3.4). The mean time it took to develop hypertension was calculated as three (SD 1) years with an inter-quartile range of 2–4 years.

A repeated measure ANOVA was performed to test the relationship between the incidence of hypertension and time after starting employment at Hotazel Manganese Mines. There was no significant relationship between the time employment started at HMM and the incidence of hypertension (p=0.95). As far as incidence goes, there was no meaningful difference between the mean number of hypertensive cases (n=26) and normotensive controls (n=19) (p=0.98). Lastly, the mean amount of time it took the hypertensive cases to develop hypertension after starting employment at HMM was not significantly different from the mean amount of time the normotensive controls were in employment (p= 0.0515). It should be noted, however, that this might have been meaningful at a slightly smaller level of confidence.



*Repeated Measures ANOVA p=0.95 found no significant difference between the period of time after starting employment at HMM and the incidence of hypertension

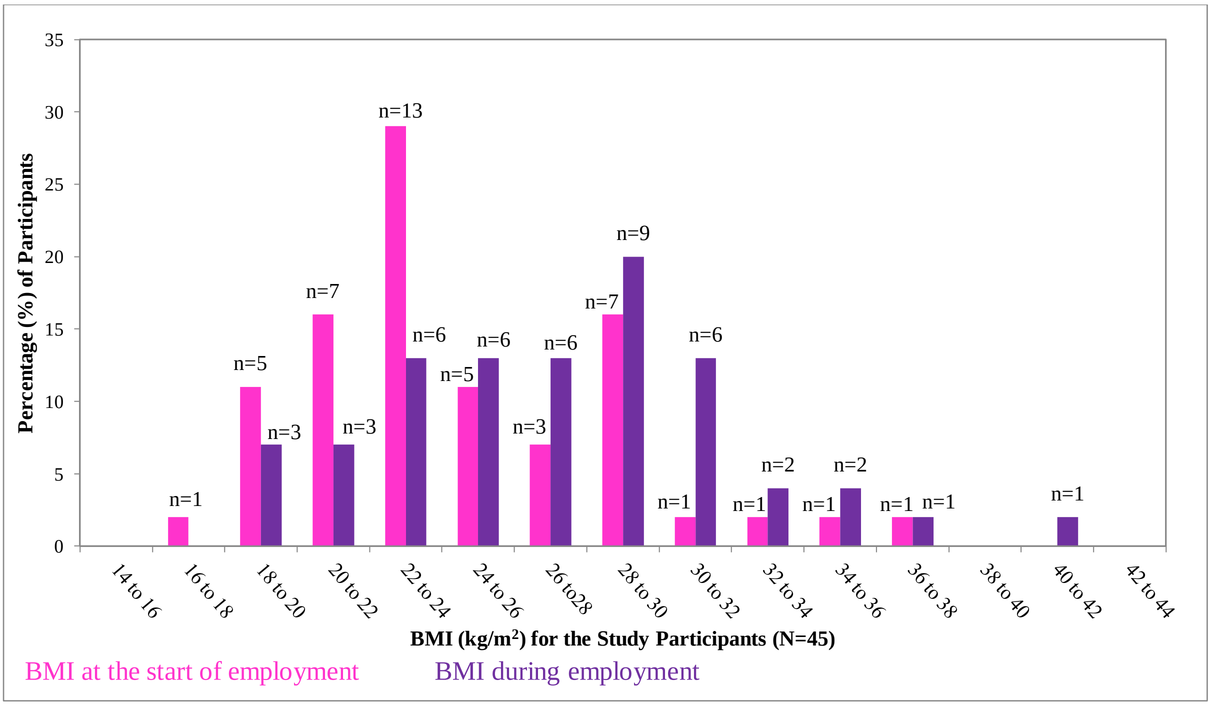
Figure 3.4: The amount of time it took the hypertensive cases to develop hypertension after being employed at Hotazel Manganese Mines (n=26)

3.4 RISK FACTORS ASSOCIATED WITH THE DEVELOPMENT OF HYPERTENSION WITH THE FOCUS ON NUTRITION AND LIFESTYLE

The association between the development of hypertension and the following risk factors were investigated: BMI at the start of employment and during employment, the change in BMI during employment, level of physical activity, level of work-related stress and energy consumption.

3.4.1 BMI at the start of employment and during employment

The majority (29%, n=13) of participants presented with a BMI of 22 to 24 (SD 4) kg/m^2 at commencement of employment at HMM. During employment the majority (20%, n=9) of the participants had a BMI between 28-30 kg/m^2 (Figure 3.5).



*Mann–Whitney U-test (p=0.97) indicated no significant difference in terms of mean BMI at the start of employment between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.44) found that there were no significant variances between the hypertensive cases and the normotensive controls in terms of BMI at the start of

Figure 3.5: BMI at the start and during employment

After a period of employment at HMM, the mean BMI for the study participants (N=45) increased to 27 (SD 4) with an inter-quartile range of 24–30. The mean BMI at the start of employment for the hypertensive cases was 24 (SD 4) and for the normotensive controls 24 (SD 5) (Table 3.2).

The observations for BMI at the start of employment were not distributed normally. The non-parametric Mann–Whitney U-test confirmed (p=0.97) the results of the parametric ANOVA test (p=0.89) that there was no significant difference in the mean BMI at the start of employment between the hypertensive cases (n=26) and the normotensive controls (n=19). Levene's test confirmed that the variances were homogeneous (p=0.44) (Table 3.2).

Table 3.2: Mean BMI at the start of employment in the study participants (N=45) employed by Hotazel Manganese Mines

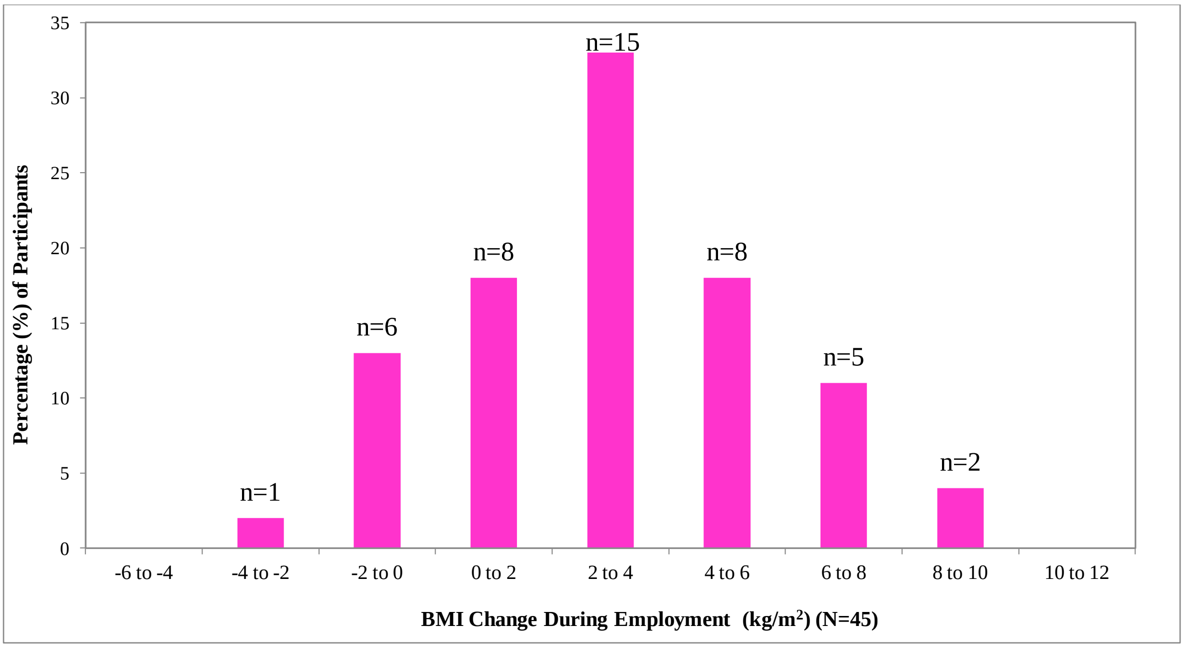
	BMI at the Start of Employment (kg/m^2)			Probability (p)	
	Mean BMI	**Standard Deviation**	**Inter-Quartile Range/(Confidence Interval)**	**Mann–Whitney U-test significance test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	24.35	4.42	21.51–26.78	N/A	N/A
Hypertensive cases (n=26)	24.27	4.03	(22.64–25.90)	0.97[1]	0.44 [2]
Normotensive controls (n=19)	24.45	5.01	(22.03–26.87)		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.97) indicated no significant difference in terms of mean BMI at the start of employment between the hypertensive cases and the normotensive controls
[2] Levene's test for the homogeneity of variance (p=0.44) found that there were no significant variances between the hypertensive cases and the normotensive controls in terms of BMI at the start of employment

3.4.2 Change in BMI during employment at HMM

A bar chart presents the change in BMI in the study participants (N=45) during employment (Figure 3.6). A normal probability plot indicated that for BMI change during employment, both groups (hypertensive cases and normotensive controls) were normally distributed and Levene's test for the equality of variance, found the variances homogenous (p=0.14). Therefore, the parametric ANOVA test was run on the data as well as the 95% confidence intervals for the mean differences.

The majority of participants (33%, n=15) showed a BMI change between 2 and 4 kg/m^2 (Figure 3.6), with the mean increase in BMI being 3 (SD 3) and the interquartile range 1–5 kg/m^2.



*ANOVA test (p=0.004) indicated a significant difference in terms of the mean change in BMI during employment between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.14) found the variances between the hypertensive cases and the normotensive controls in terms of the change in BMI during employment

Figure 3.6: BMI change in the study participants during employment (N=45)

The parametric ANOVA test found that the hypertensive cases (n=26) and normotensive controls (n=19) differed significantly in terms of the mean change in BMI after employment duration (p=0.004), with the cases indicating higher increases of 4 kg/m^2 (SD 3) (Table 3.3).

Table 3.3: Mean BMI changes in the study participants during employment (N=45)

	Mean BMI change during employment duration (kg/m^2)			Probability (p)	
	Mean BMI change	**Standard deviation**	**Inter-quartile range/(confidence interval)**	**Parametric ANOVA test significance test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	3.08	2.83	1.30–4.68	N/A	N/A
Hypertensive cases (n=26)	4.28	2.80	(3.30–5.26)	p=0.004[1]	p=0.14[2]
Normotensive controls (n=19)	1.44	1.96	(0.30–2.58)		

N/A-Not Applicable
[1]ANOVA test (p=0.004) indicated a significant difference in terms of the mean change in BMI during employment between the hypertensive cases and the normotensive controls
[2] Levene's test for the homogeneity of variance (p=0.14) found the variances between the hypertensive cases and the normotensive controls in terms of the change in BMI during employment to be homogenous

3.4.3 Level of activity

The South African guidelines for a healthy lifestyle advises at least 30–45 minutes of physical activity each day.[97] More than half (n=23) of the study participants (N=45) had a high level of physical activity (51%), 27% a moderate level of activity (n=12) and 22% a low level (n=10) of physical activity (Table 3.4). Of the hypertensive cases, 54% (n=14) had a high level of activity compared to the normotensive controls (n=9, 47%). Only 19% of the cases and 26% (n=5) of the controls had a low level of activity.

The Chi-square test was used to indicate if a significant association existed between the nominal variables activity level and incidence of hypertension (hypertensive cases and normotensive controls). A probability of p=0.84 indicated that there was no significant difference in the level of activity between the hypertensive cases and the normotensive controls. Therefore, activity level was not associated with the development of hypertension in this study.

Table 3.4: Level of activity in the hypertensive cases (n=26) and normotensive controls (n=19)

	Level of activity		
	High n (%)	**Moderate n (%)**	**Low n (%)**
Hypertensive cases (n=26)	14 (54)	7 (27)	5 (19)
Normotensive controls (n=19)	9 (47)	5 (26)	5 (26)
Study participants (N=45)	23 (51)	12 (27)	10 (22)

*The Chi-square test showed no significant difference between cases and controls (p=0.84)

3.4.4 Level of work-related stress

The stress questionnaire indicated that 98% (n=44) of the study participants were unlikely to suffer from stress. Only one (2%) of the hypertensive controls was likely to suffer from stress. A Chi-square test was performed to test the association between the nominal variables, level of stress and the incidence of hypertension (hypertensive cases and normotensive controls). No statistically significant (p=0.18) difference was found in the level of work-related stress between the hypertensive cases (n=26) and normotensive controls (n=19), indicating that work-related stress was not associated with the development of hypertension in this study (Table 3.5).

Table 3.5: Levels of stress in study participants employed by Hotazel Manganese Mines (N=45)

	Stress level	
Incidence of hypertension	**Likely n (%)**	**Unlikely n (%)**
Hypertensive cases (n=26)	26 (100)	0 (0)
Normotensive controls (n=19)	18 (95)	1 (5)
Study participants (N=45)	44 (98)	1 (2)

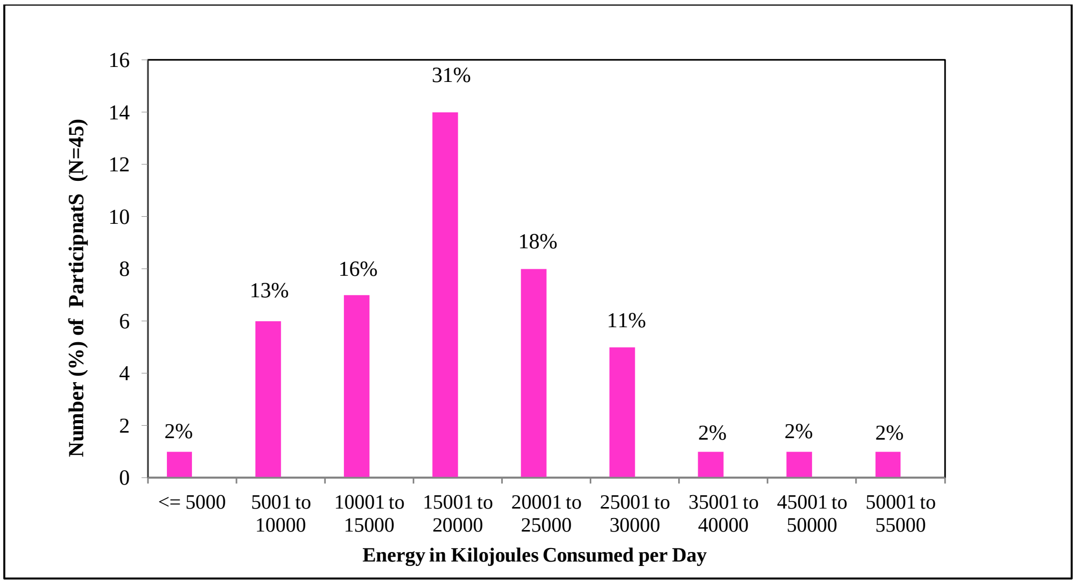
*Chi-square test showed no association between level of stress and the development of hypertension (p=0.18)

The null-hypothesis that there is no significant difference between the hypertensive cases and the normotensive controls regarding lifestyle is accepted as there was no significant difference between the hypertensive cases and normotensive controls in terms of level of stress and level of physical activity.

3.4.5 Energy consumption

The centred observations for mean energy consumption between the hypertensive cases and the normotensive controls were not normally distributed and Levene's test indicated that the variances was not homogenous (p=0.04) and therefore, the ANOVA test could not be used. The Mann–Whitney U-test found no significant difference (p=0.47) between the daily mean energy intake of the hypertensive cases (n=26) and the normotensive controls (n=19).

The recommended energy intake for moderately active males is an average of 10 500 kJ (2500 kcal) per day[91] (refer to Table 1.7)**.** Most participants (n=14, 31%) consumed between 15 000 kJ and 20 000 kJ with only 2% (n=1) consuming less than 5 000 kJ and 2% (n=1) more than 55 000 kJ (Figure 3.7).



