AN ASSESSMENT AND COMPARISON OF DIETARY INTAKE OF MINERS: A CASE STUDY OF A SOUTH AFRICAN MINE

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A Research Project Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Public Health

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DECLARATION

I declare that this research report is my own unaided work. It is submitted in partial fulfilment for the degree of Master of Public Health (MPH) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree at any other University.

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Name and signature of candidate

06/10/2020

Date

In memory of my father

Stan Shana

1934-2001

ABSTRACT

Introduction: The study was an analysis and comparison of the dietary intake of hostel and non-hostel miners using the 24-Hour Dietary Recall Method and the Recommended Dietary Allowances (RDAs) at the Rustenburg Platinum Mine.

Aim: The aim of the study was to assess the adequacy and compare the dietary intake of Hostel and Non-hostel miners at a platinum mine in Rustenburg. Furthermore, the study compared the dietary intake of miners and contrasted their Body Mass Index (BMI). Miners' food habits, Knowledge, Attitudes and Practices (KAP) with respect to nutrition were also evaluated.

Methodology: The study was a descriptive cross-sectional study. The study consisted of 100 black male miners working at the Platinum Mine in Rustenburg in North West Province. These miners mainly carried out underground jobs. The study used quantitative data to assess miners' nutritional status, food habits, KAP with regards to nutrition and the 24-Hour Dietary Recall Method. A convenience sample was selected within each group of miners from 5,254 miners. Each sample consisted of 50 miners (50 living in mine hostels and 50 living outside mine hostels) each group representing the two different feeding schemes at the mine.

Results: The results showed that the mean energy intake of hostel miners (8,972.3kJ) and non-hostel (8,361.6kJ) miners was below the recommended mean energy intake of 12000kJ for men doing light to moderate work. The miners did meet the protein requirement for the prudent dietary guideline of 15% energy. In Addition, the energy intake from total fat for hostel and non-hostel miners was higher than the prudent dietary guideline of not more than 30% energy. The mean Saturated Fatty Acid (SFA) intake for the miners was higher than the recommended value of < 10% energy. The mean dietary cholesterol intake for miners was below the recommended value of <300mg/day. Furthermore, miners did not meet the

recommended carbohydrate intake of 55+ % energy. Dietary fibre intake of 2g was below the recommended prudent dietary reference intake of 30g/day. Overall vitamin intakes for both hostel and non-hostel miners were below the dietary reference intakes with the exception of niacin and vitamin B12 which met the requirements for both hostel and non-hostel miners. The mean minerals intakes were below the dietary reference intakes for the miners. Miners' fluid intakes were below recommended intakes. The BMIs of miners showed that the majority of miners (70%) were overweight and obese. This could be attributed to miners' high muscle mass because of their hard-physical work. The BMI comprises of both muscle and fat. A chi-square test showed that there difference in the BMIs of both hostel and Non-hostel miners was not significant (χ^2 (3, N=100) =3.62, p = 0.3055).

Eating habits during working hours revealed that seventy percent of the miners did not take anything to eat to work. However, sixty-eight percent of the miners always ate before going on shift duty. Forty percent of miners were always hungry during their shift duty. Miners' knowledge regarding nutrition showed that they had limited knowledge of what a balanced diet was.

Conclusion: The low mean energy, macronutrient and micronutrient intakes for hostel and non-hostel miners could be attributed to under-reporting using the 24-Hour Dietary Recall Method, and therefore may require further analyses of the data for confirmation. However, miners needed to reduce their fat intakes to meet the prudent dietary guidelines for fat intake. The dangers of high fat diets are well documented in a number of studies showing that fat diets have been associated with chronic diseases of life style such as coronary heart disease, hypertension, obesity and certain cancers.

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LIST OF ABBREVIATIONS

BMI	**Body Mass Index**
DRI	**Dietary Recommended Intake**
E	**Energy**
g	**Gram**
KAP	**Knowledge Attitude Practices**
Kcal	**Kilocalories**
kJ	**Kilojoule**
mcg	**Microgram**
mg	**Milligram**
MRC	**Medical Research Council**
RDA	**Recommended Dietary Allowance**
REE	**Resting Energy Expenditure**
REI	**Recommended Energy Intake**
SAFOODS	**South African Food Data System**
SIMRAC	**Safety in Mines Research Analysis Committee**
WHO	**World Health Organization**
W/m2	**Watt/meter square**

GLOSSARY

Body Mass Index (BMI): An index of fatness and obesity. The BMI measures a person's weight in relation to their height. The weight (in kg) divided by the square of height (in m). The acceptable (desirable) BMI range in adults is 20-25. Above 25 is overweight, and above 30 is obesity (Nuttall, 2015).

Calorie: Used to mean kilocalorie (kcal) in nutrition: a unit of energy defined as 'the heat energy required to raise the temperature of a litre of water by 1^0C. 1 kcal = 4.2kJ (Webb, 2008).

Dietary Reference Intakes (DRIs): A set of reference values for the intake of energy, nutrients, and food components that can be used for planning and assessing the diets of healthy people in the United States and Canada (Smolin & Grosvenor, 2010).

Defective Diet: A diet lacking in a variety of types of foods that are required to provide adequate amounts of nutrients needed for good health. **(Own compilation, 2020):**

Heavy Work : Heavy and very heavy work requires you to stand for the same amount of time as medium work, but you also have to be able to lift up to or more than 100 pounds. The most difficult types of construction work, such as construction clean-up, are classified as heavy or very heavy work. Lusk (2012).

High density Lipoprotein (HDL): A blood lipoprotein. It carries cholesterol from the tissues to the liver; anti-atherogenic (Kosmas et al., 2018).

Light Work: Light work requires the ability to stand for up to six hours in an eight hour work day. You have to be able to lift up to 10 pounds frequently and up to 20 pounds occasionally. Lusk (2012).

Low density Lipoprotein (LDL): A blood lipoprotein. It acts as the primary transporter of cholesterol within the blood (Vincent, 2009).

Medium Work: Medium work requires you to stand up to six hours in an eight hour work day. You are also required to have the ability to lift 25 pounds frequently and 50 pounds occasionally. In addition, medium work involves sitting, kneeling, climbing, and squatting. Plumbing and construction are examples of medium work. Lusk (2012).

Recommended Prudent Dietary Guidelines: Are brief, positive dietary recommendations that are used to inform consumers how to choose food and beverage combinations that will lead to a diet that is adequate, that meets nutrient need and that is prudent for example, which lowers the risk of non-communicable diseases (Vorster, Badham & Venter, 2013).

Recommended Dietary Allowances (RDA): The suggested average daily intake of a nutrient for healthy people in a population. It is equivalent to the UK Resting Nutrient Intake (RNI), and represents the estimated requirement of those people with a particularly high need for the nutrient. The energy RDA is the best estimate of average requirement (Webb, 2008).

Resting Energy Expenditure (REE): Energy expenditure at rest. It is measured after 5 or 6 hours without food or exercise (Smolin & Grosvenor, 2010).

Recommended Energy Intake (REI): Energy requirements can be estimated imprecisely if the typical activity pattern is known. An average daily "activity factor" can be calculated using the values for different activities, weighted by the time engaged in such activities. The activity factor is multiplied by REE to derive energy requirements (Recommended Dietary Allowance, 1989).

Saturated Fatty Acid (SFA): A fatty acid in which all of the carbon atoms are linked with a single bond to hydrogen atoms. Fats containing a high proportion of saturates are hard at room temperature and mostly come from animal products (Bean, 2013).

VO_2max: The oxygen uptake when exercising maximally; the capacity of the cardiopulmonary system to deliver oxygen to tissues (Smirmaul et al., 2013).

CHAPTER 1- INTRODUCTION

This is a review of aspects pertinent to food and nutritional requirements for miners. Secondly, the review looks at the nutritional requirements for physically active individuals. Thirdly, the dietary intake and energy requirements in different occupational settings are presented. Finally, the aims of the study and its objectives are outlined.

1.1 Introduction

South Africa is the world's largest producer of gold and platinum. In 2013 mining and quarrying contributed 4.9% to the Gross Domestic Product (GDP) (South Africa's economy: key sectors Brand South Africa). The South African Gold and Platinum Mines are labour intensive with labour total cost estimated at 20% (Mining firms in South Africa move towards mechanization, 2014).

Miners working in the production area of platinum mines are required to carry out heavy work. Machine operated and conventional underground mining activities are classified as moderate to heavy. Often the stopes (mine underground working areas) are flat and narrow varying in width around 70 cm or even narrower, limited in height necessitating the use of labour intensive mining techniques which are often done manually (South African platinum and gold mine mechanisation-no simple path). Miners use large hand held pneumatic drills to bore holes which are then packed with explosives. These explosives are then blasted and the ore removed from the stope (Production-South Africa-PMM-Johnson Matthey).

Underground temperatures are high and gigantic cooling and ventilation systems pump air into the mine.

Adequate nutrition plays a major role in the general well-being of people in maintaining their body weight, maximizing physical activity and maintaining good health (Bean, 2013). However, a defective diet causes inefficiency and reduces energy levels leading to deterioration in health (Bean, 2013). Good nutrition therefore is not only important for health but also for work capacity and productivity. The work performed by the miners' increases body metabolism and therefore requires that miners consume diets rich in caloric value.

In the past mining companies housed, prepared food and fed both hostel and non-hostel miners (Bredenhann, 2012). However, in subsequent years, mining companies varied the types of feeding schemes for providing food to miners. At platinum mines, miners who live in the nearby towns and villages are given a food allowance to fend for their own meals, while those living in mine hostels are provided with meals at hostel kitchens.

1.2 Literature Review

There is very little information published on the dietary intake of miners. The theoretical basis of the dietary intake of miners in this study were based on research reports derived from industry workers, military personnel, miners and sports science research publications.

1.2.1 Nutritional Requirements for Physically Active Individuals

1.2.2 Carbohydrates

Studies have shown that athletes should eat or drink a carbohydrate snack before they perform their activity. This practice ensures that the two energy sources are maintained namely blood glucose and muscle glycogen (Rodriguez et al., 2009).

Furthermore, other studies conducted have shown that with carbohydrate supplementation, fatigue can be delayed and athletes' performance enhanced even during short duration intense exercises (Jeukendrup, 2014). During long duration exercises of more than 2 hours where muscle glycogen are stressed carbohydrate supplementation prevents hypoglycaemia and maintains higher rates of carbohydrate oxidation by enhanced performance through high rates of carbohydrate delivery of more than 90g/h. This permits higher and sustained work rates (Jeukendrup, 2011; Stellingwerff & Cox, 2014). Miners at the platinum mines work 8-12 hour shifts per day therefore providing them with drinks containing carbohydrates and electrolytes would provide an adequate source of energy.

The body uses carbohydrates as its chief source of energy. All carbohydrates break down into glucose in the body but the type of carbohydrate consumed makes a difference on how energetic one feels after hard work because non-refined carbohydrates are broken down slowly or gradually in the body and therefore release energy gradually as compared to refined carbohydrates (Pharr, 2010). The body stores excess glucose as glycogen or as fat in the muscles and liver. Individually a gram of glycogen contains 4kcal (17kJ) of energy (Smolin & Grosvenor, 2010).

1.2.3 Fats

It is recommended that physically active individuals should consume diets that provide 20-25% energy as fats (Smolin & Grosvenor, 2010). Fats are a concentrated source of energy and provide 9 kcal per gram. Too much dietary fat is not required by the body and too much energy consumed as fat, carbohydrates or protein increases body fat. In addition, a diet with less than 20% of energy from fats has been found not to be beneficial at enhancing performance (Smolin & Grosvenor, 2010).

1.2.4 Protein

Proteins provide the body with amino acids that are useful for building, repairing and maintaining lean tissue, muscles, bone, enzymes, and red blood cells (Dideriksen, Reitelseder & Holm, 2013). Protein provides 4 kcal of energy per gram. However, if there is adequate dietary carbohydrates to meet body energy needs, protein would not be required to provide energy, instead protein would be used for its major purpose of tissue building (Webb, 2008; Hall et al. 2012).

Adequate protein is necessary for maintaining muscle mass and strength. However, eating extra protein would not produce larger muscles. Muscle growth is stimulated by exercise and not by increasing protein intake (Smolin & Grosvenor, 2010).

According to the International Society of sports nutrition, protein requirements for persons doing physical exercise ranges from 1.3 to 2g/kg body weight per day and is reliant on physical exercise type, amount of exercise, protein quality and prominence of overall calorie and carbohydrate intake (Fox et al., 2011).

However, other studies on protein requirements for persons doing physical exercise have shown that protein intake is higher than the RDA (1.3-1.8g/kg /day and is perhaps significantly higher at 2.3 - 3.1g/kg/day as this compensates for lean mass losses (Philips, 2014).

1.2.5 Micronutrients

Fifty-one (51) different essential compounds are extracted from food by the human body because the body cannot produce them through metabolism. Some of these essential compounds are micronutrients namely vitamins and minerals (Eggersdorfer, et al., 2013).

Micronutrients are useful for optimal performance and are required for energy metabolism, antioxidant protection, repair and maintenance of body structures.

During exercise, the micronutrients required in energy metabolism are increased. Likewise, after exercise, the micronutrients required for repairing tissue damage are increased (Smolin & Grosvenor, 2010). In order to meet recommended minerals and vitamins intake, it is important that nutrient-dense foods are consumed.

1.2.6 Water

The main functions of water in the body are the provision of body fluid, energy transformation and excretion of waste and the regulation of body temperature.Total body water makes up between 45-75% of an individual's body weight (Riebl & Davy, 2013).

Hard physical work results in sweating and this entails that extra fluid be consumed. It is important that the body is hydrated before, during and after exercise (Smolin & Grosvenor, 2010). It is recommended that exercises lasting more than an hour require drinks consisting of small amounts of carbohydrates. This is because, long exercises lasting more than an hour deplete stores of body carbohydrates.

Incorporating carbohydrates in the drinks helps maintain blood glucose levels hence providing a source of glucose for the muscles and delaying onset of fatigue (Smolin & Grosvenor, 2010).

Recommendations based on the American College of Sports Medicine (ACSM) guidelines on exercise and fluid replacement and the Position of the Academy of Nutrition and Dietetics and Athletic performance state that dehydrated persons should consume 1.25 - 1.50L of fluid per kilogram of body weight lost to replace body water content (McCartney et al, 2017). However, further research needs to be conducted on the aforementioned recommendation because the fluid consumed relative to weight lost does not impact on the size of the treatment effect (McCartney et al., 2017).