*Mann-Whitney U-test (p=0.47) indicated no significant difference in terms of the mean daily energy intake between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.04) found the variances between the hypertensive cases and the normotensive controls in terms of the mean daily energy intake not homogenous

Figure 3.7: Energy intake (kJ/day) of the study participants employed by Hotazel Manganese Mines (N=45)

The mean daily energy consumption was calculated as 19 821 kJ (SD 11 366 kJ) for the study participants (N=45) whereas the mean energy intake for the hypertensive cases (n=26) and normotensive controls (n=19) was 22 117 kJ (SD 13 534 kJ) and 16 678 kJ (SD 6 585 kJ) respectively (Table 3.6).

Table 3.6: Daily mean energy intake (kJ) for the study participants employed by Hotazel Manganese Mines (N=45)

	Daily Mean Energy Consumption (kJ)			Probability (p)	
	Mean energy	**Standard deviation**	**Confidence interval**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	19 821	11 366	16 406–23235	N/A	N/A
Hypertensive cases (n=26)	22 117	13 534	16 650–27 583	p=0.47[1]	p=0.04[2]
Normotensive controls (n=19)	16 678	6 585	13 504–19 853		

N/A-Not applicable
[1]Mann–Whitney U-test (p=0.47) indicated no significant difference in terms of the mean daily energy intake between the hypertensive cases and the normotensive controls
[2] Levene's test for the homogeneity of variance (p=0.04) found the variances between the hypertensive cases and the normotensive controls in terms of the mean daily energy intake not homogenous

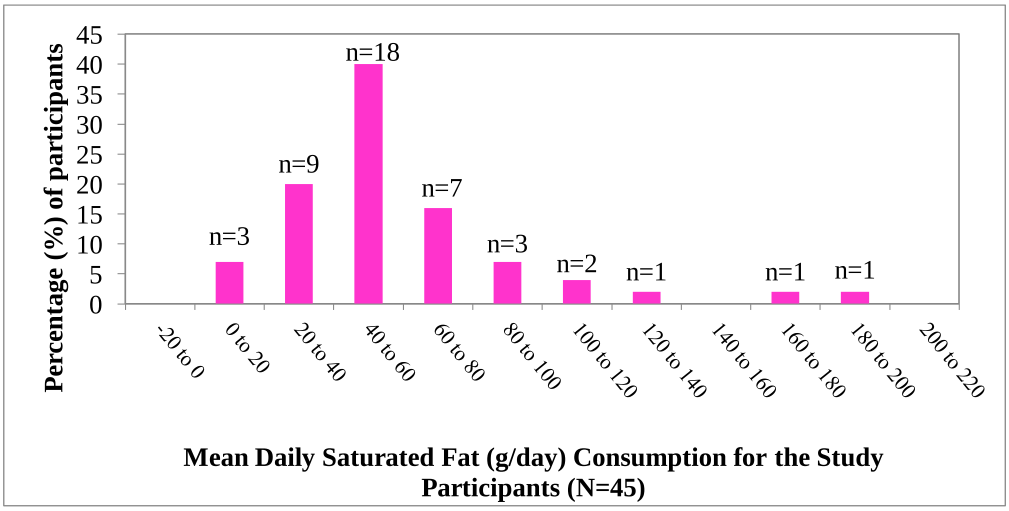
3.5 DIETARY INTAKE: SATURATED FAT, MINERALS (MAGNESIUM, POTASSIUM CALCIUM AND SODIUM) AND ALCOHOL CONSUMPTION

Descriptive statistics were used to describe the characteristics of the study participants (N=45) and bar charts presented the distribution of variables in terms of daily mean consumption of saturated fat, minerals and alcohol consumption. Levene's test for the homogeneity of variance was also performed to test if the variation of the responses between the cases and controls were homogeneous, since it is an assumption of the parametric ANOVA test. Where the parametric ANOVA test could not be used (residuals not normally distributed according to the normal probability plot and/or the variances were not homogenous) the non-parametric Mann–Whitney U-test was used.

3.5.1 Saturated fat

Levene's test found the variances between the saturated fat intake of the hypertensive cases and the normotensive controls homogenous (p=0.06) but the centred observations for each group (hypertensive cases and normotensive controls) were not normally distributed as indicated by a normal probability plot. Therefore, a non-parametric Mann–Whitney U-test (p=0.72) was used to confirm the results of the parametric ANOVA test (p=0.26).

Saturated fat consumption peaked at 40–60 g per day (14–21% of daily energy intake) for 40% (n=18) of participants, with only 7% (n=3) of individuals eating less than 20 g per day (7% of daily energy consumption) and 2% (n=1) consuming more than 180 g per day (64% of daily energy intake) (Figure 3.8).



*Mann–Whitney U-test (p=0.72) indicated no significant difference in terms of the mean daily saturated fat intake between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.06) found the variances homogenous

Figure 3.8: Mean daily total saturated fat (g/day) intake of the study participants employed by Hotazel Manganese Mines (N=45)

The recommended daily saturated fat intake for men older than 18 years, based on a 9 200 kJ (2 000 kcal) diet, is 20 g (10% of total energy intake).[66] The mean daily saturated fat consumption was higher for the hypertensive cases (n=26) at 65 g (SD 43 g) compared to the 53 g (SD 24 g) consumed by the normotensive controls (n=19). The Mann–Whitney U-test found the increased mean daily saturated fat intake of the hypertensive cases not significantly higher (p=0.72) than the mean daily saturated fat intake of the normotensive controls (Table 3.7).

Table 3.7: Mean daily saturated fat (g/day) intake of the study participants employed by Hotazel Manganese Mines (N=45)

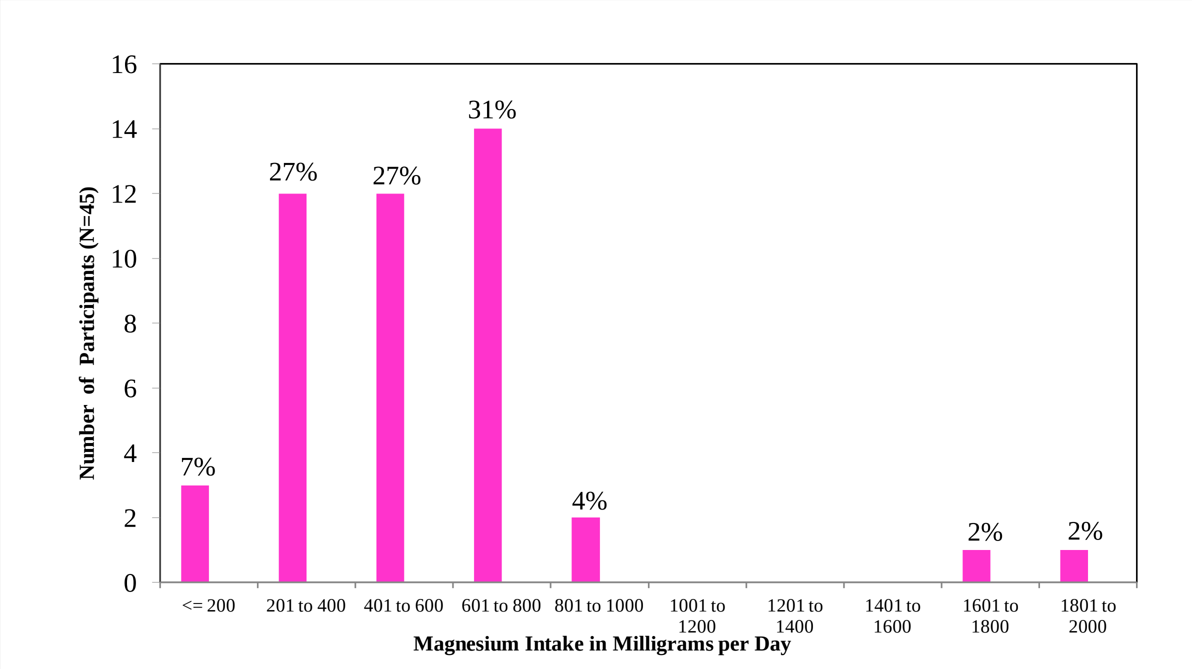
	Daily mean saturated fat consumption (g/d)			**Probability (p)**	
	Mean saturated fat	**Standard deviation**	**Inter–quartile range/ (confidence interval)**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	60.13	36.23	38.58-71.58	N/A	N/A
Hypertensive cases (n=26)	65.33	42.59	(51.05-79.62)	p=0.72[1]	p=0.06[2]
Normotensive controls (n=19)	53.01	24.43	(36.31-69.73)		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.72) indicated no significant difference in terms of the mean daily saturated fat intake between the hypertensive cases and the normotensive controls
[2]Levene's test for the homogeneity of variance (p=0.06) found the variances homogenous

3.5.2 Magnesium

A normal probability plot indicated that the residuals were not normally distributed. Therefore, the non-parametric Mann-Whitney U-test was used to confirm the results of the parametric ANOVA test (p=0.90). Levene's test showed that the variances was homogeneous (p=0.14).

The recommended daily magnesium intake is 410 mg–420 mg depending on age.[61,62,63] Thirty-one per cent (n=14) of the study participants (N=45) had a magnesium intake of 600–800 mg per day with the lowest intake less than 200 mg per day (n=3, 7%) and the highest intake of magnesium was more than 1 800 mg (n=1, 2%) per day (Figure 3.9).



*Mann-Whitney U-test (p=0.11) indicated that the mean daily magnesium intake of the hypertensive cases was not significantly higher than the mean daily magnesium intake of the normotensive controls
**Levene's test for the homogeneity of variance (p=0.14) found the variances between the hypertensive cases and the normotensive controls in terms of the mean daily magnesium intake homogenous

Figure 3.9: Total magnesium intake (mg/day) of the study participants employed by Hotazel Manganese Mines (N=45)

Total daily mean magnesium intake for the study participants (N=45) was 552 mg (SD 324 mg). The hypertensive cases (n=26) had a higher mean daily magnesium intake of 623 mg (SD 387 mg) compared to the normotensive controls (n=19), 455 mg (SD 176 mg), but this difference was not significant (Mann–Whitney U, p=0.11) (Table 3.8).

Table 3.8: Mean daily magnesium (mg) intake for the study participants employed by Hotazel Manganese Mines (N=45)

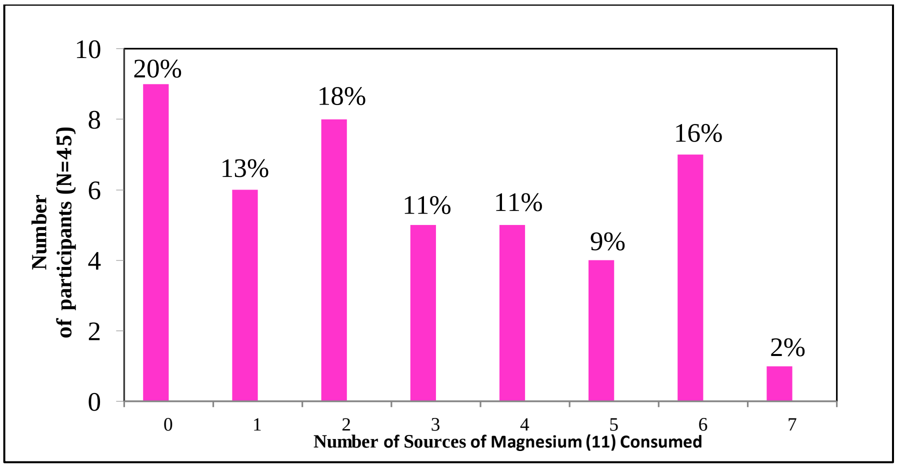
	Daily mean magnesium consumption (mg)			Probability (p)	
	Mean magnesium	**Standard deviation**	**Confidence interval**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	552	324	455–650	N/A	N/A
Hypertensive cases (n=26)	623	387	498–748	p=0.11[1]	p=0.14[2]
Normotensive controls (n=19)	455	176	309–602		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.11) indicated that the mean daily magnesium intake of the hypertensive cases was not significantly higher than the mean daily magnesium intake of the normotensive controls
[2]Levene's test for the homogeneity of variance (p=0.14) found the variances between the hypertensive cases and the normotensive controls in terms of the mean daily magnesium intake homogenous

3.5.2.1 Sources of magnesium

A normal probability plot indicated that the residuals were not normally distributed and the non-parametric Mann–Whitney U-test (p=0.72) confirmed the results of the parametric ANOVA test, p=0.61. Levene's test showed that the variances were homogeneous (p=0.08).

A list of commonly consumed foods high in magnesium was compiled and using data from the QFFQ the researcher calculated how many of each of these foods each participant consumed. A total of 11 sources of magnesium were identified (Figure 3.10).



*Mann–Whitney U-test (p=0.72) indicated no significant difference in terms of the mean daily magnesium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.08) found the variances homogenous

Figure 3.10: Total magnesium sources consumed by the study participants employed by Hotazel Manganese Mines (N=45)

The mean number of food sources high in magnesium for the study participants (N=45), the hypertensive cases (n=26) and for the normotensive controls (n=19) was three, SD 2, CI 2-3; SD 2, CI 2-4; and SD 2, CI 2-4, respectively. Cucumber, green beans and spinach were the most popular sources of magnesium consumed (Table 3.9). Mann–Whitney U-test (p=0.72) indicated no significant difference in terms of the mean daily magnesium sources intake between the hypertensive cases and the normotensive controls.