1.2.7 Dietary Fibre

Dietary fibre is defined as edible parts of plants or analogous carbohydrates that resist digestion and absorption in the human small intestines and have complete or partial fermentation in the large intestines (Papathanasopoulos & Gamilleri, 2010). Dietary fibre includes polysaccharides, oligosaccharides, lignin and associated plant substances.

Fruits, vegetables and whole grains provide good sources of dietary fibre that promote good health benefits such as supporting the growth of beneficial intestinal bacteria, reducing the risk of developing coronary heart disease, stroke, hypertension, diabetes and obesity. Furthermore, consuming foods with soluble and viscous fibre delays gastric emptying which promotes satiety and helps with regulating food intake (Anderson et al., 2009).

Two studies in South Africa carried out on black adults showed that fibre intake decreased from 20.7g to 16.7g (Steyn & Mchiza, 2014). The recommended dietary intake for fibre is about 30g/day.

1.3 Dietary Requirements in Different Occupational Settings

Food is important for the human body because it provides the body with energy and the ability to function and grow well. Food is particularly essential in maintaining good health, resisting and fighting infections, and building new cells and tissue for growth, maintenance and repair of the body (Bean, 2013). Healthy eating means consuming a variety of foods.

In order to maintain body weight, there has to be a balance between calories from food and beverages with calories expended on a daily basis (Dunford & Doyle, 2014).

An individual's energy expenditure differs according to body size, sex, age, body temperature, nutritional status and physical activity. If a lot of energy is used in an activity then more calories are required to achieve the energy balance (Rodriguez et al, 2009). Adequate energy consumption is necessary during times of high intensity exercise for maintaining body weight, maximizing exercise effects and for health maintenance. Low energy intakes cause loss of muscle mass, loss or failure to gain bone density, increased fatigue, injury and illness (Rodriguez et al., 2009).

1.3.1 The Army

In a study conducted on combat arms on body composition, upper and lower body strength, power and aerobic endurance showed that soldiers underwent changes in fitness and body composition. The soldiers experienced an overall lean body mass increase of 3%, increase in fat-free mass of 9% as well as an improvement in upper and lower body strength by 7% and 8% and upper body power increased by 9%. Aerobic performance decreased by 13% (Lester et al., 2010). The study further showed that prolonged intensive military activities can have effects on physical performance and body composition (Lester et al., 2010).

1.3.2 The Miner

Reliable information on energy requirements for miners is scanty, but projected values for the metabolic rates for underground mining workers that can be used as a reference to define energy needs of miners was used in this stiudy.

The findings on studies reported under the COMRO report on projected metabolic rates of miners connected with conventional and mechanised underground mining occupations were on average found to be of a moderately high intensity >130W/m^2 to 180W/m^2 and at very hard

work the metabolic rate increases to 240 W/m^2 . This is of a short duration and was not experienced frequently (Van Rensburg et al., 1991).

The amount of sweat lost during physical activity in heat can be caused by various factors, for example ,metabolic rate, environmental conditions and heat acclimatization status (Racinais et al., 2015). Therefore, when miners complete their shift, they should consume adequate fluids to replace sweat lost from their bodies during the shift.

1.3.3 The Professional Sportsman

Nutrition is important for athletic performance. Carbohydrates are important for maintaining blood glucose levels during exercise and replacing glycogen stores after exercise. The recommended carbohydrates required for athletes depend on the total energy expenditure, type of sport, gender and environmental conditions (Smolin & Grosvenor, 2010).

Fats are important in providing essential fatty acids, and help with the absorption of fat soluble vitamins. Fat Stored in the body help provide energy to support the needs of the longest endurance events. Physically active individuals should consume diets providing 20 - 25% of energy as fat to permit adequate carbohydrate intake (Rodriguez, et al., 2009).

Diets that are too high in fat do not contain enough carbohydrates to maximize glycogen stores and optimize performance.

1.4 Feeding Schemes

The importance of nutrition to physically demanding work cannot be over-emphasized. Eating the right food and drinking adequate fluids satisfies one’s need for macronutrients and micronutrients.

There are advantages of providing pre-shift and mid-shift feeding. The mid-shift feeding is especially important as stores of carbohydrates in the body would be near capacity after the nights' rest and the previous day's meal. Miners working underground start early in the morning from 3am to 5am. At this time miners would still be full from supper, reducing the hunger for food (Bean, 2013). However, providing miners with a small breakfast would be beneficial.

A large morning meal should not be provided because this could have negative effects on work performance. A meal consisting of large amounts of protein and fat inhibits gastric emptying (Marathe et al., 2013). A small meal could be provided to allow for gastric emptying (Bean, 2013). A light carbohydrate breakfast covers the 2-3 hour period of waiting or walking prior to start of the shift as it ensures that carbohydrates stored in the body are at maximum capacity.

However, for shifts lasting 6-8 hours, the light breakfast would not be able to prevent the reduction in carbohydrate usage or the increase in fat utilization (Jeukendrup, 2011). These mid-shift breaks are important as miners become more productive after the break. Fluid meals for both pre and during working hours are much more advantageous compared to solid feeds. Research has shown that during endurance exercise fatty acids play a greater role in supporting the energy demands of the body than glucose alone (Anderson, 2013). As more fat is burnt up by the body less muscle glycogen is used up and this "glycogen" has sparing effects that supports stamina or endurance because glycogen stores are limited but fat stores are plentiful (Anderson, 2013).

1.5 Knowledge, Attitude and Practices (KAP) on Nutrition

Nutrition studies have been conducted on athletes, sportsmen, coaches and other population groups. In a study on adolescent swimmers on nutrition knowledge and attitude, it was shown that they lacked nutrition knowledge but they had a keen attitude towards nutrition, signifying an interest to nutrition instructions (Webb & Beckford, 2014). In another study on senior school boy Rugby players it was revealed that players had a keen attitude towards nutrition but had poor nutritional knowledge and dietary practices (Walsh et al., 2011). Knowledge, Attitude and Practices (KAP) studies on nutrition of athletes, coaches, athletic trainers and strength and conditioning specialists showed that athletic trainers and strength and conditioning specialists had satisfactory sports nutrition knowledge compared coaches and athletes (McGhee-Torres et al., 2012). Another nutrition KAP study conducted on sportsmen showed that most sportsmen's knowledge on nutrition and supplements was good (Peerkhan & Srinivasan, 2010). These cited studies had different conclusions because of variations in methodology and objectives, and differences in target group.

Furthermore, in a systematic review on the relationship between nutrition knowledge and dietary intake in adults above 18 years, revealed an important, optimistic but weak relationship between advanced nutrition knowledge and dietary intake (Spronk et al., 2014).

1.6 Body Mass Index (BMI) and Nutrition

The BMI is a dependable indicator of body fatness and is an economical and simple way of measuring whether an individual is underweight, overweight or obese using World Health Organization (WHO) cut off points.

The cut-off points indicate appropriate nutritional interventions that can be used for treatment of wasting/thinness, overweight and obesity (Nuttall, 2015).

As one gets older, their percentage of body fat increases with age but their muscle mass decreases (Nuttall, 2015). A person's weight and height do not necessarily reflect such changes in the body fat and muscle mass. Lean people such as athletes, may have a high muscle mass which may not necessarily be due to fat but due to hard physical work (Nuttall, 2015). This could be the case with the platinum miners as they carry out hard physical work underground.

In an analysis of the effects of overweight and obesity in 195 countries over 25 years, Afshin et al showed an increase in prevalence of overweight and obesity. Children affected by obesity worldwide accounted for 107.7 million and 603.7 million adults in 2015 (Afshin et al., 2017).

BMI does not measure body fat directly but is an indirect measure of obesity (Nuttall, 2015).

A survey of data from 34 sub-Saharan African countries on health risks factors for non-communicable diseases revealed that the average BMI among female adults ranged from as low as 22 kg/m^2 in Madagascar, Eritrea, and Niger to as high as 28 kg/m^2 in Swaziland, Seychelles, and Lesotho, with a median of 25 kg/m^2 across the region.

Among male adults, the median for BMI was 23 kg/m^2, ranging from 21 kg/m^2 in the Democratic Republic of the Congo, Eritrea, and Madagascar, to 26 kg/m^2 in Liberia, Seychelles and Swaziland. This finding according to WHO affirmed the belief that adult females have a higher BMI than their male counterparts, who tend to be relatively less overweight or obese (WHO, 2015).

1.7 SIMRAC Mine Study

In 2002 in South Africa a similar study by SIMRAC was conducted on ten mines. A total of 497 miners were interviewed of whom 57% were non-hostel miners and 43% were hostel miners (Dias et al., 2003). The methodology used in assessing nutritional intake was similar to this study.

The 24-Hour Dietary Recall Method was used including a questionnaire that addressed KAP of miners regarding nutrition and their food habits. Findings in this study reported low energy intakes, low fat intakes and low micronutrient intakes by miners. The BMI values of miners from the ten mines were normal for eight of the ten mines with the exception of the diamond and platinum mines which reported overweight and obesity. Forty-three percent of the miners never ate before going to work. Miners who reported that they had no break while on shift were 11.9% (Dias et al., 2003). The limitations found in the SIMRAC study were that low nutrient intakes were attributed to weaknesses of the 24-Hour Dietary Recall method and the strength of the SIMRAC study was that miners were drawn from ten different mines which was comparatively a larger sample space.

1.8 Alcohol Intake

In South Africa, alcohol is a legal substance and is the most commonly used psychoactive substance. Alcohol is a depressant and consumption contributes to public interactions and decreases intoxicating negative emotional responses. Approximately 5-6 billion litres of alcohol are consumed each year in South Africa (Barnabas, 2015).

A study on the effects of alcohol among mine workers in Bloemfontein indicated that 46.9% of mine workers used alcohol while 15.3% were likely to have abusive use of alcohol (Ajani, 2010). Research has also shown that heavy alcohol intake causes blurry vision, tiredness, aggressive behaviour, depression, delusions and hallucinations (Moleko, 2012).

There are various risk factors associated with alcohol consumption namely, liver cirrhosis, cancers and cardiovascular diseases (Zyaambo et al., 2013).

1.9 Summary of Literature Review

Providing adequate nutrition is important for meeting the physical needs of miners who work underground as they perform hard physical labour. Their diets should provide adequate macronutrients and micronutrients. Adequate energy from suitable sources should be provided to fuel activities, proteins to repair and maintain muscle mass, micronutrients to permit the use of energy yielding nutrients and water to transport nutrients and cool the body (Webb 2008; Anderson , 2013). It is important that miners are given appropriate information on nutrition that may influence their attitudes and practices on foods and fluids that they consume.

1.10 Aim

To assess and compare the adequacy of dietary intake of hostel and non-hostel miners working at the platinum mine.

1.11 Study Objectives

The specific objectives of this study were:

i. To determine and compare dietary intake of fluids, energy, protein, vitamins and minerals of two groups of miners at a platinum mine, using the 24-Hour Dietary Recall Method and Recommended Dietary Allowances (RDAs).
ii. To compare the BMI of hostel and non-hostel miners at the platinum mine.
iii. To evaluate food habits, nutritional knowledge, attitudes and practices of hostel and non-hostel miners at the platinum mine.

CHAPTER 2 – METHODOLOGY

This chapter discusses the research design, recruitment of study participants, research ethics, data collection methods and data analysis.

2.1 Introduction

The aim of the study was to assess and compare the adequacy of dietary intake of hostel and non-hostel miners working at Rustenburg platinum mine.

The methodology used in the study was mainly quantitative using a questionnaire that was administered to 100 miners. The questionnaire was designed to capture relevant data relating to miners' food, fluid intake, BMI and miners knowledge, attitudes and practices.

2.2 Study Design

The study design was a descriptive cross-sectional study. The study looked at the dietary intake of a group of black male miners. The study used quantitative data to assess miners' food habits, nutritional status data using the 24-Hour Dietary Recall Method, and knowledge, attitudes and practices regarding nutrition.

2.3 Study Plan and Study Setting

The study samples were from a population of male miners working at a Platinum Mine in Rustenburg, North West Province of South Africa. The mine is located within the vicinity of Rustenburg approximately 112km from Johannesburg. According to Mining News (28 November, 2019) the mine produces platinum group of minerals (PGMs) and covers an area of about 33km^2. The mine was commissioned in 2002 and has six shafts in total. It said to

have 30 run-of-mine (ROM) semi-autogenous mills and a smelter with 37-Megawatt absorbed arc electric furnaces. The mine has a workforce that was estimated to be about 58,000 by 2019.

In this study two groups of miners were assessed, those that lived in the mine hostels (hostel miners) and those who lived outside mine hostels (non- hostel miners).

Initially, a coal mine had been selected for the study but this was changed to the Platinum mine which had a well-established food service unit with equally better access.

2.4 Study Population

The study population consisted of male miners ranging from 21 to 58 years who worked under ground with an exception of two miners who worked on the surface.

2.5 Sample Selection

The sample size of miners in this study was a convenience sample limited by resources in terms of time and money and confined to the platinum mine. Each sample consisted of 50 miners (50 from mine hostels and 50 from outside mine hostels). The hostel miners were selected consecutively as they came into the kitchen from the start of the sampling time. Access into the mine kitchen was by swiping and only hostel miners were provided with cards that they swiped to gain access into the kitchen. The miners living outside the mine hostel were also selected consecutively as they entered a designated venue within the mine premises.

In order to determine the nutrient intake of a population, a minimum of 50 subjects was required using the 24 Hour Dietary Recall Method (Dias et al, 2003). Therefore 100 miners were selected for this study to accommodate this requirement for the two different feeding schemes at the mine.

2.6 Data collection

To accommodate data collection on hostel and non-hostel miners, a questionnaire was used and sampling followed the times the hostel kitchens operated. Hostel kitchens at the platinum mine were catering for approximately 2567 miners. The hostel kitchens had dining hall facilities and hostel miners were not allowed to cook in their rooms.

The hostel kitchens were open to the miners from morning, afternoon and evening providing two meals each day namely breakfast (Kitchen A: Breakfast: 4.30 am - 7.00am, Kitchen B: 3.00 am - 7.00am) and a main meal (Kitchen A: 11.00am-18.00pm, Kitchen B: 10.00am-18.00pm). The hostel kitchens used a 7-day cycle menu.

2.7 Questionnaire

In this study a pre-existing questionnaire was used as the primary tool for data collection. The KAP section of the questionnaire was developed by conducting a focus group discussion with a group of miners. This led to slight changes on the original KAP section of the questionnaire.

The study formed part of a bigger study in which 10 mines were involved in the country in 2013. Hostel and non-hostel miners were interviewed either before, during or after completion of the shift depending on the administrative arrangement at the mine. The scheduled interviews were held on different days of the week to cover the different diets and to reduce limitations. The questionnaire covering six sections namely, demographic data, anthropometric measurements, nutrition, food habits, KAP and 24-Hour Dietary Recall Method (Section 2.7.1-2.7.6).

2.7.1 Demographic data

Demographic data included: Age, education, gender, home language, and accommodation and job titles of respondents.

2.7.2 Anthropometric Measurements

Anthropometric measurements consisted of the weight and height of each miner. Care was taken to ensure that each subject wore light clothing and that they took off their shoes during weighing. The scale readings were taken to the nearest 0.1kg. The height was determined using a height board.

In order to analyse anthropometric measurements, descriptive statistics were used to determine miner's nutritional status and their BMI was calculated using the formula:

BMI= Weight (kg) / [Height (m)] ^{2}.

2.7.3 Nutrition

This section of the questionnaire collected information on whether or not miners usually ate before or after a shift, and how many meals on average they consumed in a day.

2.7.4 Food habits

The food habits section of the questionnaire collected basic information on miners' food habits, their intake of vitamins and minerals, and what types of foods or fluids they consumed while at work.

2.7.5 Knowledge, Attitude and Practice (KAP)

The KAP section of the questionnaire was used to evaluate miners' perceptions on food and health. The assessment of their perceptions on knowledge sought to understand miners' understanding of a balanced diet and importance of vitamins and minerals. The attitudes section sought information on hostel miners' food preferences and their rating of food prepared at the hostel kitchen. The practices section addressed issues on their food habits.

2.7.6 24-Hour Dietary Recall Method

Nutrition information was collected using the 24 Hour Dietary Recall Method. The 24-hour dietary recall method can be used to measure food and nutritional intake at individual level. The major limitations of the 24-hour dietary recall method are:

(i) Memory error: study subjects have a tendency to forget more or less foods eaten hence may lead to greatly underestimating total calorie intake (Castell, Serra-Majem & Ribas-Barba, 2015).

(ii) A single 24-hour dietary recall in a study does not approximate normal intake because the subject's intake on the day the data is collected may not be characteristic of their usual intake for example as compared to weekends and week day's food consumed which, may be very different. Also, social events may amplify the subject's usual food intake (Castell, Serra-Majem & Ribas-Barba, 2015).

(iii) Interviewer bias may occur as subjects may be encouraged to remember certain dietary items more than others, therefore, causing an inaccurate picture of the subject's real diet (See section 2.9.1 for more details).

2.8 Validity and Reliability of the Data

Questions on the questionnaire were explained to the research team collecting data to ensure consistency on interpretation and meaning of each question. This was done to minimize variations in the interpretation of the questions on the questionnaire to miners. To ensure that questionnaires collected the desired information, the questionnaire was pretested with miners who were not part of this study during a workshop at the Goldfields Academy. In addition, the pre-test was done to ensure that the language and questions would be easily understood by the miners participating in the study.

The questionnaire was revised and restructured based on the Goldfields Academy workshop findings. The corrected and revised questionnaire was then used for field data collection in this study.

2.9 Data Analysis

Prior to data analysis all completed questionnaires were subjected to data cleaning and coding and also checked for completeness. Questions of qualitative nature, requiring non-numerical responses were coded into numerical data (for example questions with responses such as Yes or No) to make the analysis easy, in particular for purposes of sorting the responses in Microsoft Excel spreadsheets. Data on anthropometric measurements; demographic data; food habits and KAP were entered into Microsoft Excel (Microsoft office 2016) spreadsheets, whereas 24-hour dietary recall data was entered into Food Finder-3 (version 1.1.3) software of the South African Medical Research Council.

Inferential test statistics such as chi-square (for miners language, level of education and job titles), unpaired student's t-test (miners age, energy intake, and micronutrients intake and vitamins intake) and the Wilcoxon's Rank Sum test (for macronutrients intake) were used to examine whether there

were any significant differences between the two groups of miners regarding a particular variable. Similarly, the fisher's exact test was used to test associations between the two groups with respect of demographic attributes.

All inferential test statistics were done at 95% level of confidence that is allowing predictions with plus-minus two standard deviations from the mean or central tendency of the data distributions or frequencies where the test statistics results lead to an acceptance or rejection of the null hypothesis.

2.9.1 Demographic Data, Food habits and KAP of Miners

Demographic data, food habits and Knowledge Attitude and Practices (KAP) of miners were analysed using Microsoft Excel 10 to derive descriptive statistics and presented in tables where necessary. In order to evaluate whether similarities existed on demographics attributes between the two groups of the miners, a chi-square test of goodness-of-fit was done at 95% level of confidence. This formed the basis of the conclusions in the results (Chapter 3).

2.9.2 24-Hour Dietary Recall Method

Data on the 24-Hour Dietary Recall Method was collected by trained field workers (one medical doctor, one nursing sister, one nutritionist and one research assistant). The field workers recorded the time the food was eaten, the type of food consumed and its preparation method, for example roasted, fried etc. Standard household and metric measuring utensils, foam and plastic food models and actual food items were used to quantify food portions or sizes and amount of food consumed.

Dietary data was coded from Food Finder-3 for the type and amount of food and drinks consumed. The coded data was entered into Food Finder-3 and used for analyses of the dietary requirements data. Food Finder-3 was the latest version (at least by then) of the South African

Food Composition Database (SAFOODS), which included information in the 1991 food composition tables, food quantities in the Medical Research Council (MRC) quantities manual and Dietary Recommended Intakes (DRI).

Food Finder-3 has the capability of calculating food intakes into energy levels for a given food item. Nonetheless Food Finder-3 software does not handle robust statistical analysis.

Thus, the calculated food energies had to be exported to Excel spreadsheets for both descriptive and inferential statistical analyses.

The one sample t-tests were used for purposes of comparing the dietary reference intakes and prudent dietary guidelines as standards with miner's respective daily intakes to see if the recommended intakes differed significantly with the miners own daily intakes.

The mean energy intakes were calculated by using the Mifflin-St Jeor Equation. In order to get values for Resting Energy Expenditure in kilo Joules (kJ). The Resting Energy Expenditure was multiplied by a factor in order to get the Recommended Energy Intake (REI). The REI for average recommended energy intakes for light to moderate classes of activity was calculated with the formula Resting Energy Expenditure (REE) x 1.6. Similarly the REI for average recommended energy intake for heavy activity patterns was calculated as REE x 2.O

The data generated from the Food Finder-3 software was mainly quantitative in nature, and as an entry point the unpaired student t-test was done but yielded values that were difficult to gain insight into the tested variables. This was apparent also in the descriptive statistics that showed very large standard deviation values. In response to this and where applicable, Wilcoxon Rank Sum Test was used to draw inferences on data on macronutrients. The Wilcoxon Rank Sum Test assumes that if the data sets were similarly distributed the medians of the two samples would be equal. These tests were done at 95% level of confidence.

2.10 Ethics and Legal Aspects

Ethical approval was obtained from the Medical Committee for Research on Human Subjects from the University of Witwatersrand (Protocol Number M02-10-21). Dr Belinda Dias was the principle investigator of the overall research that involved 10 mines. Permission to obtain data from the mine was obtained from mine management. Voluntary informed consent was obtained from all miners prior to data collection. All miners signed a consent form whereby they consented to voluntary participation in the study. The aims of the study were communicated to all the subjects in a language that they understood.

All of the information provided by miners was treated with absolute confidentiality. No names were written on questionnaires, or on any document and in any of the reports concerning this study. Each questionnaire was allocated a number for ease of identification. The signed consent forms were filed separately from the completed questionnaires.

The findings from the research were not altered or manipulated. The conclusions from this study were drawn from the collected and analysed data of the two groups of miners working at the platinum mine.

CHAPTER 3 – RESULTS

This chapter describes socio-demographic characteristics and food intake assessments of miners. The food intake data was derived from the Food Finder-3 software. The body mass index (BMI) of miners and their eating habits are also presented. The chapter further discusses miners' food eating habits, their nutrition Knowledge, Attitudes and Practices (KAP).

3.1 Demographics

3.1.1 Miners' Language and Age

The miners spoke different languages as shown in Table 1. The majority of miners spoke Xhosa followed by Tswana, then Sotho and a few spoke other languages such as Shangaan, Pedi, Venda and Afrikaans.

Table 1: Miners Demographics

Characteristics	Hostel Miners	Non-Hostel Miners	p-Value
Number [n]	**50**	**48**	0.1439[a]
Age (Mean)	42	39	
SD	6	9	
Language			**p-**
Number [n]	**50**	**50**	0.038[b]
Xhosa	9 (38%)	21 (42%)	
Tswana	13 (26%)	20 (40%)	
Sotho	12 (24%)	7 (14%)	
Other	6 (12%)	2 (4%)	
Highest level of education Value			**p-**
Number [n]	**50**	**50**	0.144[b]
Primary school	1 (2%)	2 (4%)	
Secondary school	21 (42%)	31(62%)	
Tertiary	20 (40%)	13 (26%)	
No schooling	8 (16%)	4 (8%)	
Job Titles Value			**p-**
Number [n]	**50**	**50**	0.797[b]
Locomotive drivers	9 (18%)	5 (10%)	
Stope timber miners	8 (16%)	7 (14%)	
Supervisors	7 (14%)	5 (10%)	
Machine operators	4 (8%)	5 (10%)	
Winch operators	2 (4%)	3 (6%)	
Other	20 (40%)	25 (50%)	

[a]Independent two-tailed t-test; [b] Fisher's Exact Test. The p-Value for age was based on ninety-eight miners (98) as two miners did not know their age.

Fisher' exact test and t-test analyses to determine whether the two groups were any different based on their age and language. As for age, there was no significance difference in the miners age (Fisher's exact test, p = 0.144), however for language the result was significant (Fisher's exact test, p = 0.038).

3.1.2 Level of Education

The level of education of miners in the study showed that 2% of hostel miners did not have any formal education compared to 4% of non-hostel miners. Forty-two percent (42) of hostel miners had primary school education (grades 1 to 7) compared to 62% of Non-hostel miners. Hostel miners with high school education (grade 8 to12) were 40 % compared to 26% of Non-hostel miners. Sixteen percent of hostel miners had tertiary education compared to 8% of Non-hostel miners (Figure 1). A Fisher's exact test to examine whether there were significant differences between the two groups based on levels of education was not significant, meaning the two groups have comparable levels of education (Fisher's exact test, p = 0.144).

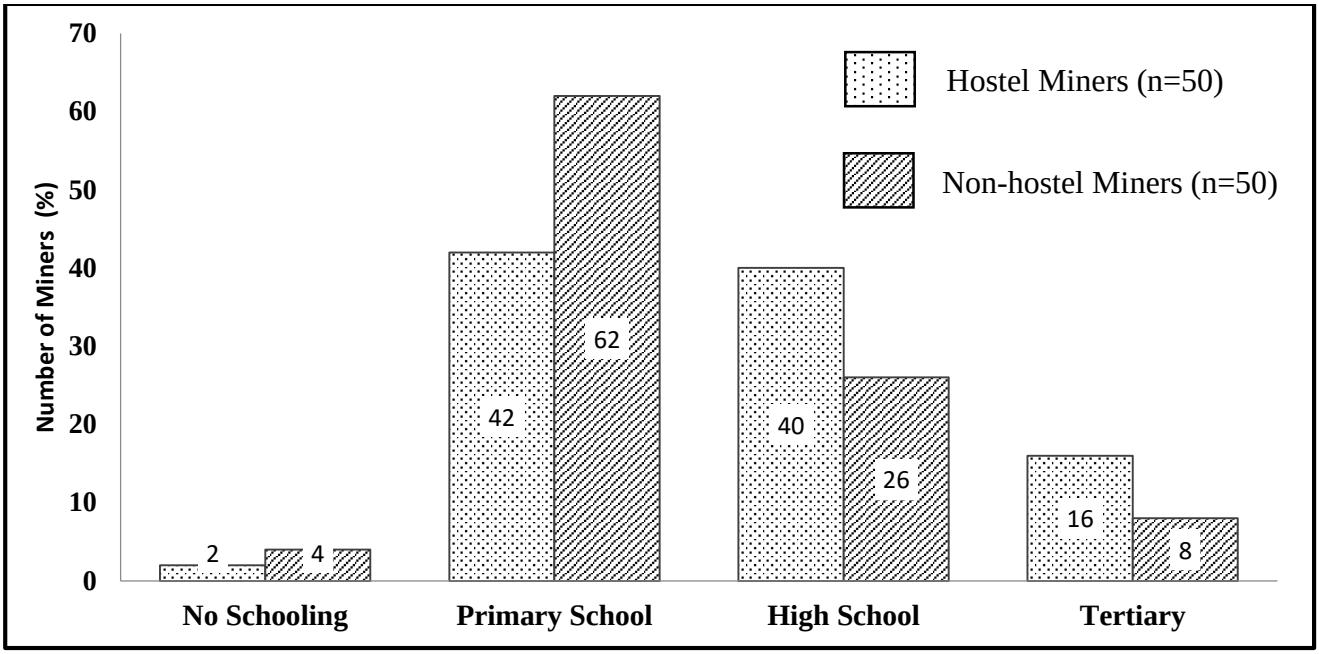

Figure 1: Miners Level of Education

3.1.3 Miners Job Titles

The study design was not stratified according to job descriptions or titles (as given in Table 1) therefore, comparison of dietary requirements of the miners based on their job classifications could not be done. Thirty-four of the miners worked as supervisors, pump attendants, stope timber or did a number of engineering jobs. Twenty-five of the miners worked as locomotive drivers, winch operators, winch drivers or assistant artisans. Nine of the miners worked as machine operators and thirty-two miners did other mine related jobs.

3.1.4 Body Mass Index (BMI)

The comparison of Body Mass Index (BMI) of hostel and non-hostel miners (Figure 2) was categorised according to four BMI classifications of underweight, normal, overweight and obese.