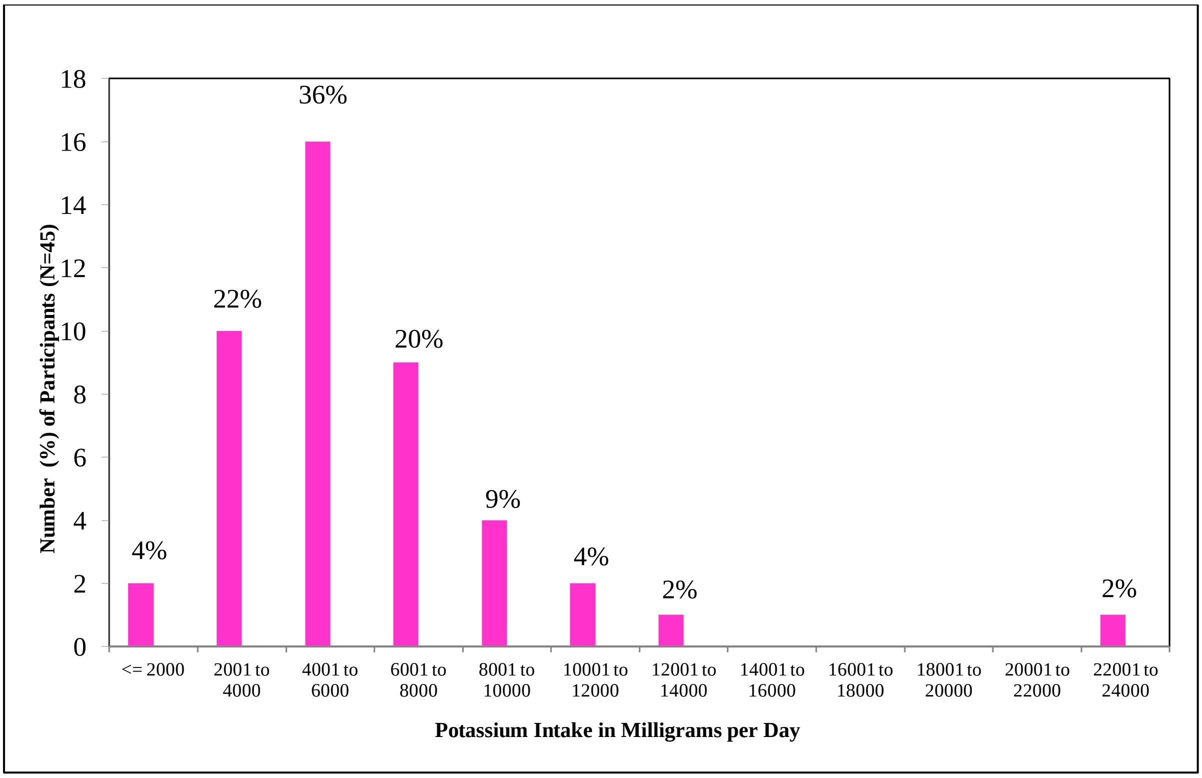
Table 3.9: Magnesium-rich food products (11) consumed by the study participants employed by Hotazel Manganese Mines (N=45)

Magnesium sources	Study participants n (%)	Hypertensive cases n (%)	Normotensive controls n (%)
Bran breakfast cereal	18 (40)	11 (42)	7 (37)
Green beans	24 (53)	16 (62)	8 (42)
Cucumber	23 (51)	14 (54)	9 (47)
Celery	0 (0)	0 (0)	0 (0)
Cantaloupe	20 (44)	13 (50)	7 (37)
Spinach	20 (44)	12 (27)	8 (42)
Bell peppers	17 (38)	10 (38)	7 (37)
Bran rice, wheat, oats	8 (18)	4 (15)	4 (21)
Dark chocolate	0 (0)	0 (0)	0 (0)
Nuts: Almonds, brazil nuts, mixed nuts	16 (36)	8 (31)	8 (42)
Seeds: Flax, sunflower, pumpkin seeds	0 (0)	0 (0)	0 (0)

*Mann–Whitney U-test (p=0.72) indicated no significant difference in terms of the mean daily magnesium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.08) found the variances homogenous

3.5.3 Potassium

The residuals were not normally distributed and therefore, the non-parametric Mann-Whitney U-test was used to confirm the results of the parametric ANOVA test, p= 0.22. Levene's test showed that the variables were homogeneous (p=0.07). The daily recommended minimum intake for potassium is 2 000 mg K for adults older than 18 years.[64] Most participants (36%, n=16) had a potassium intake of 4000–6000 mg K per day with 4% (n=2) below 2 000 mg K per day and 4% (n=2) above 12 000 mg K per day (Figure 3.11).



*Mann-Whitney U-test (p=0.51) indicated no significant difference in terms of the mean daily potassium intake between the hypertensive cases and the normotensive controls

**Levene's test for the homogeneity of variance (p=0.07) found the variances homogenous

Figure 3.11: Total potassium intake (mg/day) of the study participants employed by Hotazel Manganese Mines (N=45)

The total mean daily potassium intake for the study participants (N=45) was 5 803 mg K (SD 3 773 mg K). The average potassium intake for the hypertensive cases (n=26) was 6 392 mg K (SD 4 640 mg K) and for the normotensive controls (n=19) 4 997 mg K (SD 1 925 mg K). Although the mean potassium intake for the hypertensive cases was higher than the intake of the normotensive controls, the Mann–Whitney U-test did not find this difference of statistical significance (p=0.51) (Table 3.10).

Table 3.10: Potassium intake (mg) of the study participants employed by Hotazel Manganese Mines (N=45)

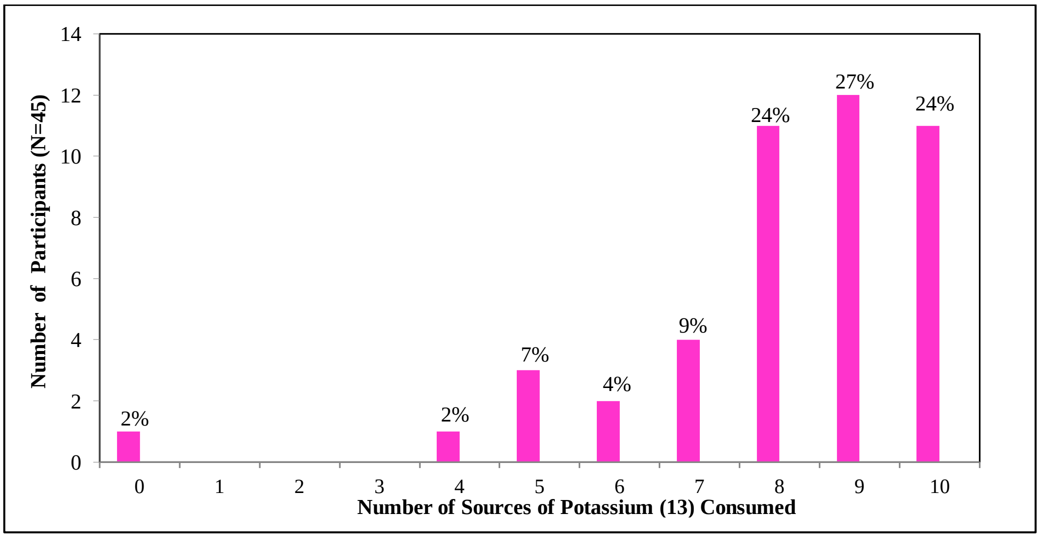
	Daily mean potassium intake (mg)			Probability (p)	
	Mean potassium	**Standard deviation**	**Confidence interval**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	5 803	3 773	4 669–6 936	N/A	N/A
Hypertensive cases (n=26)	6 392	4 640	4 908–7 875	p=0.51[1]	p=0.07[2]
Normotensive controls (n=19)	4 997	1 925	3 261–6 732		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.51) indicated no significant difference in terms of the mean daily potassium intake between the hypertensive cases and the normotensive controls
[2]Levene's test for the homogeneity of variance (p=0.07) found the variances homogenous

3.5.3.1 Sources of potassium

A list of commonly consumed foods high in potassium was compiled and using data from the QFFQ, the researcher calculated how many of each of these foods each participant consumed (Figure 3.12). A total of 13 sources of potassium were identified.

The residuals were not normally distributed and therefore, the non-parametric, Mann–Whitney U-test was used to confirm the results of the parametric ANOVA test, p=0.89. Levene's test showed that the variances were homogeneous, (p=0.39).



*Mann–Whitney U-test (p=0.43) indicated no significant difference in terms of the mean daily potassium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.39) found the variances homogenous

Figure 3.12: Total potassium sources consumed by the study participants employed by Hotazel Manganese Mines (N=45)

Most of the participants (27%, n=12) consumed nine sources of potassium and only two per cent of the participants (n=1) did not consume any of the potassium sources. An average of 8 (SD 2, CI 8-9) sources of potassium was consumed by the study participants (N=45). There was, therefore, no difference between the hypertensive cases (n=26) and the normotensive controls (n=19) in terms of the mean number of potassium sources consumed, Mann–Whitney U-test (p=0.43).

The QFFQ indicated that the potassium-rich sources mostly consumed were potatoes, bananas, and seeds/nuts. None of the participants consumed any fish (Table 3.11).

Table 3.11: Potassium-rich food products (13) consumed by the study participants employed by Hotazel Manganese Mines (N=45)

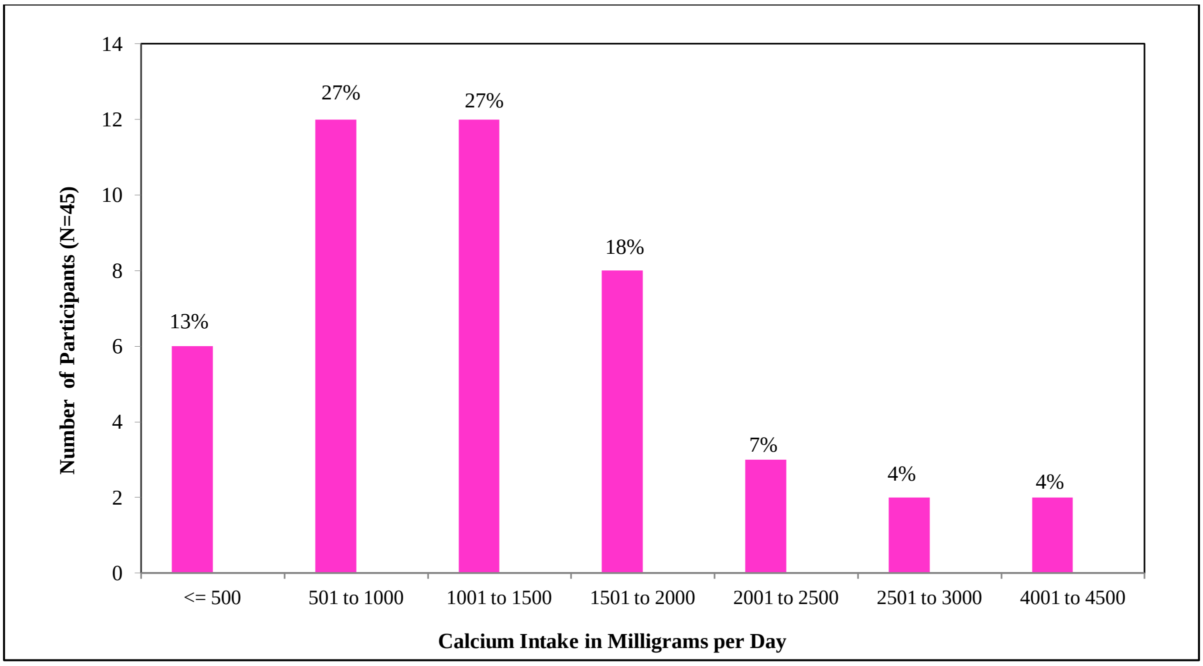
Sources of potassium	Study participants n (%)	Hypertensive cases n (%)	Normotensive controls n (%)
Dried herbs: chervil, coriander, oregano, basil	13 (29)	8 (31)	5 (26)
Dried fruit: apricot, prune, raisins, currents	32 (71)	17 (65)	15 (79)
Avocado	27 (60)	15 (58)	12 (63)
Potatoes	43 (96)	25 (96)	18 (95)
Strawberries	12 (27)	5 (19)	7 (37)
Mushrooms	10 (22)	6 (21)	4 (21)
Bananas	40 (89)	23 (88)	17 (89)
Beans/lentils	36 (80)	21 (81)	15 (79)
Fish: mackerel, sardines, tuna	0 (0)	0 (0)	0 (0)
Tomatoes	39 (87)	24 (92)	15 (79)
Fresh full cream milk and yogurt	31 (69)	18 (69)	13 (68)
Seed/nuts	38 (84)	22 (85)	16 (84)
Turkey/beef	44 (98)	26 (100)	18 (95)

*Mann–Whitney U-test (p=0.43) indicated no significant difference in terms of the mean daily potassium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.39) found the variances homogenous

3.5.4 Calcium

The residuals were not normally distributed and the non-parametric Mann–Whitney U-test was used to confirm the results of the parametric ANOVA test, p=0.28. Levene's test for the homogeneity of variance showed that variances were homogenous (p=0.20).

The recommended daily minimum intake for calcium is 1 000 mg–1 300 mg for adults over 18 years of age.[63,65] In this study, more than half (54%, n=24) of the study participants (N=45) consumed between 500 mg and 1 500 mg calcium per day with 13% (n=6) consuming less than 500 mg per day and 33% (n=15) consuming more than 1500 mg per day (Figure 3.13).



*Mann–Whitney U-test (p=0.45) indicated no significant difference in terms of the mean daily calcium intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.20) found the variances homogenous

Figure 3.13: Total calcium (mg/day) intake of the study participants employed by Hotazel Manganese Mines (N=45)

The mean calcium intake for the study participants (N=45) was 1 345 mg/d (SD 895 mg). The mean intake for the hypertensive cases (n=26) and normotensive controls (n=19) was 1 470 (SD 1 026 mg) and 1 174 mg/d (SD 664 mg) respectively (Table 3.12).The Mann-Whitney U-test found no significant difference (p=0.45) between the mean daily dietary calcium intake of the hypertensive cases (n=26) and that of the normotensive controls (n=19).

Table 3.12: Calcium intake (mg) of the study participants employed by Hotazel Manganese Mines (N=45)

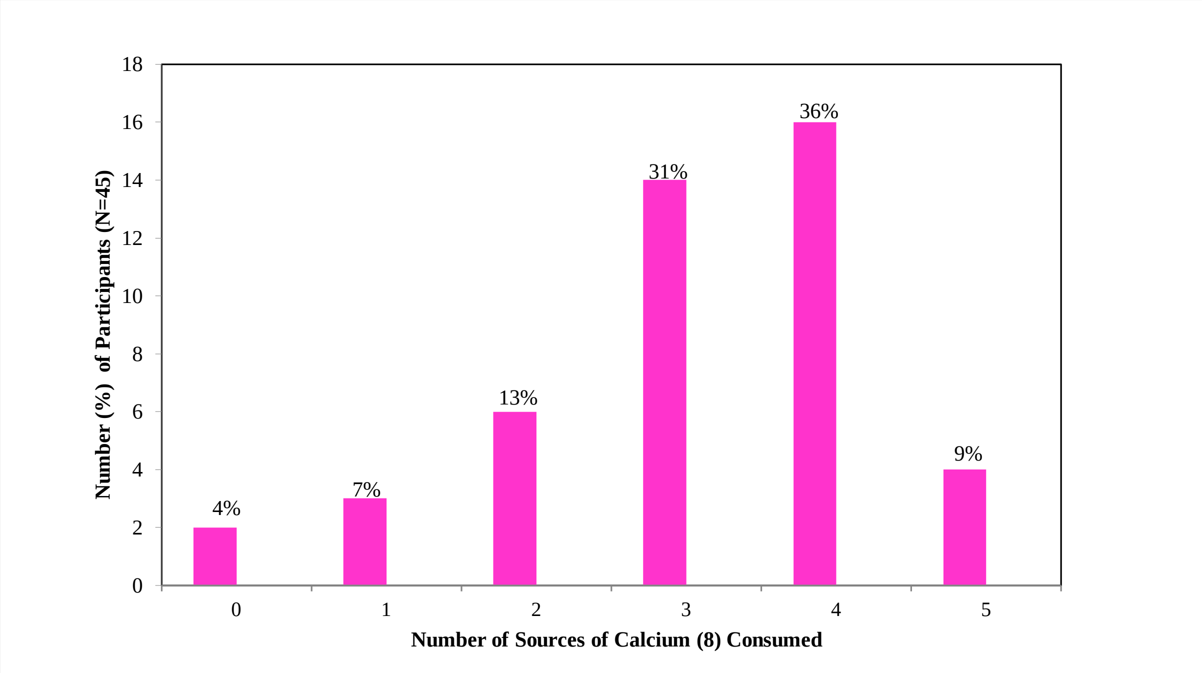
	Daily mean calcium intake (mg)			Probability (p)	
	Mean calcium	**Standard deviation**	**Confidence interval**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	1 345	895	1 076–1 614	N/A	N/A
Hypertensive cases (n=26)	1 470	1 026	1 117–1 823	p=0.45[1]	p=0.20[2]
Normotensive controls (n=19)	1 174	664	761–1 587		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.45) indicated no significant difference in terms of the mean daily calcium intake between the hypertensive cases and the normotensive controls.
[2] Levene's test for the homogeneity of variance (p=0.20) found the variances homogenous

3.5.4.1 Sources of calcium

A list of commonly consumed foods high in calcium was compiled and using data from the QFFQ, the researcher calculated how many of each of these foods each participant consumed (Figure 3.14). A total of eight sources of calcium were identified.

The residuals were not normally distributed and therefore, the non-parametric Mann–Whitney U-test was used to confirm the results of the parametric ANOVA test (p=0.1). Levene's test for the homogeneity of variance showed that the variances was homogeneous (p=0.89).