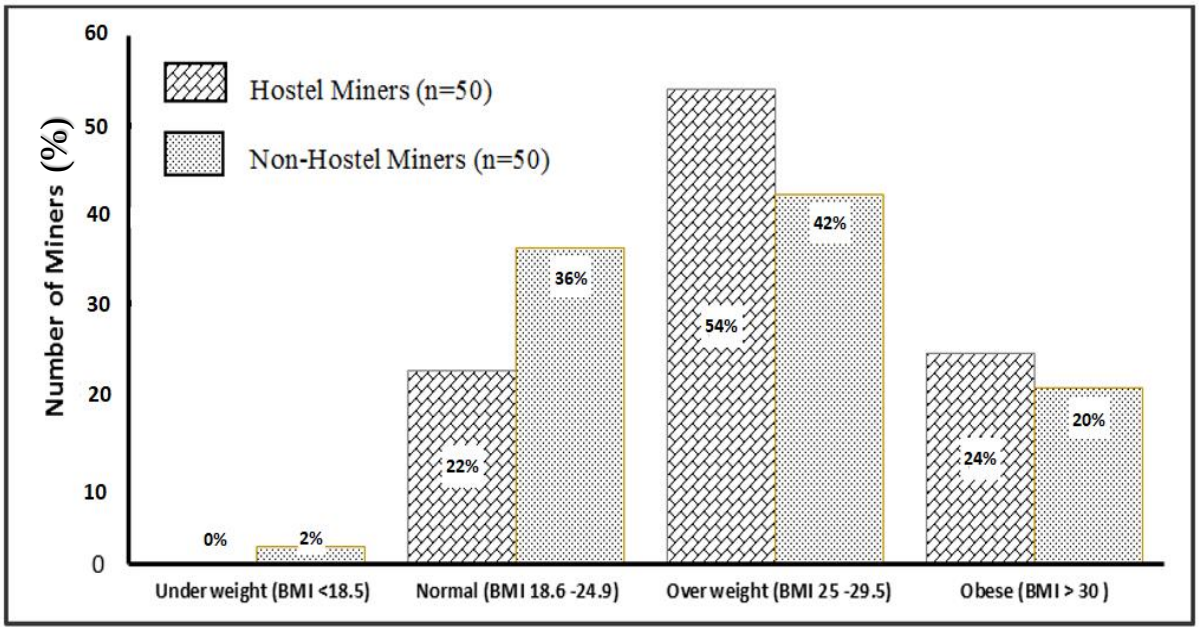

Figure 2: Miners Body Mass Index (kg/m^2)

The average height of miners was 1.6 metres. The average weight for hostel miners was 73 kg and that of non-hostel miners was 71.2 kg. The average BMI for the miners was 27.3kg/m^2. This BMI fell into the overweight category range of 25-29.5kg/m^2. Forty-eight of the miners were overweight and 22 miners were classified to be obese. Fifty-four hostel miners were overweight compared to forty-two non-hostel miners. Twenty-four hostel miners were obese compared to 20 non-hostel miners. Thirty-six non-hostel miners had a normal BMI compared to 22 of hostel miners. The BMI between hostel and non-hostel miners was not statistically significant (χ^2 (3, N=100) =3.62, p = 0.3055).

3.2 Knowledge, Attitudes and Practices (KAP)

3.2.1 Miners Nutrition Knowledge

3.2.1.1 Foods Considered to be Healthy by Miners

Foods liked and considered to be healthy by both hostel and non-hostel miners (Table 2) were similar. Pap and meat were ranked as the healthiest foods.

Table 2: Miners Opinion on Foods commonly considered being Healthy Foods by Rank

Food Type	Food Ranking	
	Hostel Miners (n=49)	Non-hostel Miners (n=49)
Pap	1 (16)*	1 (22)
Meat	2 (14)	3 (15)
Chicken	5 (8)	4 (8)
Samp	4 (11)	5 (4)

* (16) = Number of miners for the specified ranking out of 49 miners.

With exception of pap, miners' perception of other foods as being healthy foods differed considerably. What one group considered being healthy food was not at the same rank with the other group, for example, their ranking of meat, chicken and samp is a case in point.

3.2.1.2 Miners' Intake of Vitamins and Mineral Supplements

It was evident that most miners (73) did not take any vitamins or mineral supplements, and just about five miners always took supplements (Figure 3). Only 17 miners took vitamins and mineral supplements four-times or less in a week.

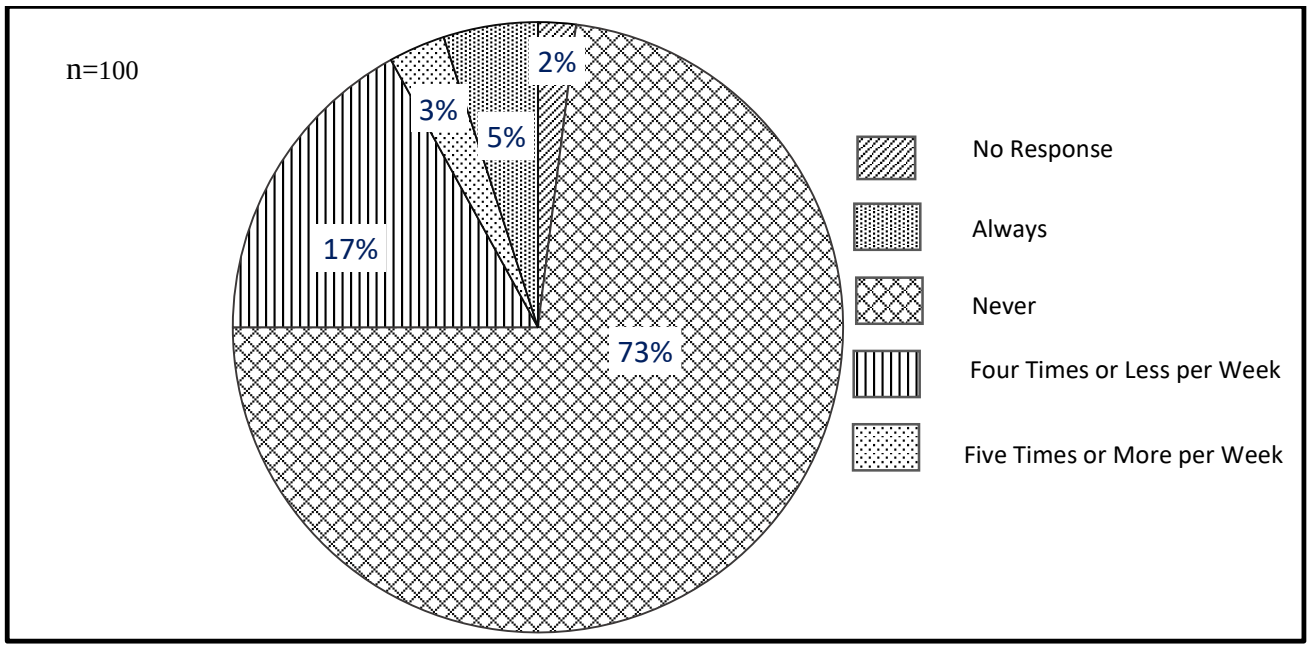

Figure 3: Miners Frequency of Vitamins and Mineral Supplements Intake

3.3 Miners' Attitude towards Food

3.3.1 Miners' Food Preferences

The most disliked food by hostel miners was pork (30) followed by pap (20). Twenty-two percent (22) of non-hostel miners disliked pap the most, followed by chicken at eighteen

percent (Figure 4). Again, there were implicit inconsistencies in miners' food preferences in that it was not clear why pap one of the foods miners considered to be healthy was also one of the most disliked foods.

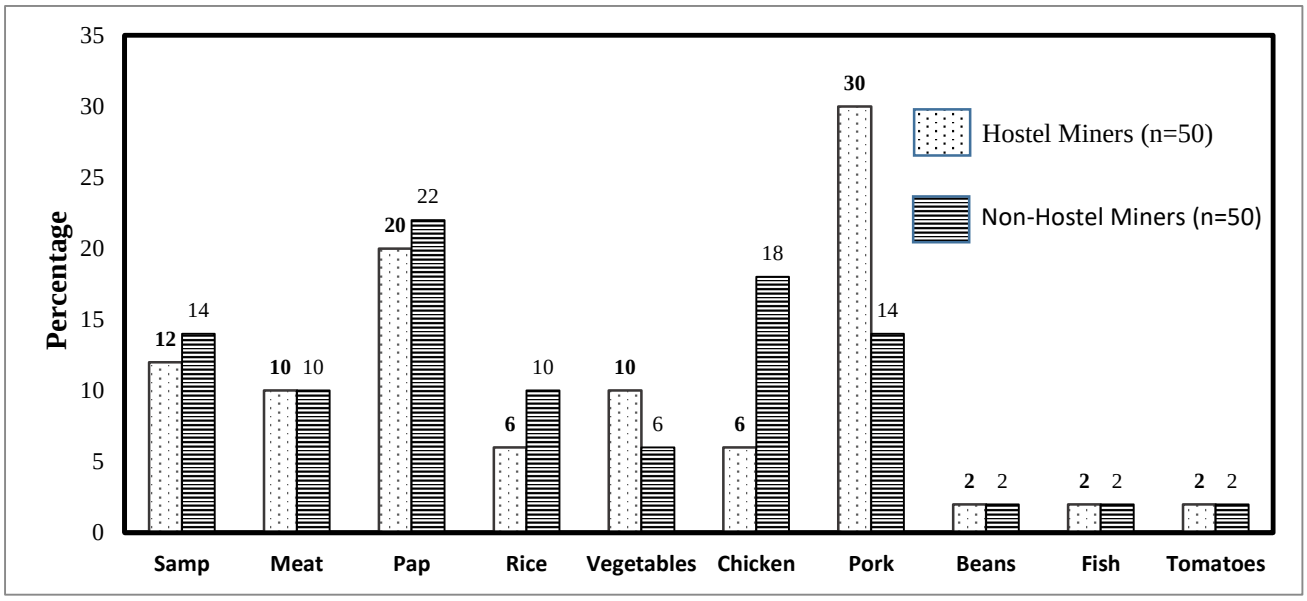

Figure 4: Foods not liked by Miners

3.3.2 Hostel Miners Kitchen Food Ratings

Seventy-four percent of the miners mentioned that the food served in the kitchen was not fresh. Sixty-two percent of hostel miners complained that they found the food finished upon arrival at the hostel kitchen for meals. Another sixty-two percent of hostel miners complained about the poor appearance of the food provided at the kitchen. Forty-eight percent of the miners reported that there was very little variety on the menu and this resulted in a monotonous diet. Twenty-eight percent of the miners mentioned that the cost of purchasing the food from the mine hostel kitchen was affordable (cheap) and the rest of the ratings with respect for each category are given in table 3.

Table 3: Hostel Miners Food Ratings (n=50)

	Category				
Rating	**Cost**	**Adequacy**	**Variety**	**Appearance**	**Freshness**
Expensive	2 (4%)				
Cheap	14 (28%)				
Inadequate		31 (62%)			
Adequate		3 (6%)			
Poor				31 (62%)	
Not Fresh					37 (74%)
Not Bad			8 (16%)		
Very Little			24 (48%)		
Good			5 (10%)		5 (10%)
*No rating	34 (68%)	16 (32%	13 (26%)	19 (38%)	8 (16%)

* Miners that had no rating for a given category.

3.4 Miners Nutrition Practices

3.4.1 Miners Eating Habits

Most hostel miners took 2-3 meals per day on average compared to non-hostel miners. On the other hand, most non-hostel miners took one-meal per day on average compared to hostel miners (Figure 5).

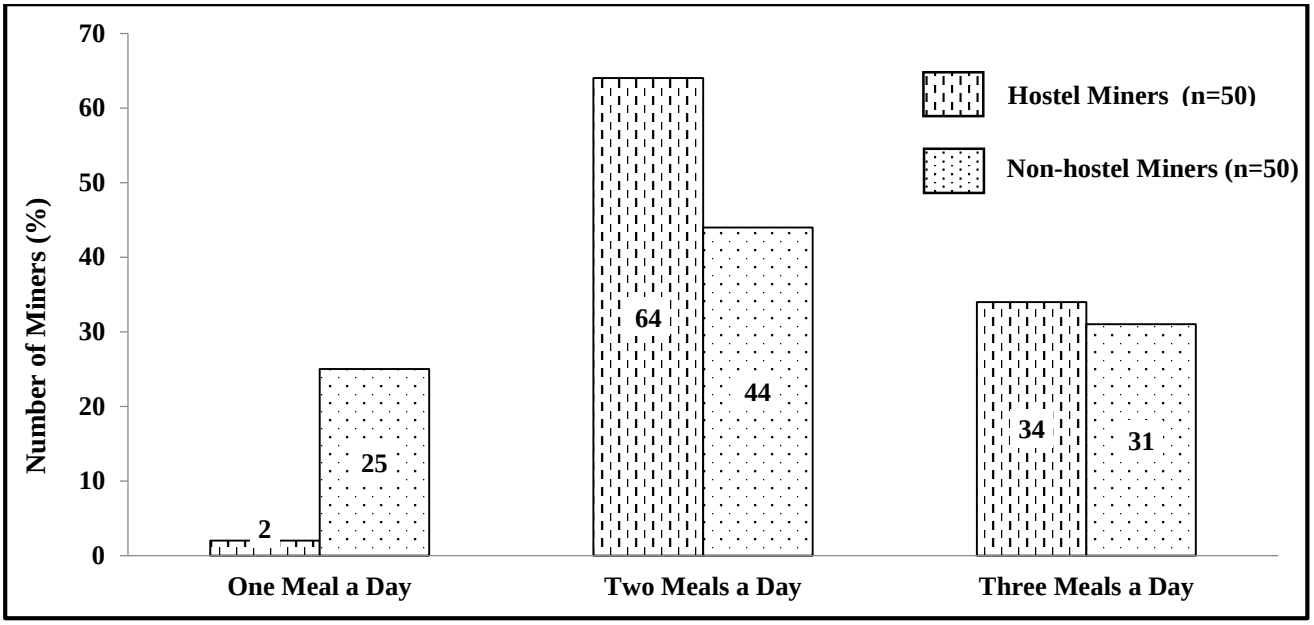

Figure 5: Miners Daily Meal Frequencies

Table 4 shows miners eating frequencies that maybe translated to their eating habits. The percentage of miners who always ate or drank something before going to work was 68% and 22% of the miners never ate or drank anything before going to work.