*Mann–Whitney U-test (p=0.14) indicated no significant difference in terms of the mean daily calcium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.89) found the variances homogenous

Figure 3.14: Total calcium sources consumed by the study participants employed by Hotazel Manganese Mines (N=45)

The average number of sources of calcium consumed by the study participants was 3 (SD 1, CI 3–4) and for the hypertensive cases (n=26) and normotensive controls (n=19) (3 (SD 1, CI 3–4 and CI 2–3 respectively). The Mann–Whitney U-test (p=0.14) indicated that there was no statistically significant difference in the number of calcium sources consumed by the hypertensive cases (n=26) and normotensive controls (n=19). Milk and milk products were the most common sources of calcium consumed followed by dried beans and cabbage (Table 3.13).

Table 3.13: Calcium-rich food products (8) consumed by the study participants employed by Hotazel Manganese Mines (N=45)

Sources of Calcium	Study participants n (%)	Hypertensive cases n (%)	Normotensive controls n (%)
Milk and milk products	43 (96)	26 (100)	17 (89)
Broccoli	14 (31)	9 (35)	5 (26)
Cabbage	26 (58)	15 (58)	11 (58)
Celery	0 (0)	0 (0)	0 (0)
Beans	35 (78)	20 (77)	15 (79)
Peas/petit pois	22 (49)	17 (65)	5 (26)
Soy products	1 (2)	1 (4)	0 (0)
Fortified cereals	0 (0)	0 (0)	0 (0)

*Mann–Whitney U-test (p=0.14) indicated no significant difference in terms of the mean daily calcium sources intake between the hypertensive cases and the normotensive controls.
**Levene's test for the homogeneity of variance (p=0.89) found the variances homogenous

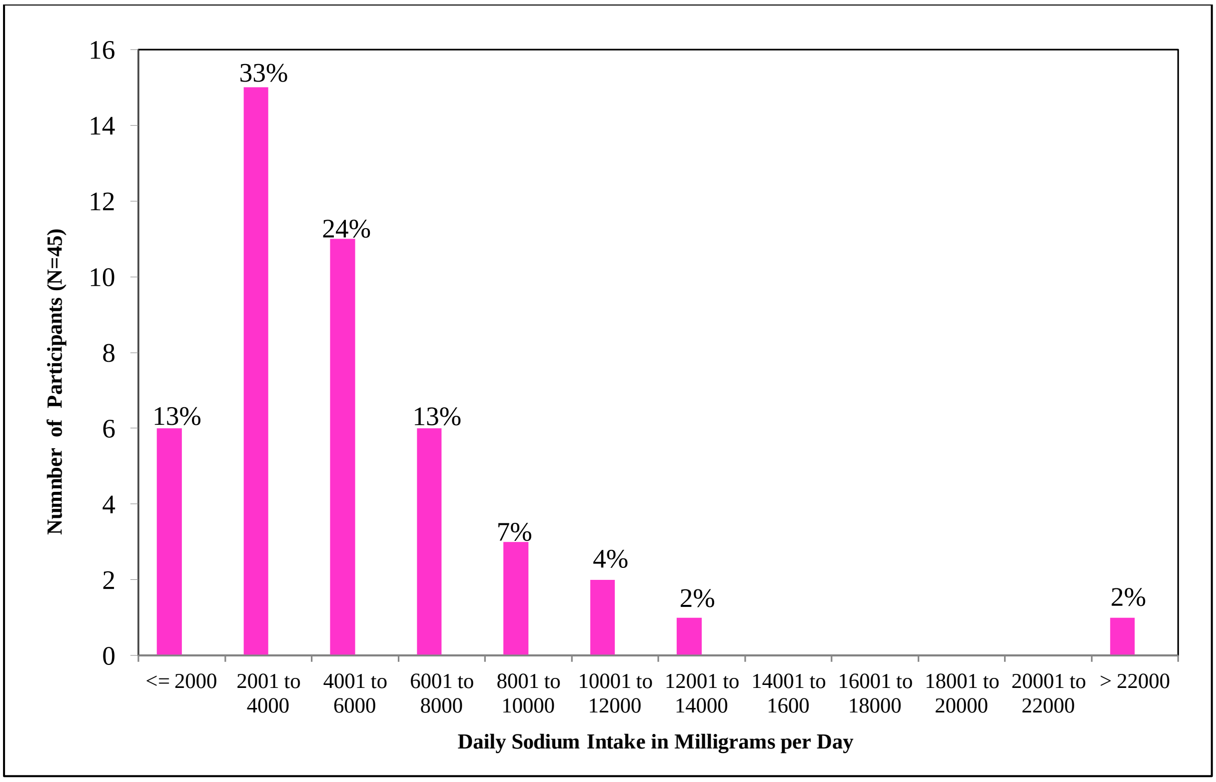
3.5.5 Total fruit and vegetable consumption

The total amount of fruit and vegetables, from a possible 40 was calculated for each individual using the fruit and vegetables listed in the QFFQ. The hypertensives consumed an average of 21 and the normotensives an average of 22, from a possible 40. The parametric Anova test (p=0.66) performed found no statistical association between the total amount of fruit and vegetables consumed and the incidence of hypertension. The non parametric Mann Whitney U test (p= 0.71) confirmed the results found by the Anova test.

3.5.6 Sodium

A non-parametric Mann–Whitney U-test was used to confirm the results of the parametric ANOVA test, p=0.92 as the residuals were not normally distributed. Levene's test, calculated that the variances was homogeneous (p=0.81). Sodium intake was analysed without consideration of salt added at the table.

The total mean daily sodium intake for the study population (N=45) was 5 269 mg (SD 3 820 mg). The WHO recommends a daily sodium consumption of less than 2 000 mg Na per day.[50] Sodium consumption peaked at 2 000 mg to 4 000 mg of sodium per day with 33% (n=15) of the participants consuming these amounts. Only 13% (n=6) consumed less than 2 000 mg Na per day (Figure. 3.15).



*Mann–Whitney U-test (p=0.85) indicated no significant difference in terms of the mean daily sodium intake between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.81) found the variances homogenous

Figure 3.15: Total mean daily sodium intake (mg) of the study participants employed by Hotazel Manganese Mines (N=45)

The Mann–Whitney U-test (p=0.85) confirmed the results of the parametric ANOVA test (p=0.92) that found no significant difference between the daily mean sodium intake of the hypertensive cases (n=26) compared to the normotensive controls (n=19) 5 219 mg (SD 3 046 mg) and 5 337 mg (SD 4 773 mg) respectively (Table 3.14).

Table 3.14: Mean daily sodium intake (mg) of the study participants employed by Hotazel Manganese Mines (N=45)

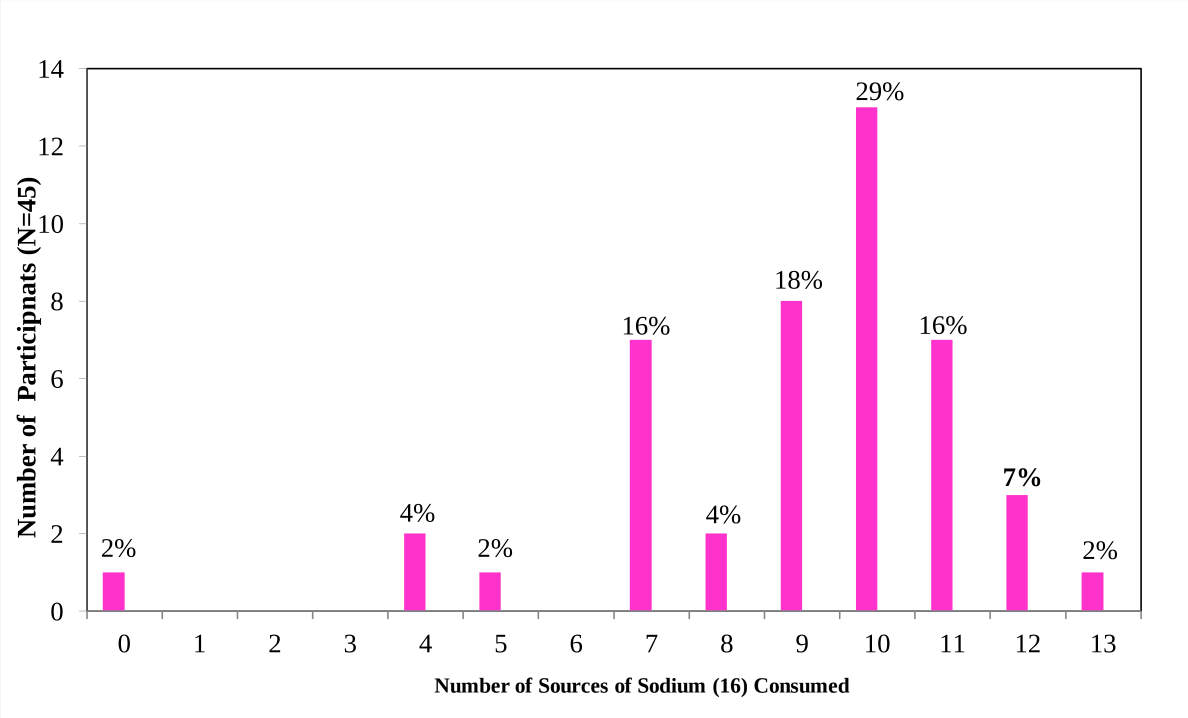
	Daily mean sodium consumption (mg/d)			Probability (p)	
	Mean sodium	**Standard deviation**	**Confidence interval**	**Mann–Whitney U-test**	**Levene's test for the homogeneity of variance**
Total study participants (N=45)	5 269	3 820	4 121–6 416	N/A	N/A
Hypertensive cases (n=26)	5 219	3 046	3 691–6 747	p=0.85[1]	p=0.81[2]
Normotensive controls (n=19)	5 337	4 773	3 550–7 125		

N/A-Not Applicable
[1]Mann–Whitney U-test (p=0.85) indicated no significant difference in terms of the mean daily sodium intake between the hypertensive cases and the normotensive controls
[2]Levene's test for the homogeneity of variance (p=0.81) found the variances homogenous

3.5.6.1 Sources of sodium

A list of commonly consumed foods high in sodium was compiled and using data from the QFFQ, the researcher calculated how many sources of each of these foods each participant consumed (Figure 3.16). A total of 16 sources of sodium were identified.

A non-parametric Mann–Whitney U-test (p=0.57) was used to confirm the results of the parametric ANOVA test (p=0.77) as the residuals were not normally distributed. Levene's test showed that variances were not homogeneous (p=0.01), thus confirming the use of the Mann-Whitney U-test.



*Mann–Whitney U-test (p=0.57) indicated no significant difference in terms of food sources rich in sodium between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.01) found the variances not homogenous

Figure 3.16: Total sodium sources consumed by the study participants employed by Hotazel Manganese Mines (N=45)

Most study participants (54%, n=24) reportedly consumed 10 or more sources of food high in sodium. Only one study participant (2%) did not consume any of the sources of sodium.

An average number of nine food sources of sodium was consumed by the study participants (N=45), hypertensive cases (n=26) and normotensive controls (n=19) (SD 2, CI 8-10; 9 SD 2, CI 8-10 and SD 3, CI 7-10 respectively). The most popular sources of food high in sodium consumed by the study participants were: all types of bread, boerewors, take-aways such as KFC and Steers and French fries (see Table 3.15).

Table 3.15: Sources of sodium (16) consumed by the study participants (N=45)

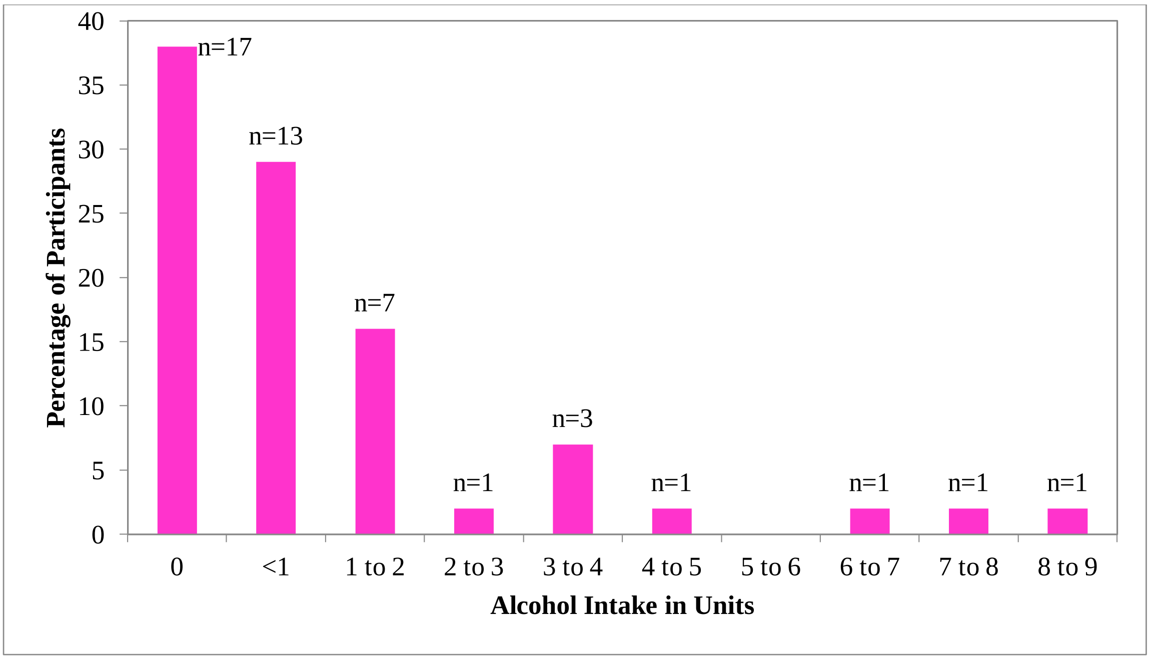
Sodium sources	Study participants n (%)	Hypertensive cases n (%)	Normotensive controls n (%)
Extra salt (yes/no)	10 (22)	6 (23)	4 (21)
Full cream fresh milk	30 (67)	18 (69)	12 (63)
Hard cheese cheddar	35 (78)	23 (88)	12 (63)
Cereals all bran, corn flakes	15 (33)	10 (38)	5 (26)
Bread: all types	43 (96)	25 (96)	18 (95)
Boerewors and other sausages	42 (93)	24 (92)	18 (95)
Cured meats: polony, ham, bacon	34 (76)	22 (85)	12 (63)
Soup powders	33 (73)	19 (73)	14 (74)
Stock cubes	20 (44)	8 (31)	12 (63)
Brick margarine	37 (82)	22 (85)	15 (79)
Aromat	14 (31)	7 (27)	7 (37)
Chips/pretzels/salted popcorn	32 (71)	19 (73)	13 (68)
Savoury biscuits	18 (40)	10 (38)	8 (42)
Take-away	38 (84)	22 (85)	16 (84)
Baked beans	32 (71)	18 (69)	14 (73)
French fries	39 (87)	25 (96)	14 (73)

*Mann–Whitney U-test (p=0.77) indicated no significant difference in terms of food sources rich in sodium between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.01) found the variances not homogenous

3.5.7 Alcohol consumption

The South African National Council on Alcoholism and drug dependence recommends no more than 36 g per day (252 g per week) of pure ethanol for men.[127] Roughly, a unit of alcohol contain between eight to 14 g of ethanol. This means that men should not consume more than two to four units per day.[127]

Thirty-eight per cent (n=17) of the study population (N=45) did not consume any alcohol. Only eight per cent (n=4) of the participants consumed more than four units per day (Figure 3.17).