Only 3% of hostel miners always took something to eat or drink at work compared to 12% of the non-hostel miners. The percentage of hostel miners who never took something to eat or drink at work was 43% compared to 27% of non-hostel miners. Also 24% of hostel miners often felt hungry while at work compared to 27% of non-hostel miners.

Table 4 : Miners Eating Habits and Eating Frequency

	Eating Frequency									
	Always		**Four times a week**		**Five times or more a Week**		**Never**		**No response**	
Eating Habit	Hostel	Non-hostel	Hostel	Non-hostel	Hostel	Non-hostel	Hostel	Non-hostel	Hostel	Non-hostel
Eats food before work (n=50	19(37%)	16(31%)	3(5%)	2(4%)	1(1%)	0(0%)	4(7%)	8(15%)	0(0%)	0(0%)
Takes food to eat at work (n=50)	2(3%)	6(12%)	1(2%)	6(11%)	0(0%)	0(0%)	22(43%)	14(27%)	1(2%)	0(0%)
Is often hungry (n=50)	12(24%)	8(16%)	10(19%)	7(14%)	3(5%)	1(2%)	1(2%)	9(18%)	0(0%)	0(0%)

Other data analysed not presented in this thesis, showed that miners consumed other types of foods during working hours. The miners consumed bread (11%), bread with bread spreads (7%) or pap (10%); meat (7%), and chicken (7%). A small number of miners ate vegetables (4%), cold meats (3%), dairy (3%), eggs (3%), rice (4%) and other foods about 14 %. Fruits were not a common food type that was being consumed by miners during working hours (only 1% of the miners claimed to have been eating fruits) and 35% of the miners claimed they ate nothing at all while on duty.

3.4.2 Foods liked by Miners

Both hostel and non-hostel miners considered similar foods to be foods that they liked (Table 5). Miners liked pap most followed by rice. The least liked food type was mutton. Foods rich in carbohydrates were the most preferred by the miners. Vegetables and fruits that are a source of common vitamins were not that liked.

Table 5: Foods Commonly Liked by Miners by Rank (n=100)

Food	Number of Miners	Rank
Pap	39	1
Rice	36	2
Meat	22	3
Samp	21	4
Chicken	16	5
Vegetables	14	6
Fruits	12	7
Bread	5	8
Mutton	3	9

3.4.3 Alcohol Consumption

Sixty-five miners (65) consumed an alcoholic beverage, in particular, beer. Non-hostel miners consumed on average 4.96 litres of beer during the week compared to an average of 2.0 litres by hostel miners (Figure 6). However, the hostel miners on average consumed 4.37 litres of beer on Fridays compared to a consumption of 2.79 litres by non-hostel miners.

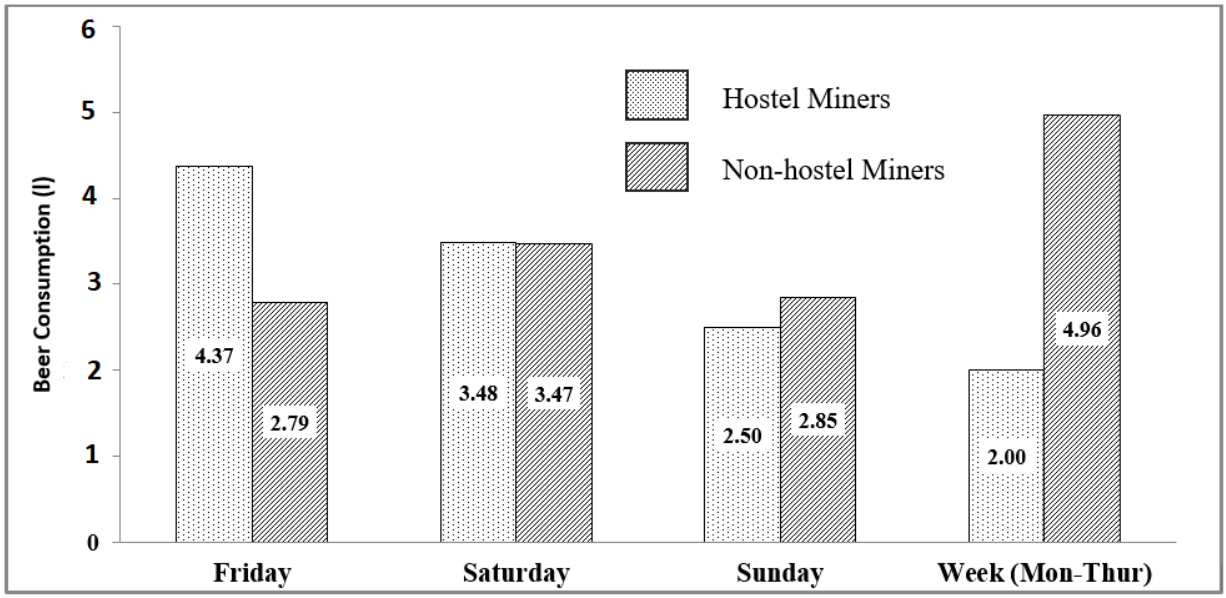

Figure 6: Miners Average Beer Consumption

In addition, non-hostel miners consumed wine and spirits during the week and on weekends, which hostel miners did not do due to lack of access to such beverages. Therefore, non-hostel miners drank a lot more alcohol during the week as compared to hostel miners. Similarly, hostel miners drank a lot more alcohol on Fridays compared to non-hostel miners.

3.5 Comparison of Food Intake of Hostel and Non-hostel Miners

3.5.1 Introduction

The nutritional content of food and fluid intake of miners is presented and compared with their dietary intake as determined by the 24-hour recall method, and the Recommended Dietary Allowances (RDA). Two platinum mine hostel kitchens were assessed during the study. Miners gained access into the kitchen by swiping their cards. The kitchens had the same recipes and food preparation procedures. The kitchens provided two meals per day namely breakfast and

one main meal. Miners living in hostels were not allowed to cook in their rooms and all meals were prepared in the hostel kitchens.

Miners ate as much starch as they like except for protein which was restricted to a single serving of 180g per person at every main meal. A ration scale was developed for giving food to the miners and was adhered to for meat and to some extent vegetables.

Six slices of brown bread per miner was served during breakfast and the spread used on the bread was the hard brick margarine, jam and peanut butter. Tea and coffee were served during breakfast and no fresh milk was given, but a dry mixture of sugar, sweetener and milk blend was also provided.

3.5.2 Energy and Macronutrient Intakes

3.5.2.1 Energy intake

Table 6 is a comparison of miners' energy intake to the recommended resting energy expenditure (REE). This was an evaluation to see whether miners met recommended energy intake thresholds. Based on the classification of recommended energy intake (REI) into two classes, namely moderate and heavy activities, which were applicable to the miners' work categories, both groups of miners were below the recommended intake of 12,000 kJ for light to moderate activities. The average recommended energy intake for hostel miners in the study for light to moderate activities was 11, 9644 kJ and 14, 956 kJ for heavy activities. Comparatively, for non-hostel miners the average recommended energy intake for light to moderate activities was 11,773 kJ and 14, 716 kJ for heavy activities (Table 6).

Table 6: Miners' Energy Intake and Recommended Resting Energy Expenditure

Energy	Hostel Miners (n=50)	Non-Hostel Miners (n=50)	p-Value
Mean Energy Intake (kJ)	8,972	8,362	0.0250
Energy SD (kJ)	4,328	4,354	-
[a]REE (kJ)	7,478	7,358	-
[b]Moderate REI = (REE *1.6) kJ	11,964	11,773	-
[c]Heavy REI = (REE *2) kJ	14,956	14,716	-

[a] **REE:** Resting Energy Expenditure = (11.6 x weight) + 879 using the age cohort 30-60 years after the subcommittee on the 10th edition of RDAs 1989.

[b] **Moderate REI**: Average recommended energy intake for light to moderate activity, calculated from the formula: Resting Energy Expenditure (REE) x 1.6

[c] **Heavy REI**: Average recommended energy intake for light to moderate activity, calculated from the formula: Resting Energy Expenditure (REE) x 2.

3.5.2.2 Macronutrients Intake

Table 7 presents the mean and standard deviation of macronutrient intakes of miners as calculated by the Food Finder-3 software. The comparison of miners' average percentage of total energy intake from macronutrients to recommended prudent dietary guidelines showed that hostel miners mean protein intake was 74.8g and the non-hostel miners' protein intake was 69.9g. Thus, on average both groups of miners took sufficient protein rich foods that were above the recommended dietary allowance of 63g.

Table 7: Miners Macronutrients Intake and Recommended Dietary Allowances (RDA) (Subcommittee on the Tenth Edition of RDAs, 1989)

		Protein (g)	Fat (g)	SFA[a] (g)	Cholesterol (mg)	MUFA[b] (g)	PUFA[c] (g)	Dietary Fibre (g)	Carbohydrates (g)
Hostel Miners (n=50)	**Mean**	74.84	111.57	34.15	206.78	43.81	25.80	2	178.17
	SD	47.46	100.09	30.70	200.45	42.48	26.73	3	112.13
Non-Hostel Miners (n=50)	**Mean**	69.90	85.68	26.15	184.67	31.90	21.09	2.05	206.08
	SD	44.68	220.14	67.66	267.10	83.91	55.01	3.91	497.13
p-Value		0.0180	0.1810	0.9810	-	0.6450	0.3690	-	0.746
RDA		63	<=30	<10	<300mg/day		Approx. 10	Approx. 30g/day	>=55

[a] Saturated Fatty Acid

[b] Monounsaturated fatty acid

[c] Polyunsaturated Fatty Acid

A statistical comparison of the two groups of miners Macronutrients Intake using the Wilcoxon Rank Sum Test for Equality of Medians was not significant (Fat, p-Value=0.1810; SFA p-Value=0.9810; MUFA; p-Value=0.6450, PUFA p-Value=0.3690, Carbohydrates, p-Value=0.746). However, the energy intake p-Value=0.0250 (table 6) and protein intake p-Value=0.0180 (table 7) were significant.

Significant results in table 7 above imply that there were differences in macronutrients intake of the given nutrient in this case for energy and protein intake. For the rest of the macronutrients, the results were not significant, meaning, that the two groups of miners were not different in their intake of these macronutrients. Non-significant results here do not mean that the two groups' intake of a given macronutrient is sufficient but rather that it is an indication that there is no difference between the two groups regarding their intake of that specific macronutrient. Whereas significant means that there were differences between the two groups.

The diet of both hostel and non-hostel miners had above the required amount RDA for fat. Fats and oils do not have specific recommendations on mono-unsaturated fat intake (Aranceto & Rodrigo**,** 2012). According to the USDA & US Department of Health and Human Resources (2010), the recommended cholesterol value is less 300mg/day per person. In this study average dietary cholesterol intake for both hostel miners and non-hostel miners was 195.72mg/day, which was satisfactory. The total dietary fibre intake of approximately 2g for both hostel and non-hostel miners was extremely low compared to the prudent dietary guidelines value of 30g/day.

Table 8 presents the mean and SD of miners' macronutrient intakes and the Polyunsaturated Fatty Acid to Saturated Fatty Acid ratios (P/S ratio) which represent the ratio between polyunsaturated and saturated fatty acids.

Table 8: Miners Macronutrients Intake and the PUFA-SFA (P/S) Diet Ratio

		Nutrient (kJ)					
		Protein Energy	Total Fat Energy	PUFA Energy	SFA Energy	Carbohydrates (Available Energy)	**P/S Ratio**
Hostel Miners (n=50)	**Mean**	200	655	201	70	481	**2.87**
	SD	320	1475	449	179	686	
Non-Hostel Miners (n=50)	**Mean**	164	437	133	107	483	**1.24**
	SD	356	1220	389	327	720	

The Polyunsaturated Fatty Acids (PUFA) intake for both groups of miners met the recommended value of approximately 10g (Table 9). However, the P/S ratio of the diet for hostel miners was higher (2.78) compared to non-hostel miners (1.24). The P/S ratio's prudent

dietary guideline value is 1, therefore both hostel and non-hostel miners were well above this requirement.

It is rather challenging to make conclusive attributions to the two groups of miners' differences in energy and protein intake given that their food habits were somewhat very similar.

Table 9: Comparison of Miners Total Energy Intake from Macronutrients with Recommended Prudent Dietary Guidelines (Aranceto & Rodrigo, 2012).

	Nutrient Mean of Total Energy (%)				
	Protein Energy	Total Fat Energy	SFA Energy	PUFA Energy	Carbohydrates (Available Energy)
Hostel Miners (n=50)	14.59	48	15	5	35
Non-Hostel Miners (n=50)	14.61	39	12	10	43
Recommended Prudent Dietary Guidelines	**15**	**20-35**	**10**	**6-11**	**55+**

Comparison of macronutrient intakes showed that the greater part of energy intake for miners came from total fats and carbohydrates. However, the energy from total fat for hostel miners was high at 48% and for non-hostel miners was at 39%.

These values are much higher than those of the prudent dietary guidelines, which range from 20-35% (Aranceto & Rodrigo, 2012). In addition, the mean SFA intake as a percentage of total energy for hostel miners was 15 and for the non-hostel miners was 12% (Table 9). These values are higher than the recommended value of 10 %E.

The average carbohydrate energy intake expressed as a percentage of total energy for hostel miners was 35% and 43% for non-hostel miners. These values are below the prudent dietary guidelines for carbohydrate intake of 55+ % E.

3.5.2.3 Micronutrient Intakes

Results of analysis of vitamin and mineral intakes of miners are shown in Tables 10 and 11 using both descriptive and inferential statistics. A number of vitamins assessed on miners' dietary intakes in relation to dietary reference intake (DRI) indicated that miners' intakes were below recommended levels (Table 10).

3.5.2.3.1 Vitamins

An independent t-test indicated that there were no significant differences between the two groups of miners' various vitamin and mineral intakes in relation to the DRI.

Fruits and vegetables, which are a source of vitamins, did not feature as favourite foods for the miners (Table 5). Coupled with their rather inconsistent eating habits, their below recommended DRI values for some of the vitamins seems self-explanatory except for Niacin and Vitamin B12 which met the DRI recommended values. The DRI values for Vitamin A for non-hostel miners also met recommended values.

There was a significant difference (p-Value <0.0057) intake of Vitamin C for both hostel and non-hostel miners, but for all the other vitamins, there were no significant differences between them. Again, results being not significant does not mean the miners met dietary requirements for these vitamins; rather their vitamins intake provided in their diets were not any different. In other words, their sources of vitamins were very likely similar.

Table 10: Miners Vitamins Intake Independent t-Test of Difference of Means

Vitamin	*DRI	Hostel Miners			Non-hostel Miners			p-Value (α = 0.05)	Result (α = 0.05)
		n	Mean	SD	n	Mean	SD		
A (mcg)	900	39	162.8	320.4	43	1274.6	5747.8	0.2246	Not significant
Thiamin (mg)	1.2	47	0.9	0.6	47	1.0	0.7	0.5153	Not significant
Riboflavin	1.3	47	0.8	0.6	47	1.2	2.2	0.3247	Not significant
Niacin (mg)	1.6	47	17.7	8.6	47	17.7	13.9	0.9708	Not significant
B6 (mg)	1.7	47	0.9	0.6	47	1.2	1.2	0.0866	Not significant
Folate (mcg)	400	47	144.9	109	47	182.5	195.2	0.1259	Not significant
B12 (mcg)	2.4	44	3.4	3.3	40	15.2	61.7	0.2108	Not significant
Pantothenate	5	47	3.1	1.8	47	3.9	4.1	0.2115	Not significant
Biotin (mg)	30	47	17.9	14.6	47	29.9	45.9	0.0907	Not significant
C (mcg)	90	26	9.9	12.7	38	40.3	25.6	0.0057	Significant
D (mcg)	10	43	3.8	5.2	40	4.7	6.0	0.4962	Not significant
E (mcg)	15	47	7.2	9.2	47	9.9	10.2	0.1894	Not significant

*****Subcommittee on the Tenth Edition of RDAs, 1989.

3.5.2.3.2 Minerals

The mean mineral intakes of hostel and non-hostel miners and the DRIs of the nutrients for men aged 30-50 years are shown in Table 11. The average intake for the minerals were below the DRIs for both hostel and non-hostel miners with the exception of Iron, Phosphorus and Zinc. Miners' iron intake fell within the DRI at 95% confidence level ($\alpha = 0.05$, $p < 0.661$), phosphorus ($\alpha = 0.05$, $p < 0.981$) and zinc ($\alpha = 0.05$, $p < 0.854$).

An Independent t-Test of difference of means was conducted (Table 11), as can be noted from the table the test revealed that there were no significant differences between the two groups with regard to their mineral intakes for calcium, iron, magnesium, phosphorus, potassium, and zinc.

Table 11: Miners Aged 30-50 Years Mineral Intake Independent t-Test of Difference of Means

Mineral	*DRI	Hostel Miners			Non-hostel Miners			p-Value	Result (α = 0.05)
		n	Mean	SD	n	Mean	SD		
Ca (mg)	1000	46	345	368	47	330.3	234.3	0.819	Not significant
Fe (mg)	8	47	8.8	4.6	47	9.3	6.1	0.661	Not significant
Mg (mg)	420	47	229	132	47	239.4	123	0.694	Not significant
P (mg)	700	47	998	544	47	1000.6	554.8	0.981	Not significant
K (mg)	2000	47	1527.6	814.1	47	1771.4	1042	0.209	Not significant
Zn (mg)	1.1	47	10.8	7.3	47	10.5	3.51	0.854	Not significant

***Subcommittee on the Tenth Edition of RDAs, 1989.**

The two groups of miners' mineral intakes were equally very similar with no significant differences.

However, the statistical analysis result here are not about adequacy of intake of any mineral, but merely highlight similarities and dissimilarities between the two groups. It is evident from the miners' food ratings that foods that are rich in iron, phosphorous and zinc were consumed on a regular basis.

3.6 Fluid Intake

The miners' fluid intake in this study included water, fanta, coke, tropical juice, fruit juice and mageu. Although there could possibly have been other fluids that miners might have been drinking, these were not reported in the survey. Further the sample sizes for each group were comparatively small with 20 non-hostel miners and 30 hostel miners reporting that they did take one or more of the listed fluids. The analysis of the fluid intake showed that hostel miners took more fluids (940ml) on average than non-hostel miners (870ml) in 24-hours. The miners took less than a litre of fluids in 24 hours far less than the recommended fluid intake for their kind of work.

3.7 Summary of Results

The highest level of education of the miners was high school. The energy intakes of hostel and non-hostel miners were below the recommended mean energy intake of about 12000kJ for men aged 25-50 years for light to moderate activities. However, the miners did meet the protein requirement for the prudent dietary guideline of 15 E. The energy intake from total fat for hostel and non-hostel miners was higher than the prudent dietary guideline of not more than 30 E.

Also, the mean SFA intake for the miners was higher than then the recommended value of < 10 E.

However, the P/S ratio for miners exceeded the prudent dietary guideline value of 1. The mean dietary cholesterol intake for miners was below the recommended value of <300mg/day (Dietary Guidelines for Americans, 2010).

Furthermore, miners did not meet the recommended carbohydrate intake of 55+% E. Vitamin intakes overall for both hostel and non-hostel miners were well below the DRI with exception of niacin and vitamin B12 for both hostel and non-hostel miners. The mean (average) intakes for the minerals were below the DRI for the two groups of miners.

Eating habits revealed that seventy percent of miners did not take anything to work to eat during working hours and sixty-eight percent always ate before going to work. Forty percent of miners were always hungry during working hours. The percentage of hostel miners who never took something to work to eat or drink was 43 of 50 (86 compared to 27 of 50 (54%) non-hostel miners. The fluid intake during exercises for both hostel and non-hostel miners was below the recommended amounts.

Hostel miners who were overweight were 27 of 50 (54%) and 12 of 50 (24%) were obese whereas, non-hostel miners who were overweight were 21 of 50 (42%) and 10 of 50 (20%) were obese. There was evidence that hostel and non-hostel miners had limited understanding of what a balanced diet meant. This was seen from their responses on what a healthy meal constituted. Hostel miners mentioned that carbohydrates (pap, rice, and samp), protein (meat, chicken), vitamins, and minerals (vegetables and fruits) but they did not mention the fat and oil group. Non-hostel miners did not mention vitamins and minerals (vegetables and fruits) nor the fat and oil group.

The three top-most liked foods by the hostel miners were pap, rice or samp and meat. The food that was most disliked by hostel miners was pork, in particular, the way it was prepared. Seventy-four percent (74%) 37 of 50 hostel miners alleged that the food served to them was not fresh. Sixty-two percent (62%) 31 of 50 hostel miners complained about the insufficiency provision of food and its poor appearance. Forty-eight percent of the miners reported that there was very little variety on the menu and this resulted in a repetitious diet. Twenty-eight percent of the miners mentioned that the cost of purchasing the food from the mine hostel kitchen was reasonable.

CHAPTER 4 – DISCUSSION

Mining work is an energy demanding activity that increases the rate of basal metabolism and therefore increases the body's energy requirements (Dabhadker et al., 2013). This study assessed and compared two groups of miners' dietary intake to determine whether the two groups received adequate or comparable nutrition and fluid intake.

4.1 Body Mass Index (BMI)

High BMI is a risk factor for non-communicable diseases (NCD's) such as diabetes and hypertension (Baleta & Mitchell, 2014).

(NCD's) such as diabetes and hypertension On the other hand, a study conducted on obesity in South Africa reported that 61% of the Southern African population is overweight, obese or severely obese (Baleta & Mitchell, 2014).

One limitation of using the BMI is that it does not differentiate between fatness and muscularity (Kruschitz et al., 2013). BMI is not also considered to be an effective measure for clinical judgements, for example, on whether or not a patient will profit from a bariatric operation. Furthermore, BMI does not differentiate against the muscular, the aged, women and racial groups, for example, Asians and African Americans (Moore & Pories, 2014). There is a strong possibility that the miners in the study were muscular because of the moderate to heavy work load they carried-out which may have resulted in increased BMI.

However, in order to account for the body fat, in this study, methods such as skinfold thickness measurements (with calipers) under water weighing, bioelectrical impedance, dual-energy x-ray absorptiometry should have been included. Nevertheless, these methods are not always

readily available and are too expensive and need highly trained workers to be carried out (Achamrah et al., 2018).

According to BMI classification of overweight (25-29.5kg/m^2) and obesity (>30kg/m^2), 48% of miners were overweight and 22% were obese. The differences in the BMI of hostel and non-hostel miners were not significant ($p < 0.3055$).

4.2 Knowledge, Attitude and Practices (KAP)

Miners demonstrated limited knowledge on their understanding of nutritional issues, in particular, their understanding of what good diet would mean. However, a study conducted on South African nursing students who were primarily from rural and township areas and were living at the University of Fort Hare hostels showed that they had inadequate knowledge on key nutritional issues (Van den Berg, 2012).

In worldwide systematic review of thirty-six studies conducted on athletes and coaches, it was found that education impacted on nutrition knowledge. Therefore, it is important that questionnaires designed to capture nutrition knowledge should accommodate different literacy levels to reflect on reliability of nutrition knowledge of respondents (Trakman et al., 2016).

Miners' most preferred food was pap (a cereal) which is a staple food among black South Africans whereas vegetables and fruits were the least preferred foods. The South African diet in the rural and peri-urban areas is very high in cereals (maize), bread and added sugar this has an effect on the level of micronutrients and fibre in their diet (Mchiza et al., 2015). In another study conducted on dietary diversity among adult South Africans, it was discovered that four provinces with the highest prevalence of poor dietary diversity were Eastern Cape, Kwazulu Natal, North West and Limpopo.

The study showed that cereals were the most consumed foods followed by meat and dairy products, but fruits and vegetables were the least consumed (Labadarios et al., 2011). It is reckoned that high consumption of staple foods (maize and bread) may be driven by the cheaper prices on these foods since the South African government subsidized these foods and no Value-Added -Tax (VAT) was being paid, thus they were costing less per unit energy as compared to meat, fruits and vegetables (Mchiza et al., 2015).

Food habits portray the manner in which people from comparable or dissimilar cultures interact in relation to different types of foods and ingredients (Lyana & Manimbulu, 2014). Seventy percent of the miners in this study did not take anything to eat to work during their eight-hour shift and thirty-five percent had nothing to eat during working hours. There are adverse consequences that may result due to inadequate food intake such as reduced strength and physical capacity, impaired immune functioning leading to infections and job absenteeism, loss of muscles and adverse psychological effects (Webb, 2008).

Hostel and non-hostel miners who did not take food to work attributed this to several factors such as, the platinum mines were dusty due to explosives that were being detonated underground which discouraged them from carrying food to work. The other reasons given were that miners ate before going to work while others stated that they didn't eat during working hours because they were too busy to take a lunch-break.

According to Peltzer et al, 2011, sub-Saharan Africa has one of the highest average alcohol consumption per drinker in the world of 19.5 litres/year (Peltzer et al., 2011).They state that, the pattern of alcohol consumption in South Africa has a high possibility of causing health or social harm.

This study found that there was relatively high alcohol consumption among miners with non-hostel miners consuming 4.96 litres of beer on average during the week as compared to 2 litres by hostel miners. In an alcohol review study conducted in South Africa by Peltzer & Ramlagan, 2009 it was found that among mine employees 9.3% of them consumed alcohol on a daily basis and 15.3% were alcohol dependent. In a similar study on alcohol consumption conducted in the mining town of Kitwe in Zambia Zyaambo et al., 2013 found that the rate of alcohol consumption was high. A study on the harmful effects of alcohol, revealed that miners had poor understanding of the dangers of alcohol on their overall health and performance (Cronje et al., 2013). Alcohol consumption has been associated with high blood pressure, cardiovascular diseases and sexual risk behaviours that can lead to the spread of Human Immunodeficiency Virus (HIV) (Zyaambo et al., 2013).

4.3 Energy and Macronutrient Intakes

4.3.1 Energy Requirements

The mean energy intake for men doing light to moderate activities in this study was below the recommended energy intake of 12000kJ. The mean energy intake for hostel miners (8,972kJ) was significantly different to that of non-hostel miners (8,362 kJ ($p < 0.0250$)).

The total energy from protein expressed as a percentage of total energy for both hostel miners and non-hostel miners was 14.6%. This value is close to the prudent dietary guidelines intake of 15% E for protein (Freedman et al., 2014).

According to Insel & Ross 2013, studies have shown that for those meals that do not provide adequate energy to sustain vital body functions, the body will sacrifice its own protein from enzymes, muscles and other tissues to make glucose for use. The result of this is further loss of muscle and reduced strength and endurance (Bean, 2013).

The main energy source in the diet of miners in this study were carbohydrates, which provide metabolic fuel to all parts of the body. The total energy from carbohydrates expressed as a percentage of total energy for hostel miners was 35% and 43% for non-hostel miners. These values are below the RDA of 55+ % of energy required from carbohydrates.

In South Africa (Vorster et al., 2011) reported a decrease in carbohydrate intake from 65% to 57% of total energy in urban areas and from 72% to 68% in rural areas. A similar study in the North West Province indicated a shift from maize meal which was reported as the biggest contributor of energy intake to a higher fat diet .This study showed a decrease of energy from the traditional high carbohydrate diet to a higher fat diet and was presumed to be a consequence of the nutrition transition due to urbanization (Igumbor et al., 2013).

Research on individuals and athletes has shown that they tend to underestimate their energy intake by approximately 15% - 20% (Poslusna et al., 2009). Pooled results from 5 validation studies of dietary self-reporting instruments showed that when three 24-Hour Dietary Recalls were averaged, the average rate of under reporting of energy intake was 15% (Freedman et al., 2014).

Other studies have shown that there has been substantial under-recording of food intake among obese people (Walker et al., 2017). In this study, 22% of miners were obese and this could be attributed to under-reporting of their energy intakes. It is likely that the low energy intakes of miners could be attributed to other diverse causes.

One of the reasons is limitations of the 24-Hour Dietary Recall Method (see section 2.7.6).

To obtain a representative food intake pattern, one could use food frequency questionnaires. In this study, a validated food frequency questionnaire on the study population was not used because it could not be developed before the start of the study due to scheduling and time constraints.