*The Mann–Whitney U-test found no significant difference (p=0.77) between the hypertensive cases and normotensive controls in terms of alcohol consumption
**Levene's test found the variances homogeneous (p=0.61)

Figure 3.17: Daily total alcohol consumption of the study participants employed by Hotazel Manganese Mines (N=45)

Mean alcohol consumption of the study participants (N=45), hypertensive cases (n=26) and the normotensive controls (n=19), were an average of one unit per day; SD 2, CI 1 -2; SD 2, CI 0.28-2 and SD 2, CI 0.39-2 respectively. The non-parametric Mann–Whitney U-test (p=0.77) confirmed the results of the parametric ANOVA test, p=0.70 that the hypertensive cases (n=26) and normotensive controls (n=19) did not differ significantly in terms of alcohol intake. Levene's test for the homogeneity of variance showed that the variances were homogeneous (p=0.61).

3.5.8 The effect of cigarette smoking

Investigating the effect of smoking in the study participants was not one of the objectives of the study but due to the association of smoking with cardiovascular disease the researcher felt it was important to report the results found. Seventy one per cent (n=32) of the study participants (N=45) did not smoke at all with five participants (11%) smoking five to ten cigarettes a day and only three participants (7%) smoking more than 25 cigarettes per day (Table 3.16).

Table 3.16: Number of cigarettes smoked by the study participants employed by Hotazel Manganese Mines (N=45)

Number of cigarettes smoked daily	Number of participants n (%)
None	32 (71)
0-5	3 (7)
5-10	5 (11)
10-15	1 (2)
15-20	1(2)
20-25	0 (0)
25-30	3 (7)

*Mann–Whitney U-test (p=0.56) indicated no significant difference in terms of the amount of cigarettes smoked between the hypertensive cases and the normotensive controls
**Levene's test for the homogeneity of variance (p=0.65) found the variances not homogenous

The study participants (N=45), the hypertensive cases (n=26) and normotensive controls (n=19), smoked an average of four cigarettes per day (SD: 8, CI: 1.52–6.5); (SD: 8.90, CI: 0.67-7.33 and SD: 7.70, CI: 0.16-7.95) respectively. A normal probability plot indicated that the residuals were not normally distributed; therefore; the non-parametric Mann–Whitney U-test (p=0.56) was used to confirm the results of the parametric ANOVA test (p=0.98). It was found that there was no significant difference between the cases and the controls in terms of the number of cigarettes smoked. Levene's test indicated that the variances were homogenous (p=0.65).

From the results in section 3.4 and 3.5 it is concluded that the null-hypothesis, that there is no significant difference between the hypertensive cases and the normotensive controls regarding lifestyle, is accepted as there was no significant difference between the hypertensive cases and normotensive controls in terms of level of stress, level of physical activity, smoking and alcohol consumption. The null-hypothesis of "no significant difference between the cases and controls regarding diet" is also accepted as there was no significant difference between the cases and controls in terms of energy, saturated fat, sodium, magnesium, potassium, and calcium intake.

3.6 COMPARISON OF THE PARTICIPANTS OF MAMATWAN MINE, WESSELS MINE AND HOTAZEL TOWN IN TERMS OF THE INCIDENCE OF HYPERTENSION

More participants (n=15) who worked on Mamatwan mine developed hypertension (n=11, 73%) compared to those employed at Wessels mine (n=13, 50%) and Hotazel town, (n=2, 50%) (see Table 3.17).

Table 3.17: Place of work of the study participants employed by Hotazel Manganese Mines (N=45)

Mine	Number of participants	Number who developed HT (hypertensive cases) n (%)	Number who did not developed HT (normotensive controls) n (%)
Hotazel town	4	2 (50)	2 (50)
Mamatwan	15	11 (73)	4 (27)
Wessels	26	13 (50)	13 (50)
Total study Participants	**45**	**26**	**19**

*Chi Square test (p=0.30) found no significant difference between the place of work of the hypertensive cases and the normotensive controls

The Chi-square test was performed to investigate the association between the place of work and the development of hypertension (not adjusted for ethnicity). There was no statistical significant association (p=0.30) between place of work and the development of hypertension (hypertensive cases versus normotensive controls).

When ethnicity was taken into consideration, 40% of the white participants (n=2) that worked at Hotazel offices, 60% of those working at Mamatwan (n=3) and none at Wessels mine developed hypertension (Table 3.18). The M-L Chi-square test found a significant association between place of work and the incidence of hypertension for the white participants (p=0.01). However, no significant association was found between the place of work and the incidence of hypertension in the black (p=0.35) and coloured (p=0.23) participants.

Table 3.18: Incidence of hypertension in the ethnic groups at the different mines

Ethnicity	Hotazel n (%)		Mamatwan n (%)		Wessels n (%)		Total N	P value
	Incidence of hypertension							
	Yes	No	Yes	No	Yes	No		
White	2 (40)	1 (25)	3 (60)	0 (0)	0 (0)	3 (75)	9	0.01[1]
Black	0 (0)	1 (9)	7 (47)	3 (27)	8 (53)	7 (64)	26	0.35[2]
Coloured	0 (0)	0 (0)	1 (17)	1 (25)	5 (83)	3 (75)	10	0.23[2]
Total	**2**	**2**	**10**	**5**	**13**	**13**	**45**	

[1]p=0.01 (M-L Chi-square test) indicated a significant relationship between place of work and the white participants
[2]p>0.05 (M-L Chi-square test) indicated no significant relationship between place of work of the black and coloured participants

3.7 ADDITION OF EXTRA SALT AND THE DEVELOPMENT OF HYPERTENSION

Only 22% (n=10) of the study participants reported adding extra salt to their food. Of the 26 individuals who developed hypertension during employment at HMM (i.e. the hypertensive cases) only six (23%) added extra salt to their food and only 21% (n=4) of the normotensive cases (n=19) added extra salt to their food. A Chi-square test found no statistical difference (p=0.87) in salt addition between the hypertensive cases (n=26) and the normotensive controls (n=19). Therefore, the null-hypothesis: "There is no significant difference between individuals who added extra salt to their meals and those who did not in terms of the incidence of hypertension," is accepted.

When ethnicity was taken into consideration, there was no significant difference in the addition of extra salt between the cases and controls in white participants (M-L Chi-square test (p= 0.76) and the Fisher exact one-tailed test (p=0.64)).

Eighty seven per cent (13 out of 15) of the black-, and 67% (4 out of 6) of the coloured hypertensive cases did not add extra salt to their food. Both the M-L Chi-square test and the Fisher exact one-tailed test did not indicate a significant difference between cases and controls in terms of extra salt addition in black (p=0.73 and p=0.57 respectively) and coloured participants (p=0.12 and p=0.33 respectively).

The Cochran-Mantel-Haenszel test with continuity correction calculated no statistically significant difference between the different ethnic groups' extra salt intake in the cases (hypertensives) and controls (normotensives) (p= 0.87).

3.8 CONTRIBUTION OF NUTRITIONAL SUPPLEMENT USAGE TO HYPERTENSION PREVENTION

Thirty-five (77%) participants of the study participants (N=45) did not use the nutritional supplements issued by HMM and of these, 21 participants (60%) developed hypertension. Fifty per cent of the ten participants that did use the nutritional supplements developed hypertension.

A two-way summary table adjusted for the black participants (n=26) indicated that 80% (n=12) of the black participants who did not use the nutritional supplements developed hypertension. Both the M-L Chi-square test (p=0.57) and the Fisher exact one-tailed test found no significant difference (p=0.16) between the black cases and controls in terms of nutritional supplement use.

Eight of the 10 (80%) coloured participants did not take the supplement and 50% (n=4) of these developed hypertension. The two participants that took the supplement both developed hypertension. No significant difference was found between the coloured cases and controls in terms of supplement intake (M-L Chi-square test p=0.12, Fisher exact one-tailed p=0.33). The Cochran–Mantel-Haenszel test for repeated 2X2 tests of independence (with continuity correction) gave a p-value of 0.82, indicating that there was no statistically significant difference between ethnicity (blacks and coloureds) in terms of the consumption of nutritional supplements and the development of hypertension. None of the white participants (n=9) took any nutritional supplements and five (56%) of them developed hypertension.

Therefore, the null-hypothesis: “There is no significant difference between individuals who took additional nutritional supplements and those who did not in terms of the incidence of hypertension,” is accepted.

3.9 THE INCIDENCE OF HYPERTENSION BETWEEN DIFFERENT JOB POSITIONS AND EMPLOYMENT DURATION

3.9.1 Effect of job position

Sixty-two per cent of the study population (28 out of 45) held a level four job position (miners, artisans, administrators) and 16 (57%) of these developed hypertension. Level three job positions was held by 24% (11 out of 45) and six (54%) of these developed hypertension. The only participant (2%) to hold a level two job position developed hypertension. The Mann–Whitney U-test (with continuity correction) indicated no significant difference between the job level held by participants and the incidence of hypertension (p=0.96).

When taking ethnicity into consideration the M-L Chi-square test found no significant difference between the cases and controls in the white (p=0.40) and the black participants (p=0.16) in terms of their job level. In the case of the coloured participants 67% (n=6) of the hypertensive cases held a job position of level three (second most skilled workers) compared to none of the normotensive controls. This was a significant difference (p=0.01), indicating that the coloured participants in a more senior position were possibly more likely to develop hypertension in this study compared to the coloured participants appointed in lower levels.

The null-hypothesis that there is no significant difference between the cases and controls regarding job position is therefore only accepted for the white and black participants but rejected for the coloured participants.

3.9.2 Effect of employment duration

Fifty-four per cent (n=14) of the hypertensive cases was employed for more than 12 years and the normotensive cases (89%, n=17) for less than 12 years (Table 3.19). The centred observations for each group were not normally distributed, therefore, the non-parametric

Mann–Whitney U-test (p<0.01) was used to confirm the results of the parametric ANOVA test (p=0.004) that found the hypertensive cases were significantly longer employed at 14 years (SD10, CI 11-18) compared to the normotensive controls with six years' (SD 7, CI 2-10) employment. Levene's test for the homogeneity of variances found the variances was not homogeneous (p=0.0117).

In addition to the Mann–Whitney U-test, a Chi-square test found a significant result where most hypertensive cases (n=26) were employed for more than 11 years, whereas the majority of the normotensive controls (n=19) were employed 11 years or less (p=0.0071) (Table 3.19).

Table 3.19: Duration of employment and the incidence of hypertension among the study participants employed by Hotazel Manganese Mines (N=45)

Incidence of hypertension	Employment duration		Total
	> 11 years n (%)	**= < 11 years n (%)**	
Yes (hypertensive cases)	15 (88)	11 (39)	26
No (normotensive controls)	2 (12)	17 (61)	19
Study participants	17 (38)	28 (62)	45

*Chi-square test (p=0.0071)

3.10 A SET OF RECOMMENDATIONS TO PREVENT HYPERTENSION IN EMPLOYEES OF HMM

A set of recommendations are provided in Chapter 5 according to the findings to address the corresponding objectives.

CHAPTER 4: DISCUSSION

4.1 INTRODUCTION

The main findings of this study are discussed in this chapter. The results are interpreted and compared with other published research to determine how this study adds to the body of work available. Also, the scope for further research is identified.

4.2 HYPERTENSION

4.2.1 Incidence of hypertension

This study found that more than half of the study cohort developed hypertension after employment at Hotazel Manganese Mines. However, when interpreting the incidence of hypertension in the employees of Hotazel Manganese Mines, one should firstly consider that the study cohort was very small (N=45). A larger study may have found different results. On the other hand, the prevalence of hypertension was significantly underestimated due to Life Health Services using a diastolic cut-off value of 100 mm HG and not the South African Heart and Stroke Foundation's classification of hypertension. After applying the South African Heart and Stroke Foundations classification to the original sample of 88 "normotensive" subjects, only 45 did not have hypertension (according to the South African Heart and Stroke Foundation's classification) and were, therefore, included in the study. At the start of this study, there was an almost 50% underestimation of the prevalence of hypertension using the Life Health Services' cut-off points. This also means that the blood pressure lowering medication prescribed could have skewed the results although to a lesser extent as fewer individuals where diagnosed with hypertension due to the cut-off points used.

Almost all the hypertensive cases developed mild hypertension (140/90 mm HG–159/99 mm HG) whilst the remaining participants developed moderate hypertension (160/100 mm HG–179/109 mm HG). At the start of employment systolic blood pressure for the population peaked at 125-130mm HG and the majority of the participants (60%) had a diastolic blood pressure of 80-89mm HG. Systolic blood pressure at the start of employment is in line with the average systolic blood pressure measurements recorded for the Northern Cape (127 mm HG) during the South African National Health and Nutrition Examination Survey (SANHANES-1 2012), whilst diastolic blood pressure at the start of employment was higher than the average for the Northern Cape at 79 mm HG.[109] A clear shift can be seen in systolic blood pressure before and after commencement of the study. The peak systolic blood pressure of the study population (N=45) increased from 125–130 mm HG before commencement of the study to 135 mm–140 mm HG during employment. Furthermore, it was noted that systolic blood pressure suddenly dropped off after a peak of 140 mm HG, before and during employment. This observation could possibly be explained as the stage where employees were diagnosed as being hypertensive by the Life Health Services occupational nurses and received blood pressure lowering medication. Blood pressure lowering medication could also possibly skew the results of the systolic and diastolic blood pressure readings during employment (although to a lesser extent) as it is not indicated when participants started with the medication—if at all. Diastolic blood pressure peaked at 80–90 mm HG, but there was no clear shift in the diastolic blood pressure before and after employment duration.

4.2.2 Effect of age

Only one tenth of the study population were older than 50 years and the mean age for the study participants was 40 years. Hypertensive cases (average age 42 years) were significantly older than the normotensive controls (average age 36 years) in this study. Systolic blood pressure rose almost linearly with age in most developed populations.[128] Not all populations reported this increase, however, and it is unclear why the rise of systolic blood pressure was seen in some but not in others.[129] This suggests that the rise in systolic blood pressure is not age-related and thus preventable.[129] In individuals up to the age of 50, both systolic and diastolic blood pressure contributes separately to high blood pressure. In individuals over the age of 50, systolic blood pressure is more important in calculating the risk for cardiovascular disease.[12,128] Therefore, age cannot be ascribed as the sole causal factor of this shift in systolic blood pressure seen in this study and further investigation is needed. The increased systolic blood pressure is a cause for concern though, as increased systolic blood pressure is a better predictor of cardiovascular risk than increased diastolic blood pressure.[129]

4.2.3 Employment duration

Increased age goes hand-in-hand with increased employment duration and therefore, the significant association found between employment duration and the development of hypertension in the study population is more likely to be a result of a combination of increased age and the length of employment. In terms of duration of employment, work-related stress could come into play although it was not picked up by this study due to the small sample size of the study participants. A multivariate analysis, with adjustment for confounding variables would have confirmed this assumption. The researcher could, however, not perform this test due to the small sample size.

The average time for the cases to develop hypertension was three years. Repeated ANOVA measurements did not find a significant relationship between the development of hypertension and time after starting employment at Hotazel Manganese Mines. However, the cases had significantly higher mean employment duration of 14 years compared to only six years for the controls. A Chi-square test also calculated a significant association between employment duration of more than 11 years and the development of hypertension, with most of the cases being employed for more than 11 years.

Nevertheless, the suggestion that age may have played a crucial role in the development of hypertension in this study, adds to the findings of a 2012 study in gold miners, where an increased prevalence of hypertension was seen with increased age.[110]

4.2.4 Place of work

No significant association was found between the place of work of the cases and the controls. After ethnicity was taken into consideration, it was found that for the white participants, place of work played a significant role in the development of hypertension. All the white participants in the study population who were employed at Mamatwan Mine developed hypertension. This significant influence of work place on the development of hypertension was not confirmed in the black and coloured participants. It is not clear why employment at Mamatwan mine is a risk factor for the development of hypertension in the white participants, but the results must be interpreted with care due the very small number of white participants as a larger sample may have been given different results. Mamatwan mine differed from the other workplaces in that it is an open-cast mine, therefore much warmer than the underground mine where wide tunnels and powerful fans ensure continuous circulation of cool air and in that sense, is a less strenuous working environment. Further investigation is needed to determine whether the type of mine environment (open-cast or underground) could have an effect on the development of hypertension in certain ethnicities.

Two out of the three white participants employed on Mamatwan mine held more senior job positions and could, therefore, have more work-related stress, although the assumed link between job level and stress could not be confirmed by the results of the stress questionnaire.

4.2.5 Job position

Two-thirds of the study participants held a level four job position (miners, artisans, administrators) and two out of three of these participants developed hypertension. There was no significant difference between the level of job position performed by the cases and the controls. When ethnicity was taken into consideration, no significant relationship was found between job level and the development of hypertension for the white and black participants, however, a significant association was found for the coloured participants. The coloured participants who developed hypertension, mostly held level three job positions (the second most skilled workers). Level three job position included the following types of jobs: specialists, supervisors, shift bosses and safety officers. These types of jobs have a higher level of responsibility and participants employed in these positions could, therefore, be more likely to suffer from stress, although the stress levels between different job levels was not tested in this study.

4.2.6 Stress

An increased number of studies since 2010 indicated that managers and professionals are experiencing higher levels of work-related stress and in turn, increased levels of psychological distress and reduced physical health.[130] Workplace stress was found to be a major contributing factor in employee welfare.[131,132]

Although one expects to find higher levels of stress with higher job levels,[130] in this study only one participant indicated that they might be likely to suffer from stress. This may be explained by the small sample size not including enough individuals doing more jobs levels associated with higher stress levels (level 3). Mental health issues in mining communities in South Africa have been documented in a 2007 study "Family Disorganisation and Mental Health in the South African Mining Industry".[130] Hotazel Manganese Mines meet some of the causal attributes linked with mental health problems, discussed in the 2007 study, namely a rural setting, being fairly isolated and the unique working conditions at each mine—all challenging in their own way.[132] Challenges range from being responsible to drive large earth-moving vehicles, handling of explosives and meeting production targets. Manganese prices are cyclic and every few years, results in job losses, making job security uncertain. Mental stress has been proven to be evidently and completely linked to the development and maintenance of high blood pressure.[132]

In this study, however, stress was not found to be a significant risk factor in the development of hypertension for reasons already explained. Additionally the ISMA^{UK} stress questionnaire used to measure stress in this study was not validated for a mine setting in South Africa and also not for the unique population of mine workers and thus, stress could be underreported in this study. The mine setting in which this study took place, is unique and no specific stress questionnaire could be found that was validated for a mine setting. The ISMA^{UK} was used as it's a leading body in stress management, well-being and performance and has been widely used to assess stress in the work place.[120]

4.3 RISK FACTORS FOR HYPERTENSION

4.3.1 Effect of BMI

After investigation of possible risk factors for the development of hypertension, BMI at the start of employment was found to be at the higher end of the normal category with an average BMI of 24 kg/m^2. BMI peaked at 22–24 kg/m^2 at commencement of employment at HMM and during employment the peak BMI was 28–30 kg/m^2.

During employment, BMI increased with an average of 3 kg/m^2 in the study population with an average BMI of 27 kg/m^2 during various periods of employment and falling into the pre-obese category. This is in line with Stadler that reported an average BMI of 28 kg/m^2 in a population of miners in a South African open-cast mine.[122] The cases had a significantly higher change in BMI (4 kg/m^2) than the controls (1 kg/m^2). Although no significant association was found in this study between BMI at the start of employment and the incidence of hypertension, various studies have indicated that increased BMI is positively and significantly associated with the incidence of hypertension and that this was true over the whole BMI spectrum, even for BMIs still in the "normal" range.[96,133] This warrants a need for future research on a larger study population of mineworkers.

4.3.2 Effect of energy intake

The average energy intake of the sample population was almost double the recommended intake of 10 500kJ (depending on activity level) for the general population. This could possibly be explained by over reporting as the QFFQ is known to over report dietary intake.

Similar studies reported lower average energy intake (Stadler 120881Kj and Dias et al 8014kJ.) It has to be noted though that the 24 hour recall questionnaire, used by Dias et al, is known to underreport dietary intake.[111,122] "A Review of Dietary Intakes in the Adult South African Population from 2000-2015" also reported on average similar energy levels as Dias et al (8867Kj) but include rural and urban populations and the instruments used to obtain the data include both the QFFQ and 24 hour recall questionnaires.[134]

The cases also reported a higher energy intake than the controls. Although this difference was not statistically significant it still indicated a trend of a higher energy intake among the hypertensives and may be of clinical value. Therefore the hypothesis cannot out rightly be rejected as this will skew the results. Lifestyle interventions to prevent and treat hypertension always include weight reduction (thus a reduced calorie intake).[135] Increased BMI, high energy consumption and employment duration more than 11 years, when combined, may have contributed to the development of hypertension in this study even though the individual contributions may not have been significant.

Measurement of energy intake at the start of employment was not possible due to the historical (retrospective) nature of the data collected from medical records. However, it can be expected that energy intake after commencement of employment could be higher due to additional nutritional supplement consumption provided by HMM. Supplement ingestion was quantified and added to the relevant participants' data (energy, macro- and micronutrient intake. The manufacturer/supplier of the supplements provided a generic average of the total nutrients provided by all the different types (including shakes and porridge) and flavours of the product. A 100 g of the supplement provided, contributes 1 693 kJ or 16% of the total energy requirements on average over all the different types. Supplement consumption other than that provided by HMM was not recorded. After comparison of the hypertensives versus the normotensives in terms of supplement intake, no significant association was found. It should also be noted that more than three quarters of the black participants who did not consume the nutritional supplements developed hypertension, even though the effect of nutritional supplements was not statistically significant. Therefore, no evidence was found that the nutritional supplementation is beneficial to this population and provision thereof by the mining company should be reviewed, especially since it appears that the nutritional supplements are not taken by a large number of participants. The lack of evidence might be due to the small sample size of the study and the association of supplement intake and incidence of hypertension need further investigation. No literature was available on nutritional supplement usage and its effect on hypertension in a mine setting and there is a clear paucity of comparative data.

4.3.3 Effect of saturated fat intake

Two fifths of the population of mine employees consumed a large amount of saturated fat, with saturated fat consumption peaking at a level double the recommended daily allowance for fat intake of no more than 10% of total energy intake. Therefore, the peak saturated fat consumption of the study participants contributed one fifth of the recommended total energy consumption from saturated fat. This is also double the average saturated fat intake reported by Stadler (33g).[122] The "Review of Dietary surveys in the Adult South African Population from 2000 to 2015 calculated an average saturated fat intake of 25% of the total average energy intake more than double the recommended 10%.[134] The hypertensive cases consumed more saturated fat than the normotensive controls but this difference was not statistically significant. Although no significant association could be found between saturated fat intake and the development of hypertension, the descriptive data clearly indicates that saturated fat intake of this study population is too high, with both the hypertensives and normotensives consuming far more than the recommended daily amount of saturated fat.

The Multiple Risk Factor Intervention Trial, comparing the intake of monounsaturated fats and saturated fats in a diet and their effects on blood pressure found that the monounsaturated fats reduced systolic and diastolic blood pressure and that the type of fat rather than the amount of fat was more important in determining health outcomes.[136,137] One of the main findings of the Multiple Risk Factor Intervention Trial was that there was a significant positive relationship between saturated fat consumption and increased diastolic blood pressure, thus consuming less saturated fat and more monounsaturated fat could decrease diastolic blood pressure, although there was no shift in the diastolic blood pressure in this study.[135] No effect was found between reduced saturated fat intake and reduced systolic blood pressure in these studies. It is known, however, that a high saturated fat diet increases body weight (and therefore BMI) and can also increase blood cholesterol, which may increase the risk of hypertension and cardiovascular disease. Therefore, it is recommended that this population of mine workers reduce their saturated fat intake and increase their monounsaturated fat intake.[13,138]

4.3.4 Effect of sodium intake

One third of the study participants consumed between 2 g and 4 g sodium per day, with the recommended daily allowances being no more than 2 g per day. Apart from the salt added during meals, the mean sodium intake for the total group was more than double the recommended daily maximum intake. Surprisingly, the hypertensive cases and the normotensive controls consumed the same amount of sodium through their diet. These amounts could be even higher as the Foodfinder software, which was used to analyse dietary intake, did not include daily added salt and it is not clear how accurately Foodfinder analyses sodium content. This is due to the different amounts of sodium added to food products which varies vastly between types of products and brands.

Although statistical tests did not show a significant association between the sodium consumption and the development of hypertension in this study population, it is clear from the descriptive data that sodium consumption for the whole group is much higher than the recommended consumption for good health outcomes. High sodium intake is linked to elevated blood pressure, which in turn, is a major risk factor for the development of cardiovascular disease.[139] Findings from this study support the findings of the “Global Sodium Consumption and Death from Cardiovascular Disease” study that 119 out of 187 (88%) countries investigated exceeded the recommended two grams of the WHO with more than one gram.[139] It appears that in populations on a salt intake of more than three grams per day, the proportion of individuals with hypertension rises with age, and the phenomenon is more pronounced when the salt intake is higher.[139] According to the QFFQs analysis in this study, an average of nine food sources with a high sodium content were consumed by the group as a whole. The high sodium intake is, however, not represented by the average number of sodium sources consumed. That could be due to the type of sodium sources consumed with some sources having higher sodium content per 100 g than others. For all the popular sodium sources consumed, the cases consumed more sources than the controls. Boerewors and other sausages, cured meats, brick margarine and take-aways contributed the most to the average daily sodium intake of the study participants.

4.3.5 Added salt

The amount of extra salt participants added to their food could not be quantified, as food finder does not provide this option. Each participant did however indicate if they regularly add extra salt to their food in a yes/ no question format. The cases and controls was statistically analysed for extra salt addition.

Only one fifth of the hypertensive cases reportedly added extra salt to their food. Of the black participants, nearly 90% developed hypertension without having added extra salt to their foods. This association between race and hypertension was found to be insignificant, but this adds to the various studies highlighting race as a major contributory factor in hypertension development as the black race have been found to be more sensitive to rises in blood pressure due to their impaired ability to excrete salt.[140] Also, salt intake in black population is mostly due to the types of food they eat and not through adding extra salt to their food.[141]

4.3.6 Effect of mineral intake

The DASH diet has been found to significantly lower blood pressure and contains a high amount of potassium, calcium and magnesium, mostly due to the high consumption of fruit and vegetables that are an integral part of the DASH diet.[138] The high levels of potassium, calcium and magnesium are thought to be to some extent responsible for the blood pressure lowering effects of the DASH diet.[136]

In this study, the mean consumption of magnesium, potassium and calcium were all higher than the recommended daily consumption, and much higher than the values in “A review of Dietary Surveys in the Adult South African Population from 2000 to 2015”.[134] The cases had a higher average intake than the controls for all three minerals but this was not significant and no protective effect of these minerals could be seen in this study

The relatively high calcium consumption found in this study could be explained by the type of calcium sources consumed and not the quantity, as an average of three sources were consumed by the group as a whole. Milk and milk products had the highest consumption followed by beans, cabbage and peas/petit pois. A high calcium intake can cause constipation and it could also interfere with the absorption of iron and zinc although it is rare getting too much calcium from food.[65]

Clinical trials have found a beneficial association between a higher calcium intake and reduction in blood pressure and the risk of hypertension although the reductions were inconsistent.[65] In contrast, other studies have found a weak or no association between increased calcium consumption and incidence of hypertension[65] and that is in line with the results of this study where no protective effect of calcium on the incidence of hypertension was found.

The total study participants consumed an average of three magnesium sources. On average 552 mg of magnesium was consumed by the total study participants and the hypertensive cases and normotensive controls consumed 623 mg and 455 mg respectively, more than the recommended dietary allowance of 410 mg–420 mg. This high consumption of magnesium from food sources does not pose a health threat as the extra magnesium is excreted by the kidneys in the urine.[61] The magnesium sources mostly consumed were green beans, cucumber, and spinach. Magnesium and calcium might help to lower blood pressure, especially if consumed in accordance with the DASH dietary pattern. Yet, evidence confirming the blood pressure lowering effects of magnesium and calcium are still inconclusive and it is advised to meet the adequate intake for calcium and the recommended dietary allowance for magnesium from food sources and not from supplements.[141,142]

In this study, potassium intake was high—almost double the recommended daily allowances and more than the DASH diet's recommended adequate intake for potassium (4 700 mg/day). It was also more than the safe upper or guidance level of intake (3 700 mg) according to the RDI.[142] The high intake of potassium in this study should not be detrimental to the participants health as the toxicity of potassium is rare due to the excretion of excess potassium by the kidneys and toxicity is mostly found with a high consumption of potassium supplements.[141] It could be beneficial though, as high potassium intake has been linked with a reduced risk of death due to cardiovascular disease.[143]

The average number of potassium sources consumed was eight. The high potassium intake in this study is probably due to the high number of potassium sources consumed by the study participants. Of these food sources mostly consumed by the study participants, beans, lentils and potatoes contained the most potassium.

Potassium works in conjunction with sodium to maintain the body's normal blood pressure.[143] Research suggests that a high potassium intake protects against the development of hypertension by increasing the amount of sodium removed from the body and a high potassium intake has also been associated with a lower risk of cardiovascular disease. The association between a high potassium intake and risk for cardiovascular disease have not been tested in this study and warrants further investigation. No statistical association was found between the amount of total fruit and vegetables consumed by the hypertensive cases and the normotensive controls.

4.3.7 Effect of alcohol intake

HMM hold social functions where alcohol is served frequently, thus the alcohol consumption was not as high as anticipated. Nearly four out of every ten participants consumed no alcohol and less than ten per cent consumed more than six units per day, with the mean alcohol consumption being one unit per day. This is in line with the recommendations by the South African National Council on Alcoholism and Drug Dependence that advises no more than two to four units per day for men. No significant difference was found between the alcohol intakes of the cases and the controls. These findings are in line with current studies that indicate the difficulty in establishing a causal link between alcohol and blood pressure due to confounding.[103] Alcohol is energy dense and could contribute to obesity and therefore, even with the number of units of alcohol consumed within the recommended allowance it could still be a contributory factor in the increased BMI of the sample participants as two to four units per day add up to an additional 112 to almost 400 calories per week.[101] Alcohol intake could possibly be under-reported and therefore, introduce information bias[144] as the participants may not have included alcohol intake at social gatherings and be seen as drinking too much.

4.3.8 Effect of cigarette smoking

Less than one third of the participants reportedly smoked, thus smoking was not found to be a risk factor for the development of hypertension in this study. No significant difference was found between the hypertensives and normotensives in terms of the number of cigarettes they smoked. Even though this study reported a low incidence of smoking, the number of cigarettes smoked could have been underreported by the study participants and information bias introduced.[142] Irrespective of the result, smoking cessation should be actively promoted as smoking is a major risk factor for the development of cardiovascular disease.[43,145]

4.3.9 Effect of physical activity

The level of physical activity was not found to be significantly different between the cases and controls. One fifth of the hypertensive cases and a quarter of the normotensive controls had a low activity level. This might be due to the high number of participants doing non-supervisory jobs with two thirds being employed on level four (miners, artisans, administrators). Only a tenth was employed on level five (cleaners, operators, helpers), performing jobs which tend to be more manual and labour-intensive. Increased physical activity has been found to reduce systolic and diastolic blood pressure with 2–3 mm HG[146] and regular aerobic activity should be encouraged for all job levels. The conclusion is, therefore, that physical activity or lack thereof was not a risk factor in the development of hypertension in this study.

In summary, although many factors did not appear to play a significant role in this study, the small sample size may not have been effective in identifying statistically significant differences due to type III error and due to reduction in the power of statistical tests and mistaken acceptances of the null-hypotheses. However, all the small, insignificant results, when combined, could produce an overall significant result, similar to those reported in the case of the DASH diet principles.[74, 142]

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

5.1.1 Summary of findings and conclusion

The incidence of hypertension in the employees of HMM was vastly underestimated due to the diastolic cut-off used by the health practitioners of Life Health Services. More than half of the participants developed hypertension (hypertensive cases) after being employed at Hotazel Manganese Mines.

Most of the hypertensive cases were employed for more than 11 years. Systolic blood pressure increased during employment but diastolic blood pressure followed more or less the same pattern before and during employment. The increase in systolic blood pressure could be linked to the increased age of the study participants that are again associated with the increased duration of employment. The hypertensive cases (n=26) worked on average significantly longer than the normotensive controls (n=19) and were also significantly older than the normotensive controls. Coloured participants in more senior positions were significantly more likely to develop hypertension compared to those in lower-level jobs. For the white participants only, the incidence of hypertension was significantly associated with whether they were employed on Wessels mine, Mamatwan mine or Hotazel town (with those employed on Mamatwan mine more likely to develop hypertension). Lifestyle played a role in the incidence of hypertension with a significant increase in BMI during employment in the hypertensive cases of 3 kg/m^2. The increase of BMI during employment could be linked to the energy intake of almost double the recommended dietary allowances alongside saturated fat consumption of more than double the recommended dietary allowances, although energy-, and saturated fat intake was not found to be significantly associated with the incidence of hypertension in this study.

Consumption of sodium was also more than double the recommended dietary intake, although only a fifth of the participants added extra salt to their food. Thus, the deduction can be made that the high sodium consumption can be ascribed to the types of food eaten rather than the mere addition of extra salt.

The consumption of other minerals, important in the DASH diet due to their blood pressure lowering effects,[141,142,143] like magnesium, potassium and calcium were all above the recommended dietary allowances and no association were found with these minerals intakes and the incidence of hypertension. The consumption of these minerals are a positive sign as most fruit and vegetables are rich in these minerals and therefore, could indicate that most participants consumed plenty fresh fruit and vegetables, a recommendation of the DASH diet. The level of physical activity, stress levels, alcohol consumption, smoking, and nutritional supplement usage were also not identified as risk factors for the incidence of hypertension in this study.

5.2 SUMMARY OF HYPOTHESES TESTED

- The null hypothesis, “There is no significant difference in the incidence and classification of hypertension in male employees of the different Hotazel Manganese Mines,” remains unanswered.

- The null-hypothesis, “There is no significant difference between the hypertensive cases and the normotensive controls regarding lifestyle” was accepted as there was no significant difference between the hypertensive cases and normotensive controls in terms of level of stress and level of physical activity.

- From the results in section 3.4 and 3.5 it is concluded that the null-hypothesis, that there was no significant difference between the hypertensive cases and the normotensive controls regarding lifestyle, was accepted as there was no significant difference between the hypertensive cases and normotensive controls in terms of level of stress, level of physical activity, smoking and alcohol consumption.

- The null-hypothesis of “no significant difference between the cases and controls regarding diet” was also accepted as there was no significant difference between the cases and controls in terms of saturated fat, sodium, magnesium, potassium, and calcium intake. The null-hypothesis for energy intake cannot be out rightly rejected because although no statistical significant differences were found between the cases and the controls, the cases consumed much more energy than the controls, indicating a trend in energy intake and the development of hypertension. This trend may be of clinical value.

- The null-hypothesis: “There is no significant difference between individuals who took additional nutritional supplements and those who did not in terms of the incidence of hypertension,” was accepted.

- The null-hypothesis, “There is no significant difference between the cases and controls regarding job position” was only accepted for the white and black participants but rejected for the coloured participants.

5.3 IMPLICATIONS OF THE STUDY

The study gave a good insight into the eating habits and lifestyle of the study participants and was able to identify factors Life Health Services should focus on in improving the overall health and hypertension status of miners. Not many nutritional studies in a mining environment are available and this study added valuable data on lifestyle factors despite the small sample population. This study also gave valuable insight into the obstacles and problems to consider when undertaking future studies of this nature in mines and could be used as a pilot study for future reference.

5.3.1 Potential for further research

Other factors that warrant further research but fall outside the scope of this investigation

Carbohydrates: A review of whole grain intake over 11 prospective studies strongly indicated that increased whole grain intake (unrefined carbohydrates and fibre) protects against high blood pressure. In cohort studies carbohydrate intake in relation to total energy intake was not found to be associated with blood pressure and in a meta analysis of adults the replacement of fats with carbohydrates strongly indicated to a short term increase in blood pressure. It is difficult to establish the effect of refined carbohydrates on blood pressure due to the association of unrefined carbohydrate intake with obesity, a major risk factor for hypertension.

Trans fatty acids: Positive links was found between trans fatty acid intake and hypertension in women middle-aged and older women. The effect of trans fatty acids in men are not clear although various studies found a positive association between dietary trans fatty acid intake and cardio vascular disease.

Unsaturated fats: In the Omniheart study comparing three diets. All of the diets where like the Dash diet lower in saturated fat, cholesterol, and high in fruit, vegetables, fiber, potassium and other minerals. In addition, the three diets differed with the first being high in carbohydrates (58% of the total calorie content), the second rich in protein and the third rich in unsaturated fats (especially monounsaturated fats). All diets lowered blood pressure and with a further replacement of 10% of the calories from the carbohydrate with either protein from plant origin or unsaturated fats blood pressure were lowered even further.

5.4 LIMITATIONS OF THE STUDY

- Blood pressure and weight was not measured at the time of data gathering as the researcher could not use the Life Health Services facilities at the time of data gathering. This was not known in advance and was due to a significant number of patients at the time of data collection. Therefore, the last available weight and height measurements recorded in the medical files for each participant were used. This meant that the BMI at the start, BMI after a period of employment and the change in BMI calculated might not represent the true values and could be over- or under represented.
- Life Health Services used a diastolic cut-off of 100 to classify hypertension, which is not correct according to the South African Heart and Stroke Foundation's classification with a diastolic cut-off of 90. This cut-off resulted in the perceived prevalence of hypertension being greatly underestimated. It also resulted in the small sample size as the researcher only started to classify the employees according to the South African heart and stroke foundation classification after most of the data has been collected. Therefore, about half the data already collected, could no longer be used.
- Measurement of height to calculate BMI was not standardised by Life. Differing measures of height was available for some participants. A mean height was used for calculation of BMI in these instances. Again, this meant that BMI at the start, BMI after employment duration (last available BMI) and the change in BMI might not have been correctly calculated and could be over- or under represented.
- The original list of employees randomly drawn for Wessels mine could not be used, therefore the participants on Wessels mine were not chosen randomly. This meant that individuals were included in the study based on availability rather than to be representative of the population on Wessels mine. This introduced biases like the under- or over representation of particular groups. In this case a larger proportion of the lower skilled workers took part in the study as it was less disruptive when they were absent from their duties for the purpose of data gathering.
- Due to the small sample size of this study, the large probability values calculated for some of the risk factors not necessarily indicates that no association or link exists, but only that the sample was too small to detect a significant link or association.
- Some of the mine mangers were not willing to support the study even though it was approved by head office.

- The pilot study was very small and not adequately representative and inclusive enough of the study population, therefore, the difficulty some participants experienced with understanding the questions was not highlighted during the pilot study.
- The stress questionnaire used was not validated for a mine setting and therefore, stress levels could be underreported.
- The Quantified Food Frequency Questionnaire used to elicit dietary data on usual food intake is known to over report dietary intake. The extent of the possible over reporting was not quantified. Further studies are needed to investigate the possible over reporting using repeated food records or dietary records. This will enable calculation of within-subject variation of energy intake- a requirement for the Goldberg cut-off points.

5.5 RECOMMENDATIONS

Ignorance and lack of health education are mostly the reasons for unhealthy eating habits and the following recommendations were formulated to improve overall knowledge and education of the employees of HMM; as well as recommendations for the occupational nurses and for the Life Health group to assist in improving health and hypertension status in all employees.

- 5.5.1 Teach employees the principles of the DASH diet[136]
    - Eat plenty of fresh fruit and vegetables
    - Reduce the consumption of foods high in saturated fat, cholesterol and trans fats
    - Eat more whole grains, fish, poultry and nuts
    - Eat less food with a high sodium content, sweets, sugary drinks and red meat
    - Reduce added salt
- Provide basic, mandatory nutritional guidance to all employees and arrange for a nutritionist or dietician to visit each mine at least once a month to provide nutrition education. Nursing staff of Life Health Services should have clear guidelines of when to refer employees to the dietician timeously.
- Advise employees on the danger of excessive alcohol consumption and the benefits of smoking cessation and its effect on their health and hypertension status.
- Provide cooking classes to employees and their partners/wives regarding healthy eating once a month by a chef or nutritionist—demonstrating healthy recipes and healthy cooking methods.

- Make health an integral part of the mine's health and safety systems. Personal safety is promoted throughout the mines using banners, billboards, posters and signs; and the same should be done with health information and warnings about alcohol consumption and smoking. The messages on health signs and posters must be presented consistently and to the point, without bombarding the reader with too much information.
- Standardise the procedures performed by staff at Life Occupational Health Group in taking weight and height measurements as well as blood pressure.
- Only use the most recent classification system to classify hypertension such as the Heart and Stroke Foundation's system. By introducing the increased diastolic cut-off bias, a large number of participants will have hypertension according to the Heart and stroke foundation classification system, which would not be identified when using the current system used by Life Health group. Furthermore, the Life Health system's cut-off values should emphasise the systolic blood pressure rather than the diastolic blood pressure. Studies have shown that systolic blood pressure is a better predictor of cardiovascular risk than diastolic blood pressure.[129]
- Change nutritional supplements to coupons that can be exchanged at the surrounding supermarkets for fresh fruit and vegetables. In the same way that the supplements are being distributed through a workshop on each mine, the coupons can be distributed to eligible employees—especially those on lower income levels.
- Monitor new employees at HMM with a BMI in the high normal range (23 kg/m2).
- Implement weight reducing interventions for those employees with a BMI over 25 kg/m2. The "Biggest Loser"-type competitions between employees have shown, in the past, to produce good results, but as soon as participants return to their "normal" way of eating they regain the weight lost. The following suggestions should be considered regarding a "Biggest Loser challenge" or to make it positive "the biggest winner".
    - Increase the incentives for participating. Find sponsors for prizes for the winners.
    - Make the competition wider. Rather than only have employees from Hotazel Manganese Mines competing against one another, get all the surrounding mines involved (e.g. Thsipi, Kumba, and Black Rock).
    - Hold the competition annually and have a prize-giving ceremony.

    - Motivate the employees to maintain the weight they lost with prizes given for those who maintain their goal weight longer with six monthly and yearly intervals etc.
- Give special attention to employees approaching or falling in the “at risk of hypertension” age group (>40 years).
- Give special attention to participants falling into the more “at risk” ethnic groups such as the black population.
- Investigate and validate the usage of the ISMAUK in a mine setting or use the Brunel Mood Scale (BRUMS)[147] that have been validated for a South African population in 2011 to investigate mood rather than stress.
- Get an expert on stress to come and talk to the employees and give them practical ways to help them to feel less stressed.
- In terms of dissemination of the information to the study population, the Life health care workers will play a crucial by:
    - Formal feedback will be given to management of HMM, educating them on the outcomes of the study and the recommendations
    - Explaining the outcomes of the study at each employee’s yearly check up and providing a information leaflet to each employee explaining the outcomes of the study and the recommendations in a language they understand
    - Involving the employees in the weight loss competitions. making sure the posters and information boards educating the study population about the findings and recommendations of the study are placed at strategic places around the mines

5.6 PERSONAL DEVELOPMENT GAINED BY THE RESEARCHER

Deciding on a research subject was a bit tricky. However, growing up in Hotazel town and the surrounding area (with my parents both being employed by Hotazel Manganese Mines), I knew I wanted to base my study on the mines. I also really wanted the thesis to be of benefit to the people working at the mines. The whole process of searching for literature to back up statements has given me a whole different outlook on research in general and I am much more critical when reading any research. I am now much more confident than before the commencement of this study to search for literature and to review it. Before I would not have thought of myself as an academic, but being able to complete this thesis made me realise I can do anything I set my mind to. It has taught me to think analytically and look critically at the evidence presented.

There were numerous obstacles to overcome while doing this study and various people have told me just to throw in the towel. Also, the constant change in senior management of the mining group made it difficult to progress smoothly as this meant new correspondence to explain the study, which delayed the progress, as I could not carry on with the study without new approved consent. I have never been a quitter and finally, being able to submit the thesis, is such a personal achievement.

I did not anticipate liking to write the section on the discussion. I found it challenging, but by bringing all the findings together, I also found it really rewarding to see how the research I have spent so much time on, start to form a picture in terms of the factors investigated. I feel that I achieved my goals for doing this study; the research will give Life Health Services and Management of Hotazel Manganese Mines a good indication on problem areas (even with the relatively small sample size). The recommendations I wrote should also improve the overall health and hypertension status of the population.

5.7 CONCLUSION

After investigating the perceived incidence of hypertension in a male cohort of 45 participants employed by Hotazel manganese mine in the Northern Cape of South Africa, it was found that more than half of the study participants developed mild hypertension after being employed for more than three years. The risk factors for the development of hypertension identified were:

- Age (mean age 40 years), alongside an employment duration of more than 11 years
- Place of work for white participants, with those employed on Mamatwan mine being more likely to develop hypertension
- An average BMI change over employment duration of 3 kg/m^2
- Coloured participants in more senior positions (level one and two) were more likely to suffer from hypertension

Other factors that caused reason for concern were:

- Systolic blood pressure that increased from between 125-130 mm HG before employment to 135-140 mm HG during employment
- It took, on average, three years to develop hypertension
- A very high energy intake of almost double (19 821 kJ) the recommended allowance of 10 500 kJ.
- Very high saturated fat consumption of an average of 60 g/day on average, more than twice the recommended maximum allowance of 28 g/day

- More than double the maximum recommended sodium allowance of 2 g, with a high average sodium intake of 5.3 g per day and a high average consumption of sodium sources (nine out of 16)
- Thirteen (87%) out of the fifteen black participants who did not add extra salt to their food still developed hypertension

Potassium, magnesium and calcium intake was, on average, above the recommended daily intake advised and in line with the DASH diet recommendations. The high energy intake of the cases (although not significant), alongside increased BMI and long employment duration may increase the likelihood of the population developing hypertension.

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ADDENDA

Addendum 1: Nutritional supplements composition

Supahealth Product
Typical analysis-AVERAGE NUTRITIONAL CONTENT PER 100GM

Product: Milkshake	Flavour: Banana	

Moisture	gm		3.17
Kilo Calories	K cal		420
Kilojoules	kj		1693
Total Protein	gm		6.48
Total Fat	gm		10.64
Saturated fatty acids	gm		9.76
Mono-unsaturated fatty acids	gm		0.29
Poly-unsaturated fatty acids	gm		0.00
Cholesterol	milligram		0.00
Total Carbohydrates	gm		78.20
Dietary Fibre	gm		0.00
Ash	gm		2.79
Calcium	milligram	Ca	200
Phosphorus	milligram	P	163
Iodine	ug (microgram)	I	30
Iron	milligram	Fe	4.1
Magnesium	milligram	Mg	16
Potassium	milligram	K	420
Sodium	milligram	Na	647
Copper	milligram	Cu	0.19
Zinc	milligram	Zn	3.25
Selenium	ug (microgram)	Se	13
Vitamin A	RET equivalents		206
Thiamine	milligram	Vitamin B1	0.28
Riboflavin	milligram	Vitamin B2	0.37
Nicotinic acid	milligram	Vitamin B3	3.6
Vitamin B6 (Pyridoxine)	milligram	Vitamin B6	0.413
Total Folic acid	ug (microgram)	Vitamin B9	41
Vitamin B12 (cyanocobalamin)	ug (microgram	Vitamin B12	0.2
Pantothenic acid	milligram	Vitamin B5	1.26
Biotin	ug (microgram)	H	20
Ascorbic acid	milligram	Vitamin C	262
Vitamin D	ug (microgram)	Vitamin D	1.00
	IU	Vitamin D	40
Vitamin E	M g a – TE	Vitamin E	2.08
	IU	Vitamin E	3.00
Potassium chloride	milligram	Electrolyte	+
Sodium bicarbonate	milligram	Electrolyte	+
Basic Composition: Sugar, creamer, carbohydrates, permitted flavourants and colourants. Additives: Vitamins and minerals, extra Vitamin C, calcium and electrolytes S. Scharf RD / DWB 02/04			

Addendum 2: Malnutrition Universal screening tool

BAPEN
Advancing Clinical Nutrition

'Malnutrition Universal Screening Tool'

MAG
Malnutrition Advisory Group
A Standing Committee of BAPEN

BAPEN is registered charity number 1023927 www.bapen.org.uk

'MUST'

'MUST' is a five-step screening tool to identify **adults**, who are malnourished, at risk of malnutrition (undernutrition), or obese. It also includes management guidelines which can be used to develop a care plan.

It is for use in hospitals, community and other care settings and can be used by all care workers.

This guide contains:

- A flow chart showing the 5 steps to use for screening and management
- BMI chart
- Weight loss tables
- Alternative measurements when BMI cannot be obtained by measuring weight and height.

The 5 'MUST' Steps

Step 1

Measure height and weight to get a BMI score using chart provided. ***If unable to obtain height and weight, use the alternative procedures shown in this guide.***

Step 2

Note percentage unplanned weight loss and score using tables provided.

Step 3

Establish acute disease effect and score.

Step 4

Add scores from steps 1, 2 and 3 together to obtain overall risk of malnutrition.

Step 5

Use management guidelines and/or local policy to develop care plan.

Please refer to *The 'MUST' Explanatory Booklet* for more information when weight and height cannot be measured, and when screening patient groups in which extra care in interpretation is needed (e.g. those with fluid disturbances, plaster casts, amputations, critical illness and pregnant or lactating women). The booklet can also be used for training. See *The 'MUST' Report* for supporting evidence. Please note that 'MUST' has not been designed to detect deficiencies or excessive intakes of vitamins and minerals and is of **use only in adults.**

Addendum 3: BHP Billiton letter of consent

bhpbilliton

resourcing the future

Samancor Manganese (Proprietary) Limited
1 Paperboom Ave
Hotazel
8490
Northern Cape
South Africa
Tel +27 53 742 2000
Fax +27 53 742 2106
www.bhpbilliton.com/bb/ourBusinesses/manganese.jsp

Hotazel Manganese Mines

29 October 2009

To Whom It May Concern

Dear Sir / Madam

Letter of Consent

Hotazel Manganese Mines (Proprietary) Limited ("HMM"), hereby gives Catharina Maldment (student no: 13136798), the necessary permission to have access to the following relating to her research for the Masters in Nutrition at the University of Stellenbosch:

- HMM Employee participation (individual consent will have to be requested);
- Access to information from Human Resources and other relevant departments of HMM;
- Access to clinics at Hotazel, Mamatwan and Wessels Mines and permission to see the relevant employees selected for the study;
- Consultation with medical personnel (consent will be also obtained from Ria Langeveldt, Life Occupational Health Manager);
- Limited use of the clinic facilities (consent will be also obtained from Ria Langeveldt, Life Occupational Health Manager);
- Catharina Maidmet undertakes to at all times keep all information provided by HMM and its employees confidential and may not publish or in any other way disclose any of such information without the prior consent of HMM. Catharina Maidmet shall also ensure that no other person or institution shall publish or disclose such confidential information without the prior consent of HMM. Any information provided by HMM or its employees shall be considered confidential unless stated otherwise. Any breach by Catharina Maidmet or such other person or institution of any confidentiality undertaking shall entitle HMM to take such measures as are by law reasonable in order to protect its interest, including denying Catharina Maidmet further access to HMM's facilities or employees and claiming damages in a court of law.

Yours sincerely,

JF Janse van Vuuren
General Manager

25/03/2011

Addendum 4: Information and informed consent form

INFORMATION AND INFORMED CONSENT FORM

An investigation of possible contributing risk factors related to diet and lifestyle which may cause hypertension in male employees of Hotazel Manganese Mines (Northern Cape Province, South Africa).

Ethics reference number:

Principal Investigator: Carin Maidment

Contact Number : 00 44 (0) 79 810 09257

Research Assistant: Hannetjie van der Merwe

Contact Number: 083 692 6843

Address: Ground Floor Flat, 15 St Albans Road, Barnet, United Kingdom, EN5 4LN

Dear Sir

You are being invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study staff any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you decline, this will not affect you negatively in any way whatsoever. You are free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Committee for Human Research at Stellenbosch University** and will be conducted according to the Ethical Guidelines and Principles of the International Declaration of Helsinki, South African Guidelines for Good Clinical Practice and the Medical Research Council (MRC) Ethical Guidelines for Research.

Addendum 5: Quantified Food Frequency Questionnaire recording sheet (QFFQ)

Name of Participant:

D	D	M	M	Y	Y	Y	Y

Participant number:

Birth Date:

Interviewer:

A. Food items (with Food photo manual)	B. Description of food item	C. Item Code	D. Amount usually eaten (g) Generic/amount=g	E. Eaten every day Times/Day	F. Eaten every week Days/Week	G. Eaten at least once a month Times/Month
Dairy-Blue						
1. Tea						
1. Coffee						
1.Sugar in tea coffee						
2.Milk in tea/coffee						
2.Milk with porridge						
3.Buttermilk/maas						
4.Milk drinks						
5.Yogurt						
6.Cottage cheese						
7.Hard cheese						
8.Processed cheese						
9.Ice cream & Ice lollies						
Other						
Starch-Brown						
1.Brown bread/rolls						
1.White bread/rolls						

2.Traditional bread/roti						
2.Fat cakes						
3.Breakfast cereals						
4. Maize porridge soft						
4.Maize porridge stiff						
4.Mabele/maltabella soft						
4. Mabele/maltabella stiff						
4.Oats						
5.pasta witout sauce						
6.Pasta dishes						
7.Rice						
7.Samp mealie rice						
7.Wheat Rice						
8.Pizza & Savoury tart						
Other						
Fats-Tan						
1.Brick margarine						
1.Tub margarine						
1.White margarine						
1.Butter						
2.Animal fat, i.e. lard						
3.Cream and substitutes						
4.Oils						
5.Salad dessing						
5.Mayonnaise						
Other						
Spreads-Pink						
Cheese spread						
Fish paste						
Honey/syrup						
Jam						
Marmite						
Meat spread i.e. Bovril						
Peanut butter						

Sandwich spread						
Other						
Eggs-Yellow						
Boiled						
Fried						
Omelette						
Scrambled						
Other						
Fruit-Orange						
1.Apples						
2.Bananas						
3.Berries						
4.Figs/Prickly pears						
5.Fruit salad						
6.Grapes						
7.Guavas						
8.Mango/paw paw						
9.Melons						
10.Naartjies						
11.Oranges						
12.Peaches						
13.Pears						
14.Pineapples						
15.Plums						
16.Dry fruit						
17.Fruit juice						
Other						
Soup, Legumes,Nuts						
1.Soups						
2.Beans & lentils						
3.Nuts & seeds						
Other						
Fish and seafood-Beige						
1.Fried fish						

2.Grilled/smoked/dried fish						
3.Pilchards & sardines						
3.Tuna						
Other						
Meat-Red						
1.Beef & Ostrich						
2.Patties & mince						
3.Burgers & Take-aways						
4.Chickens & turkey						
5.Cold meat						
6.Meat fillings						
7.Meat pies						
8.Mutton						
9.Pork						
10.Sausage & viennas						
11. Traditional & organ meats						
12.Vegetarian products						
13.Dry sausage & biltong						
Other						
Vegetables-Green						
1.Asparagus						
2.Avocado						
3.Baby marrow						
4.Beetroot						
5.Butternut & pumpkin						
6.Broccoli/cauliflower						
7.Cabbage						
8.Carrots						
9.Gem squash						
10.Green beans						
11.Mealies						
12.Mixed vegetables						
13.Mushrooms						
14.Peas						

15.Potatoes						
16.Potato chips						
17.Salad vegetables						
18.Spinach/ marog						
19.Sweet potatoes						
20.Tomatoes						
Other						
Biscuits,cake & pudding						
1.Biscuits/cookies						
2.Biscuits/savoury						
3.Buns/Muffins/scones						
4.Cakes & tarts						
5.Doughnuts & eclairs						
6.Pancakes/waffles						
7.Puddings & custard						
8.Rusks						
9.Special breads						
Other						
Snacks,sweets & cold drinks-Pink						
1. Carbonated cold drinks						
1.Diet cold drinks						
2.Energy drinks/Sports drinks						
2.Squashes						
3.Crisps & popcorn						
4.Sweets/chocolates						
Other						
Sauces & condiments-Grey						
1.Cheese & white sauces						
2.Chakalaka/Achar						
2.Tomato sauce & other						
3.Additional Salt						
3.Spices & seasoning						
Other						

Alcoholic drinks-Grey						
1.Beer & cider & coolers						
2.Wine						
3.Spirits						
4.Liquers & fortified wine						
Other						
Back to basics-nutritional supplements						
Supa health porridge						
Supa health milkshake						
Supa health tropicana dairy style drink						
Supa health diabetic milkshake						
Supa health traditional style drinks amasi,maghew						
Supa health cold drinks						
Supa health soups						
Other						
Smoking						
Amount of cigarettes per day/week/month						

Addendum 6: Physical Activity Questionnaire

Participant number:-----------------------------

PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people undertake 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/garden work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you undertook in the **last 7 days**. **Vigorous** physical activities refer to those that require intense physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you undertake **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ **days per week**

☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

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

☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to those that require moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you undertake **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ **days per week**

☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one or more of those days?

Addendum 7: Stress questionnaire

Participant Number:…………

Date:………………

Questionnaire - Stress Test

This questionnaire will assess how well you are currently managing the demands of life and work. Please work through each question and give yourself a realistic score. There are no right or wrong answers

Please only **circle** **one** answer at each question.

1. **Do you have difficulty sleeping?**

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

2. Do you find it difficult to concentrate?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

3. Do financial problems get you down?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

4. Do you feel you have to be the 'coper' for the family or for colleagues, with no option for seeking support for yourself?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

5. Do you find yourself coping with additional consumption of alcohol, nicotine or other substances?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

6. Do you get angry quickly?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

7. When you have been ill with relatively minor illnesses, does it take you a long time to recover?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

8. Do you find you are prone to negative thinking about your job?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

9. Do you feel you are isolated, with no-one to talk to?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

10. Would you take a sick day, not because you feel ill but overwhelmed, just to keep your 'head above water' emotionally, mentally and physically?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

11. Do you feel out of control and as if you're not in the driving seat of your life and health?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

12. Do you 'snack' instead of eating 'wholesome' meals?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

13. When conflict arises at work or at home, do you tend to over-react?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

14. Do you feel that there is more work to do than you realistically have the capacity to do?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

15. Do you feel caught between the pressures of responsibility for family and your work?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

16. Do you feel 'under par' even at the beginning of a working day?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

17. Do you shy away from social contact with colleagues and friends?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

18. Do other people comment on your not taking care of your appearance?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

19. Do you claim you have no time for hobbies and interests?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

20. Do you feel misunderstood or unappreciated by your colleagues, friends or family members?

a. Not at all b. Rarely c. Sometimes d. Often e. Very Often

END OF QUESTIONNAIRE. THANK YOU FOR YOUR PARTICIPATION.

Addendum 8: Demographic questionnaire

Investigator:…………………

Participant Number:…………

Date:………………………….

Demographic Questionnaire

Please circle one answer only where appropriate

1. **Age?** ....years

2. Marital status?

a. Single b.Married c.Divorced d. Widower e. Partner

3. Residence?

a.Mine Hostel b. House c. Single quarters d. Other (Specify)

4. Highest Qualification?

a. Grade 9 or lower b. Grade 10 c. Grade 11 d. Grade 12 e. Diploma/Degree

f. Post graduate qualification g. Other (Specify)

5. Job description?

a. Level 1-Management b. Level 2- Superintendents

c. Level 3- Supervisor/Specialist d. Level 4- Other (Specify)

6. Level of responsibility:

a. Manager b. Supervisory c. Non supervisory

7. Years service? ………………….years

8. Current place of work?

a. Hotazel b. Wessels c.Mamatwan d.Mamatwan sinter

END OF QUESTIONNAIRE. THANK YOU FOR YOUR PARTICIPATION.

Addendum 9: QFFQ interviewing steps

1. **Start the interview by saying the following:** "I want you to think back over the past 6 months about the foods and drinks you ate/drank. Try and remember how much you usually have of each item"
2. **Now use Food flash cards and ask participant the following:** "Please look through these photographs and make two piles. Pile 1 for items you hardly ever or never/ate drank over the past 6 months. Pile 2 for items you did eat/drink over the past 6 months"
3. **Put pile 1: items hardly or ever eaten/drank over past 6 months.**
4. **Now asks participant look trough pile 2 again:** "Please look through the pile in front of you of items you indicated you eat/drank over the last 6 months. Divide them into two piles. Pile 1 for items eaten/drank nearly every day. Pile 2 items you ate /drank less frequently like once a fortnight/month".

COMPLETE STEPS 5 AND 6 TOGETHER

5. **Proceed through each item of the frequently eaten pile with the participant.**
    - Ask how frequently each item in the pile is usually eaten per day/week.
    - Enter this amount in the appropriate column in the FFQ.
    - Example: If white bread is eaten usually once a day, every day, **fill in a 1 in the E column (eaten daily). Items eaten every week (but not every day) should be filled in column F according to the number of days per week eaten.**
    - Know do the same as above for the less frequently eaten pile completing column G.
6. **Determine the usual portion size of each item consumed.**
    - Perform this step per item as you work through the commonly eaten foods in step 5.
    - This must be done for each item directly after the frequency of intake was determined.
    - Use the food photo manual and other available aids to determine the portion sizes.
    - Please note that each item has a number that corresponds to the number and colour of the photos in the manual.
    - Identify the appropriate food code from the Food photo manual and enter it in column C on the food frequency Questionnaire.

Addendum 10: Ethics approval

UNIVERSITEIT•STELLENBOSCH•UNIVERSITY
jou kennisvennoot • your knowledge partner

Ethics Letter

18-Aug-2014

Ethics Reference #: S12/03/075
Title: An investigation of possible contributing risk factors related to diet and lifestyle which may cause hypertension in male employees of Hotazel Manganese Mines (Northern Cape Province, South Africa)

Dear Professor Martha Herselman,

At a review panel meeting of the Health Research Ethics Committee that was held on 4 August 2014, the progress report for the abovementioned project has been approved and the study has been granted an extension for a period of one year from this date.

Please remember to submit progress reports in good time for annual renewal in the standard HREC format.

Approval Date: 4 August 2014 Expiry Date: 4 August 2015

If you have any queries or need further help, please contact the REC Office 0219389207.

Sincerely,

REC Coordinator
Mertrude Davids
Health Research Ethics Committee 2