4.4 Macronutrients

4.4.1 Protein Intake

In a study conducted by Dabhadker et al., 2013 on miners, they found that miner's protein intake was below the recommended standard. The RDA for protein in the United States, Canada and the Australian Recommended Dietary Intake (RDI) state that a daily protein intake of 0.75 - 0.80g. kg^{-1} meets the needs of about 98% of the population (Phillips & Loon, 2011). However, some published data suggests that individuals performing resistance or endurance exercises require more protein than sedentary individuals since "extra" dietary protein is expected to help synthesize new muscles or "repair" dietary muscle damage (Phillips & Loon, 2011). The American College of Sports Medicine recommendation on dietary practices for athletes on protein intake is 1.2 - 1.7g.kg^{-1}.day^{-1} for endurance and resistance trained athletes (Gerovasili et al., 2009).

The protein intake for hostel miners was 74.08g and non- hostel miners was 69.9g. The protein intakes were above the RDA for protein which is 63g (Subcommittee on the Tenth Edition of the RDAs, 1989). The difference between hostel and non-hostel miners' protein intake was significant ($p<0.0180$).

4.4.2 Carbohydrate Intake

The South African Food Based Dietary Guidelines recommends that starchy foods such as whole grains, legumes and root vegetables should be part of most meals instead of refined starches and sugars (Vorster et al., 2013). The dominant part of the diet was refined maize meal (pap) or porridge for most miners. The carbohydrate intake was 178.17g and 206.08g for hostel miners and non-hostel miners respectively. The differences in carbohydrate intake were not significant ($p<0.0746$).

A review conducted by Vorster et al., 2011 using South African data from rural and urban population showed a decrease in staple foods rich in starch and dietary fibre but an increase in energy dense snacks, carbonated sweetened beverages, commercial alcoholic drinks, foods with added sugar, fats and oils.

An example of nutrition transition is maize meal intake among adult African men, showed a decrease in maize meal intake (articulated as dry mass per person per day) from 136g in rural areas to 85g in urban areas (Vorster et al., 2011). The nutrition transition has given rise to the non-communicable diseases with deaths ranging from 41% and 39% in stroke, 16% ischemic heart disease, 21% and 28% hypertensive heart disease, 16% and 14% from diabetes (Vorster et al., 2011).

4.4.3 Fats

4.4.3.1 Total Fat Intake

High fat diets are a risk factor as they increase the chances of one becoming overweight or obese (Ng et al., 2014). Studies on dietary intake among black South Africans in the Cape Peninsula by Smuts & Wolmarans, 2013 showed that fat intake patterns were different within some sections of the population, with some taking total fat intake of more than 30% energy.

In this study, the results showed that miners' energy intake from total fat was much higher than the recommended prudent dietary guideline value of not more than 20-35% E. The hostel miners' energy from total fat was comparatively higher at 48% E compared to non-hostel miners' at 39% E. However, the difference on the fat intake was not significant (p-Value < 0.8110).

4.4.3.2 Saturated Fatty Acid (SFA)

The SFA intake of hostel and non-hostel miners was not significant (p-value <0.9810). The mean Saturated Fatty Acid (SFA) intakes of hostel miners was 15% and non-hostel miners was 12% of total energy and these values are above the recommended amount of < 10%. An increase of above 10% energy from SFA is a risk factor that can lead to development of coronary heart disease (CHD) (Micha & Mozaffarian, 2010). SFA are known to increase CHD through their ability to raise cholesterol levels (Micha & Mozaffarian, 2010). LDL are commonly referred to as the "bad cholesterol". Total plasma cholesterol consists of both LDL and high-density lipoprotein (HDL) the "good cholesterol". Recent findings by Chiu et al., 2017 show that enlarged intake of small to average sized SFA's can increase LDL when replaced with either carbohydrates or unsaturated fats. Suggesting that very high saturated fat intake could escalate CVD risks.

4.4.3.3 Dietary Cholesterol

Observation from the 24-Hour Dietary Recall showed that some miners consumed as much as 6 eggs per day. Eggs are a concentrated source of cholesterol with approximately 213mg cholesterol in a large egg (Smolin & Grosvenor, 2010; Brown, 2008). A meta-analysis on dietary cholesterol determined that most persons beyond the range of practical intake (0-400mg/d), each 100 mg contributes to a rise in total cholesterol by 0.056mmol/l, HDL-cholesterol by 0.008mmol/l and LDL cholesterol by 0.02mmol/l (Lecerf & de Lorgeril, 2011).

Nonetheless, numerous metabolic studies have produced inconsistent findings on the effects and the relation between dietary cholesterol intake through egg consumption; dietary cholesterol and plasma cholesterol (Lecerf & de Lorgeril, 2011). Although dietary cholesterol heightens plasma cholesterol (LDL-cholesterol and HDL-cholesterol, this increase is small and

therefore, the interpretation of an HDL-cholesterol increase is doubtful. In conclusion, current epidemiological research has not found any relationship concerning cardiovascular risk and dietary cholesterol intake or egg consumption as such effects are very small (Lecerf & de Lorgeril, 2011).

The miners average dietary cholesterol intake was satisfactory meeting the recommended threshold of <300mg/day, hostel miners had a higher cholesterol intake of 206.78mg compared to 184.67mg for non-hostel miners. In this study the large standard deviations for cholesterol may be attributed to large intakes of eggs or liver by some miners.

4.4.3.4 Polyunsaturated Fatty Acid (PUFA)

The P/S ratio is a shorthand monitor that shows probable consequences of fat or dietary intake on the plasma cholesterol concentration (Guo, 2010). A study conducted in Cape Town among the urban black population found that the P/S ratio was considerably greater in men and women in 2009 compared to 1990 (Steyn et al., 2016).

The Polyunsaturated Fatty Acids (PUFA) in the diets of miners in this study did not meet the RDA recommendation of approximately 6-11% E. The polyunsaturated to saturated fatty acid ratio (P/S ratio) of the diet of non-hostel miners was lower at 1.24 compared to that of the hostel miners at 2.87 suggesting that hostel miners consumed foods high in polyunsaturated fatty acids (Table 8).

4.5 Micronutrient Nutrients

The average vitamin and mineral intakes for most miners in the study was below the Dietary Reference Intake (DRI) and this may be due to the limitations of the 24-Hour Dietary Recall Method.

Low intakes of vitamin A for hostel miners and vitamin C for both hostel and non-hostel miners is a concern because of the key role Vitamin A plays in night vision (especially for underground miners) and immune function respectively.

The difference between hostel and non-hostel miners on the average vitamin and mineral intakes in relation to the DRI with the exception of Vitamin C, were not significant ($p < 0.0057$). Studies on the diet of adult South Africans found that they had several micronutrients deficiencies namely Calcium, Zinc, Vitamin A, B12, C, D, E and pantothenic acid when compared to DRI (Kolahdooz et al., 2013) ; Steyn et al., 2016. Additionally, low micronutrient intakes in overweight and obese individuals could lead to a double burden of co-existence of under and over nutrition in the same person (Vorster et al., 2011). (Jeukendrup, 2011; Stellingwerff & Cox, 2014).

In this study consumption of fruits and vegetables by miners was low. In a study conducted by Steyn et al., 2016 on the urban black population of Cape Town it was found that there was low fruit and vegetable intakes were below recommended intakes. According to them adequate amounts of fruits and vegetables are required to lower the risk of Ischemic Heart Disease (IHD), stroke, high blood pressure, stomach and colorectal cancers.

In another systematic review study on fruits and vegetables intake and the risk of cardio-vascular disease, it was found that fruits and vegetables decreased the risk of cardiovascular disease and all-cause mortality. The study noticed that up to an intake of 800g/day of fruits and vegetables decreased such risks (Dagfinn et al., 2017). Therefore, increasing the intake of fruit and vegetables in the diet could reduce mortality from certain diseases. Furthermore, eating a variety of foods in the diet, especially fruits and vegetables, should be encouraged because it assists in meeting nutrient requirements (Lutz et al., 2015).

Some good sources of micronutrients such as iron, phosphorus and zinc are meat, poultry, liver, eggs, milk, green leafy vegetables, cereal and legumes. Maize meal is also a good source of phosphorus (Maize (Corn)/Agro-Hub, 2013). Pap was one of the most consumed and liked food amongst miners in the study and this would have made a substantial impact towards the increase of calcium intake due to fortified maize. Intakes of iron, phosphorus and zinc was above the DRI for the miners.

4.6 Dietary Fibre

The advantages of consuming diets high in fibre are that they increase the volume of stools thus reducing transit time therefore preventing constipation. Dietary fibre helps with the regulation of energy intake by slowing down glucose absorption and preventing hypoglycaemia (Webb, 2008). High dietary fibre intakes are important in reducing the risk of type 2 diabetes and coronary heart disease (Post et al., 2012; Mann & Cummings, 2009,).

A review on the rural and urban population of South African conducted by Vorster et al., 2011 showed a decrease in consumption of staple foods rich in starch and dietary fibre but an increase in consumption of energy dense snack foods, carbonated sweetened beverages, commercially available alcoholic beverages and foodstuffs with added sugar, fats and oils (Vorster et al., 2011).

The very low dietary fibre intakes of 2g for hostel and non-hostel miners were of concern compared to the recommended dietary fibre intake of 30g per day. This low dietary fibre intake revealed that miners consumed mainly highly refined carbohydrates.

4.7 Fluid Intake

Studies have shown that physical performance is reduced when 2% or more of body weight is lost through sweat and when more than 4% of body weight is lost during physical activity as this leads to heat illness, heat exhaustion, heat stroke and death (Kreider et al., 2010). Therefore, adequate fluid intake during physical activity should be consumed in order to maintain hydration status. Kreider et al., 2010 states that the normal sweat rate of athletes range from 0.5-2.0l/h and this is dependent on temperature, humidity, exercise intensity and sweat response to exercise. Therefore, sustaining fluid balance and preventing dehydration requires that individuals consume 0.5 to 2L/h of fluid indicating that a regular consumption of 177ml-237ml of water every 5-15 minutes during physical exercise is required (Kreider et al., 2010).

Rodriguez et al., 2009 state that dehydration or a water shortage of 2-3% of body mass reduces exercise performance therefore acceptable fluid intake amounts before, during and after exercises is vital for health and prime performance. Also, in a study conducted on underground miners in Northern Australia found that most miners began their shifts in a dehydrated state (Polkinghome et al., 2013).

The results of this study showed low mean fluid intake (940 ml) for hostel miners and (870ml) for non-hostel miners during shift duties.

4.8 Summary

The difference in the education levels of hostel and non-hostel miners was not significant ($p<0.1667$). The mean energy intake of hostel and non-hostel miners was significant ($p< 0.0250$). The low energy intakes for both hostel and non-hostel miners could be attributed to under reporting by the 24-hour dietary recall method and therefore this would require further

analyses to validate whether had been under reporting or aim at reducing the effects of under reporting. Total energy from protein for hostel and non-hostel miners was (14.6%) which is in line with the prudent dietary guideline of 15% E. The protein intake for the miners was above the RDA for protein at 63g.

The miners' protein intake was significant ($p < 0.0180$). Miners macronutrient intake was not significant (carbohydrates ($p<0.0746$), fat intake ($p < 0.811$) and SFA ($p < 0.9810$)).

With the exception of vitamin C which was significant, the average vitamin and mineral intake in relation to DRI for hostel and non-hostel miners were not significant ($p < 0.0057$), which showed significant differences. The low mean intakes of micronutrients among the miners is of concern especially that of vitamin A and vitamin C, and therefore, needs to be addressed.

Fluid intake of hostel and non-hostel miners during shift duties showed that they had low fluid intake as compared to recommended amounts. Miners' knowledge on what could be considered to be a balanced diet was rather scanty. Seventy percent of miners did not take anything to eat during their 8-hour shift citing reasons mentioned earlier.

The hostel miners rated the food served at the hostel kitchen using five categorical variables namely cost, adequacy, variety, appearance, and freshness. Seventy-four percent of the hostel miners claimed that the food served to them was not fresh. Sixty-two percent of the miners complained about the poor appearance of the food and the inadequacy of food in the kitchen because some food items (fruits and vegetables) on the menu finished well before they could get to the kitchen.

Moreover, non- hostel miners' beer consumption (4960ml) on average was relatively high during the week and hostel miners' beer consumption (2000ml) on average was high on Fridays.

The BMI classification of the two groups of miners was not significant ($p<0.3055$). Fifty-four percent of hostel miners were overweight compared to forty-two percent of non –hostel miners. Nonetheless, BMI does not differentiate between muscles and body fat and this could have had an effect on miners due to their possible development of arm muscles linked to their hard physical work.

4.9 Study Limitations

The likely limitations of this study are:

(i) The sample size of this study was not determined using the statistical power calculations, thus the assessed sampling units may not have been large enough to provide an accurate assessment of dietary intakes. From standard statistical power graphs a simple size of about 90 miners per group would have given sufficient power at the default power of 80% (0.8) at 0.5 level of significance.

However, the purpose of the sample size was that it was the minimum number of miners to interview for the 24-hour Dietary Recall Method in order to determine nutrition intake for each group.

According to Ormrod & Leedy, 2010 for a population size of 5,254 as was the case in this study, the sample size would have been close to four-hundred respondents. It must be emphasized that this sample size is applicable to quantitative variables in the study applying a 5% margin of error at 95% level of confidence.

(ii) Body mass index (BMI) was the only indicator used to measure levels of overweight and obesity among. The study could have used the waist circumference to complement the BMI index. Although imperfect, BMI is the most widely used tool for this measurement.

(iii) The 24-hour dietary recall method relies heavily on a participant' memory, thus validity and reliability cannot be ascertained.

(iv) Dietary intake over the weekend was not captured during the research and this could have contributed greatly to lower mean dietary intake results because individuals are known to eat and drink a lot more over the weekend (Webb, 2008).

(v) During data analysis no provision was made for the use of enriched maize meal and bread. Maize meal and bread used at the mine was enriched with calcium and B vitamins. This discrepancy probably underestimated the calcium intake of the hostel miners as well as the non-hostel miners who consumed enriched maize meal and bread at their homes.

(vi) Food frequency does play an important role. For hostel miners this frequency was expected to be invariant. Hostel miners were on rigid meal times as prescribed by the mine kitchen, hence recall bias can be expected between the two groups of miners. Even if the recall bias for both would have had no effect, the type of food consumed and choice could be a confounding variable, in particular, for non-hostel miners. Possible recall biases could include selection, information and also confounding biases. Ideally these should have been addressed at the planning stage of the research process in order to identify possible sources. A well designed research strategy that would be purely experimental entrenching controls and replicated treatments with a longitudinal design would greatly have enhanced the findings of this rather cross sectional study.

Calculated values of REE are not completely accurate for individuals, but serve as a guide for dietary planning. REE equations take into account age, sex, and weight, but ignore height, which was found not to affect the precision of prediction of REE.

CHAPTER 5 - CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study at the platinum mine assessed and compared whether hostel and non-hostel miners received adequate nutrition and fluid intake. Key findings show that the mean energy, fluid, macronutrient and micronutrient intake of miners were below recommended intakes with exception of SFA, Iron, Phosphorus, Zinc, Niacin, Vitamin B12 and Vitamin A (only in non-hostel miners for Vitamin A). This could be due to the limitation of the 24-hour dietary recall method. The hostel and non-hostel miners were overweight and obese according to BMI classification. However, BMI does not distinguish between fat and muscle and miners may have been very muscular due to their high physical work demands. The study recognizes that the sample size was small, and may not have been representative of all miners in South Africa. Therefore, the study cannot be generalized to all mines in South Africa. There is need for a broader study to look at the nutritional status of miners in South Africa, more so, stratified according to work categories and age cohorts. An in-depth longitudinal study is recommended in order to determine some practices concerning eating or taking food/fluid before and during working hours.

5.2 Recommendations

5.2.1 Information, Education and Communication (IEC) in Nutrition

The platinum miners need nutrition IEC on eating habits, the importance of eating a variety of good food and limited alcohol intake. Nutrition IEC should be implemented through health facilities at the mine and form an essential part of the nutrition awareness programmes or campaigns.

5.2.2 Fruits and Vegetables

Dietary fibre intake was very low among the miners and should be improved by reducing intake of refined carbohydrates and adding more vegetables and fruits to miners' diet. Fruits and vegetables did not feature well in the miners eating habits.

5.2.3 Fluid Intake

Miners should be encouraged to drink fluids before, during and after working hours. A fact sheet on the importance of fluid intake written in local languages should be published and be available for distribution to miners.

The recommendation for fluid intake for people engaged in physical activities is 400-600ml of fluid and should be consumed 2 hours before starting the exercise. The recommended amount of fluid that should be consumed during exercises for every 15-20 minutes, depends on an individual's fluid tolerance and is around150-350ml of fluid. Similarly, owing to sweat losses during mining, miners should drink enough fluid that is about 450-675ml for every 0.5kg of body weight lost during exercise.

5.2.4 Mid-shift Feeding

The importance of taking food to work to eat while at tea/lunch breaks needs to be emphasized by sensitizing miners on this need at nutrition IEC campaigns. Miners should be taught on the importance of consuming an adequate nutritious well-balanced diet given their underground working environment.

5.2.5 Hostel Kitchen

The catering manager should supervise and give refresher-training courses on a regular basis on food preparation and presentation to kitchen staff/cooks.

The preparation of food in the hostel kitchens can be improved by ensuring that adequate fresh food is prepared to meet nutritional needs of miners. Furthermore, it is important that the catering manager should have routine checks and ensure that adequate food stocks are ordered. The food should be consumed before its expiry date to ensure its and moreover consumption should be based on stocking dates, that is, old stocks should be used first.

5.3 Further Areas of Research

Future research on a larger sample of miners will be important by conducting repeated 24-hour dietary recalls. A sufficiently larger sample size than used in this study and data for the 24-hour dietary intake should be collected during weekdays as well as weekends. An appropriate sample size can be statistically determined where the population size is known applying a 5% margin of error, at 95% level of confidence for all quantitative variables to be assessed.

A food frequency questionnaire would be designed and be based on food intake data collected from the 24-hour dietary recall method which should be more accurate in determining the amount of foods consumed over a given period as well as information on the source of the food. Laboratory analysis to determine the nutritional status of miners and correlations with standard or recommended dietary intakes would further support recommendations where deficiencies are established.

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APPENDICES

APPENDIX 1: The 24-Hour Dietary Recall Questionnaire and KAP

Section A: General Information

1. Case study number: _____

2. Date of interview _____/_____/20____
(dd mm yy)

3. Name of interviewer _____

4. Patients industry no.:_____

a. Contractor/ Permanent

b. Name of contractor_____

5. Name of mine/quarry _____

6. Date of birth: ___/____/19____ or approximate age in years: _____
dd mm yy

7. What is your home language: _____

8. Highest level of education: _____

9. What is your job description:_____

10. What work do you do most of the time: _____

Section B: Anthropometric Measurements

11. Height _____m

12. Weight _____kg

13. Body fat percentage _____%

14. BMI _____

Section C : Nutrition

15. Do you get an allowance for food? Yes / No
    If yes, how much do you get? R_____

16. Do you get an allowance for accommodation? Yes / No
    If yes, how much do you get? R_____

17. Do you get an allowance for transport? Yes / No
    If yes, how much do you get? R_____

If NO, go to question 18

18. Approximately how much money do you spend a month on:

    i. Food R_____

    ii Accommodation R_____

iii. Transport R_____

19. Where do you live now?

a. Hostel if you circled a go to question 30

b. Other if you circled b go to question 20

20. Do you stay at

a) Skoonspruit	_____km	j) Churchill	_____km
b) District 6	_____km	k) Bendell	_____km
c) Tfineng	_____km	l) Oomslag	_____km
d) Maruping	_____km	m) Farm-Mshwanig	_____km
e) Laxey	_____km	n) Magobing	_____km
f) Pepsi	_____km	o) Magojaneng	_____km
g) Gamopedi	_____km	p) kathu	_____km
h) Penrym	_____km		
i) Other	(specify) _____		

21. Are there cooking facilities available? Yes / No

22. How do you cook your food?

1 Electricity (stove / electrical plate)

2 Gas

3 Fire

4 Paraffin

5 Other (specify) _____

23. Do you have a fridge were you stay? Yes / No

24. Who makes the food?

1 Self

2 Wife

3 Daughter

4 Grandmother

5 Girlfriend

6 Other (specify) _____

25. Do you usually eat

Before the shift Yes / No

After the shift Yes / No

A third meal Yes / No

If you answered yes to one of the following meals, please complete the attached Questionnaire

26. If you do not eat at home, where will you usually go to get something to eat?

27. How do you get to work? _____

28. How long does it take you to get to work (including waiting and travel time)?

_____

29. How many kilometres do you travel to get to work? _____

GO TO Q41

30. What is the name of the hostel?_____

31. How do you obtain your food at the hostel?

1) Buy a meal ticket

2) Credit card system

3) Swipe your card to get into the kitchen

4) Pay with money the food items you want to eat

5) Don't eat at the hostel

6) Other (specify) _____

32. How many meals a day on average do you have from the hostel kitchen?

1) 1 meals a day

2) 2 meals a day

3) 3 meal a day

33. How many times a week do you eat at the hostel kitchen?

a) Always

b) Most of the time (five or more times a week)

c) Sometimes (four or less times per week)

34. How many other people do you share a room with? _____

35. Do you prepare food in your room? Yes / No If NO go to question 38

36. If yes, how do you cook the food?

37. What do you usually make to eat?

38. How do you get to work? _____

39. How many kilometres do you travel to get to work? _____

40. How long does it take you to get to work (including waiting and travel time)?

Section D: Food Habits

43. How often per week, do you drink vitamins or mineral supplements? _____

a) Never (go to Q44)

b) Always

c) Most of the time (five or more times a week

d) Sometimes (four or less times per week

44. If YES what is the name of the vitamin/mineral supplement you take?

45. How often per week, do you drink traditional medicine?

a) Never (go to Q46)

b) Always

c) Most of the time (five or more times a week)

d) Sometimes (four or less times per week

46. If YES what is the name of the traditional medicine that you take?

47. How often do you eat and/or drink something before you go to work?

a) Never

b) Always

c) Most of the time (five or more times a week)

d) Sometimes (four or less times per week)

48. How often do you take something to eat and/or to drink to work?

a) Never

b) Always

c) Most of the time (five or more times a week)

d) Sometimes (four or less times per week

49. How often do you feel hungry when you are at work?

a) Never

b) Always

c) Most of the time (five or more times a week)

d) Sometimes (four or less times per week

50. Have you ever experienced any of the following symptoms while working?

a) Light headed Yes / No *If Yes* *WHEN* _____

b) Faint Yes / No *If Yes* *WHEN* _____

c) Muscle cramps Yes / No *If Yes* *WHEN* _____

If No go to q52

51. How often have you experienced light headedness, faint and/or muscle cramps?

a) Every shift

b) Five or more times a week

c) Four or less times per week

d) Once a month

e) Once in the last year

52. If you take something to eat and/or to drink to work, what do you take most of the time

What do you take to eat and to drink?	**Source? (from where is he food obtained)**	**How Much? (quantity)**

53. Are you a vegetarian? Yes / No

54. Do you have any of these medical conditions?

1) Diabetes

2) Hypertension (high blood pressure)

3) Other (specify) _____

55. Do you drink alcohol?

a) Never

b) Only during the week

c) Only during the weekend

d) During the week and over the weekend

56. How much over the week do you drink?

Day	Traditional Beer (mls)	Commercial Beer (mls)	Wine (mls)	Spirit (mls)
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				

57. Do you smoke? **Yes / No**

58. If no are you an ex-smoker? Yes / No

59. How many cigarettes did/do you smoke a day? _____

60. For how many years do you / did you smoke? _____

61. Which year did you stop smoking? _____

Section E:KAP Study

62. What food do you think is good for you?

63. How many meals a day do you eat? _____

64. What foods do you not like?

65. What foods do you like?

66. Do you think that the food that you eat ensures that you are able to do your job well?
67. Do you have easy access to food whenever you are hungry? Yes / No
68. Have there been any issues concerning food at this mine? Yes / No
    If YES, What have been some of the issues? _____

69. How often per week, do you go to work without eating?
    a) Never
    b) Always
    c) Most of the time (five or more times a week)
    d) Sometimes (four or less times per week)
    If they are staying in the hostel please ask the following two questions or else go to the24-hour recall!!

70**.** How do you find the food that is provided by the mines in terms of:

Cost	**cheap / affordable / expensive**
Smell	**bad / haven't noticed / good**
Taste	**poor / not bad / good**
Appearance	**poor / not bad / good**
Variety	**very little / not bad / good**
Accessibility to the kitchen	**not easy / haven't found any problems / always open when I need to eat.**

71. What would you change about food at this mine?

Section F: 24-Hour Dietary Recall Questionnaire

Dear Sir/Madam

I would like to ask you about the food that you ate and drank yesterday, from the time you got up until you went to bed last night. Please tell me at about what time did you have the first thing to eat or to drink; what was it; how was it prepared (if applicable); and how much was it?

1. CASE NO _____ 2. DATE ____/____/20____

ddmmyy

3. INTERVIEWER _____ 4. DATE OF BIRTH ____/____/19____

ddmmyy

5. AGE_____ 6.Did you work on the mine yesterday? **Yes / No**

7. What day of the week was yesterday?

a) Monday

b) Tuesday

c) Wednesday

d) Thursday

e) Friday

f) Saturday

g) Sunday

8. What shift were you working? _____

What time did it start_____h___?

What time did it end? _____h____

Time	Source	What did you eat and drink?	How was it Prepared?	How much? (quantity)

APPENDIX 2: Questionnaire Consent Form for the KAP Study and the 24-Hour Dietary Recall Method

SIMRAC NUTRITION PROJECT

SUBJECT: INFORMATION SHEET and REQUEST FOR CONSENT FROM MINE EMPLOYEES AND MINE EMPLOYERS

Dear Sir/Madam

Re: Catering Arrangements at the Mine

Hi, my name is Dr Belinda Dias. We would like you to take part in our research project, which this mine has agreed to help me and my research team with. It is a SIMRAC (Safety in Mines Research Advisory Council) project to see if the food and fluid you eat and drink is enough to keep you healthy and give you all the energy you need to perform your work in the mine.

A member of the research team will ask you some questions about all the food and fluid you ate and drank over the past 24 hours. We would also like to know how you feel about the food you eat and how you think food may or may not affect your health.

The research team member will not take your name, and any information you tell him will be kept in strict confidence and will not be passed on to anyone outside the small research team.

Taking part in the study is voluntary and not taking part will not affect your employment in anyway. You are free to refuse to take part or to stop taking part in the interview at any time. If you agree to participate, please answer the questions as honestly as you can. Your opinions are very valuable, so feel free to express them. If you want more information about the study or if you have any questions please ask the research team member.

APPENDIX 3: Informed Consent Form

I, Mr/Mrs _____ do hereby agree to participate in the study being undertaken by Dr Belinda Dias regarding nutrition in the mines. It has been explained to me and I do understand that this study is purely for research purposes.

I also understand that I have the right to withdraw/discontinue my participation at any time, if I may decide otherwise.

Consent given:

Date: _____ Researcher: _____

Date: _____ Participant

APPENDIX 4: Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS (MEDICAL)
Ref: R 14/49 Mhango

CLEARANCE CERTIFICATE **PROTOCOL NUMBER** M02-10-21

PROJECT An Assessment and Comparison of Dietary Intake of Miners: A Case Study of a South African Mine

INVESTIGATORS Ms R Mhango

DEPARTMENT School of Public Health, Wits Medical School

DATE CONSIDERED 02-10-25

DECISION OF THE COMMITTEE Approved unconditionally

Unles otherwise specified the ethical clearance is valid for 5 years but may be renewed upon application This ethical clearance will expire on 30 July 2007.

DATE 02-12-02 CHAIRMAN ..... (Professor P E Cleaton-Jones)

* Guidelines for written "informed consent" attached where applicable.

c c Supervisor: Prof M Ross
Dept of School of Public Health- Wits Medical School
Works2\lain0015\HumEth97.wdb\M 02-1021

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and ONE COPY returned to the Secretary at Room 10001, 10th Floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. I agree to a completion of a yearly progress form. I/we agree to inform the Committee once the study is completed.

DATE 14/12/2002 SIGNATURE .....

PLEASE QUOTE THE PROTOCOL NO IN ALL QUERIES : M 02-10-21

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES