Dietary intake of the African-PREDICT study population

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Ephesians 3:20

“Now all glory to God, who is able, through His mighty power at work within us, to accomplish infinitely more than we might ask or think.”

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ABSTRACT

Background: Ethnicity and socioeconomic status (SES) contribute to the dietary intake of individuals, which, in turn, plays an important role in the development of non-communicable diseases (NCDs). South Africa (SA) is currently in the middle of a health transition characterised by a quadruple burden of NCDs, communicable diseases, and perinatal- maternal- and injury-related disorders, as well as experiencing a nutrition transition (NT). The NT causes individuals to shift to a westernised diet consisting of unhealthier dietary choices leading to various metabolic conditions related to NCDs. Comparisons between the different ethnic groups and the different socioeconomic groups will give a better understanding of the dietary intake differences of these groups.

Objectives: The aim of this study was to determine the difference in dietary intake between the different SES groups and the two ethnic groups (black and white population) of the baseline of the African-PREDICT study population.

Design and Methods: The African-PREDICT study is a prospective observational study which stretches over a follow-up period of 10 years. Data included in this study are the baseline data collected from 2013-2016 and include 904 participants. Each participant completed three 24-hour dietary recall interviews. After the three 24-hour dietary recalls were completed, they were coded and household measures were converted to grams. The nutrient and food analysis of the baseline dietary data was conducted by the South African Medical Research Council using the food composition tables for SA. After the food and nutrient intake were determined the Mann-Whitney U test were used for the comparison between the two populations within the three SES groups, and the Kruskal-Wallis test was used for the comparison of the three SES groups within the two populations. Exploratory factor analysis was used to determine nutrient patterns.

Results: Clear differences were seen between the dietary intake of the black and the white population across all SES classes. The white population had a diet consisting of a larger variety of nutrients, while the black population's diet was very monotonous. The black population had a greater consumption of foods such as cooked maize porridge and atchar while the white population preferred rice and pasta as their starch. Both populations had high intakes of bread. SES also played a role in the food choices of the study population. The high SES groups had a higher intake of vegetables and fruits, as well as milk and milk products, whereas the low SES groups had low intakes of fruit and vegetables (leading to low intakes of fibre, calcium, magnesium, folate and vitamins A, C and E) and higher intakes of refined starches and carbonated cold drinks. Three nutrient patterns were identified in the study population which explained 63.3% of the variance in the diet. These patterns were named according to the

largest positive loadings on nutrients namely: plant protein, carbohydrates and folate nutrient pattern, the calcium, phosphorus and potassium nutrient pattern and finally the vitamin E and unsaturated fats nutrient pattern.

Conclusion: There were clear differences between the black and white populations and the different SES groups. The high SES groups follow a diet consisting of healthier options which includes vegetables and fruit as well as milk and milk products. Whereas the low SES groups consumed less vegetables, fruits and milk and also tend to buy cheaper products, which are also the less healthy options. These unhealthy dietary choices can lead to various metabolic conditions, such as hypertension or overweight/ obesity, all related to NCDs and contributing to the disease burden of SA.

Key words: South Africa, 24-hour recall dietary interview (24hr), nutrient intake, dietary intake, nutrient patterns, nutrition transition, ethnicity, SES.

OPSOMMING

Agtergrond: Etnisiteit en sosio-ekonomiese status (SES) dra tot die dieetinname van individue by, wat weer ’n belangrike rol in die ontwikkeling van nie-oordraagbare siektes speel. Suid-Afrika (SA) is tans in die middel van ’n gesondheidsoorgang wat deur ’n viervoudige las van nie-oordraagbare siektes, oordraagbare siektes en perinatale- moeder- en beseringsverwante afwykings, asook ’n voedingsoorgang gekenmerk word. Die voedingsoorgang veroorsaak dat individue meer na ’n Westerse lewenstyl oorgaan wat hoofsaaklik uit ongesonde dieetkeuses bestaan wat tot verskeie metaboliese toestande lei wat met nie-oordraagbare siektes verband hou. Vergelykings tussen die verskillende etniese groepe en die verskillende sosio-ekonomiese groepe sal ’n beter begrip van die dieetinnameverskille van hierdie groepe gee.

Doelstellings: Die doel van hierdie studie was om die verskil in dieetinname tussen die verskillende SES-groepe en die twee etniese groepe (swart- en witbevolking) van die basislyn van die African-PREDICT studiebevolking te bepaal.

Ontwerp: Die African-PREDICT studie is ’n voornemende waarnemingstudie wat oor ’n opvolgperiode van 10 jaar strek. Data in hierdie studie ingesluit, is die basislyn data wat vanaf 2013-2016 versamel is en sluit 904 deelnemers in. Elke deelnemer het drie 24-uur dieetherroep onderhoude voltooi. Nadat die drie 24-uur dieetherroepe voltooi is, is hulle gekodeer en huishoudelike mates is in gram omskep. Die nutriënt- en voedselanalise van die basislyn dieetdata is deur die Suid-Afrikaanse Mediese Navorsingsraad uitgevoer deur van die voedsel samestellingstabelle vir SA gebruik te maak. Nadat die inname van voedsel en nutriënte vasgestel is, is die Mann-Whitney U-toets vir die vergelyking tussen die twee bevolkingsgroepe binne die drie SES groepe gebruik. Die Kruskal-Wallis-toets is vir die vergelyking van die drie SES groepe binne die twee populasies gebruik. Verkennende faktoranalise is gebruik om nutriënt patrone te bepaal.

Resultate: Duidelike verskille is tussen die dieetinnames van die swart en die wit bevolking in al drie SES groepe waargeneem. Die wit bevolking het ’n meer diverse dieet gehad – dit is deur hoër innames van die meerderheid nutriënte aangedui – terwyl die swart bevolking se dieet baie eentonig was. Die swart bevolking het ’n groter inname van voedsel soos gekookte mieliepap en atchar gehad, terwyl die blanke bevolking rys en pasta as hul stysel verkies het. Albei bevolkings het ’n hoë inname van brood gehad. SES het ook ’n rol in die koskeuses van die studiebevolking gespeel. Die hoë SES groepe het ’n hoër inname van vrugte en groente, asook melk en melkprodukte gehad, terwyl die lae SES groepe lae innames van vrugte en groente gehad het (dit lei tot lae innames van vesel, kalsium, magnesium, folaat en vitamiene A, C en E) en hoër inname van verfynde stysels en gaskoeldranke gehad het. Drie nutriëntpatrone is in die

studie populasie geïdentifiseer wat 63.3% van die variasie in die dieet verduidelik. Hierdie patrone is benoem volgens die nutriënte met die grootste positiewe ladings, naamlik: die plant proteïen, koolhidrate en folaat nutriëntpatroon, die kalsium, fosfor en kalium nutriëntpatroon en laastens die vitamien E en onversadigde vette nutriëntpatroon.

Gevolgtrekking: Daar was duidelike verskille tussen die swart en die wit bevolkings, sowel as tussen die verskillende SES groepe is. Die hoë SES groepe volg 'n dieet bestaande uit gesonder opsies soos groente en vrugte asook melk en melkprodukte. Die lae SES groepe het minder groente, vrugte, melk en melkprodukte ingeneem en is geneig om goedkoper produkte te koop, wat ook die minder gesonde opsie is. Hierdie ongesonde dieetkeuses kan tot verskeie metaboliese toestande, soos hipertensie of oorgewig/ vetsug lei, wat almal met nie-oordraagbare siektes verband hou en tot die siektelas van SA bydra.

Sleutelwoorde: Suid-Afrika, 24-uur herroep dieet onderhoud (24hr), nutriënt inname, dieetinname, nutriënt patrone, voedingsoorgang, etnisiteit, SES.

LIST OF ABBREVIATIONS

mmHg	Millimetre of Mercury
Cm	Centimetre
%	Percentage
kg/m^2	Kilograms per square meter
kJ	Kilojoules
G	Gram
Mg	Milligram
µg	Microgram
24hr	24-hour dietary recalls
African-PREDICT	African Prospective study on the Early Detection and Identification of Cardiovascular Disease and hyperTention
BMI	Body Mass Index
CHD	Chronic Heart Disease
CRDs	Chronic Respiratory Diseases
CVDs	Cardiovascular Diseases
DM	Diabetes Mellitus
DRIs	Dietary Reference Intakes
FFQs	Food Frequency Questionnaires
HART	Hypertension in Africa Research Team
LMIC	Low-to-Middle-Income Countries
MUFAs	Monounsaturated Fatty Acids
NCDs	Non-Communicable Diseases

NT	Nutrition Transition
PUFAs	Polyunsaturated Fatty Acids
SA	South Africa
SAMRC	South African Medical Research Council
SD	Standard Deviation
SES	Socio-economic Status
T2DM	Type two Diabetes Mellitus
WHO	World Health Organization

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CHAPTER 1: INTRODUCTION

1.1 Background

The nutrition transition (NT) is a phenomenon that is happening globally, together with the epidemiological and demographic transition. The term NT refers to a change in the diet because of modernisation, economic development, urbanisation and an increase in wealth (Misra & Bhardwaj, 2014). It can also be defined as dietary and physical activity changes reflecting as nutritional outcomes (e.g. changes in average body composition or stature) (Popkin, 2003b). These changes include population size and age composition, disease patterns and dietary and physical activity patterns (Popkin, 2003b). The demographic transition is defined as changes from a high-fertility and -mortality pattern to a low-fertility and -mortality pattern (especially in modern industrialised countries) (Popkin, 2003a), while the epidemiological transition is defined as changing from a pattern with a high prevalence of infectious diseases, which are associated with malnutrition, famine and poor environmental sanitation to a pattern that has a high prevalence of chronic and degenerative diseases, which are associated with an urban-industrial lifestyle (Omran, 2005; Popkin, 2003a).

The adverse health outcomes of the NT, such as a rise in overweight/ obesity and non-communicable diseases (NCDs) are now coexisting with the burden of undernutrition, especially in developing countries (Shetty, 2013). These adverse health outcomes are resulting from lifestyle changes such as changes in a population's diet – increased intake of fats (especially saturated fats), salt, sugars and low in fibre, and a reduction in physical activity levels (Shetty, 2013). This double burden of malnutrition (under- and over-nutrition) is contributing to the health and economic burden that developing countries are experiencing (Shetty, 2013).

South Africa (SA) is also currently in the middle of a health transition, which is characterised by the occurrence of a rise in NCDs (WHO, 2013b). This health transition is the result of the lifestyle changes leading to the adverse health outcomes of the NT (Steyn *et al.*, 2012).

NCDs, or otherwise known as chronic diseases, are diseases with slow progression and are generally of long duration (WHO, 2013a). NCDs can also be described as medical conditions or diseases which are classified as being non-infectious and non-transmissible among people (Kim & Oh, 2013). There are four main clusters of NCDs – cardiovascular diseases (CVDs), type two diabetes mellitus (T2DM), chronic respiratory diseases (CRDs) and cancer. These four main clusters account for approximately 80% of all NCD-related deaths (Lozano *et al.*, 2012). According to the World Health Organization (WHO), NCDs contributed to 36 million deaths globally in 2008, which is 63% of the 57 million total deaths for 2008 (WHO, 2013a), but, in 2015, the Global Burden of Disease Study together with the WHO stated that NCDs are the

reason for 40 million deaths each year; this is 70% of all deaths globally (Forouzanfar *et al.*, 2015). There are 15 million people, between the ages of 30 and 69, that die from NCDs annually and about 80% of these deaths occur in low-to-middle-income countries (LMIC) (Forouzanfar *et al.*, 2015). Of the 594 071 deaths, occurring in SA in 2010, 38.9% were because of NCDs. When compared to the white population of SA, the other population groups had higher NCD mortality rates.

There are four common, modifiable risk factors that are associated with the four main NCD disease clusters. These risk factors include poor diet, tobacco use or smoking, the use of alcohol and physical inactivity (Hunter & Reddy, 2013). Dietary intake, one of the risk factors, plays an important role in the development of NCDs. The NT is causing individuals to change from a traditional diet to a more westernised diet, which is low in vegetables and fruit, whole grains and nuts or seeds and is higher in salt and fat (Ezzati & Riboli, 2013). A diet that is high in saturated and trans-fats, salt and sugar is contributing to at least 14 million deaths, 40% of all deaths, annually (Wagner & Brath, 2012). These unhealthy dietary choices lead to various metabolic conditions (hypertension, high glucose levels, high cholesterol levels, overweight/ obesity and cancer-associated infections) that are associated with NCDs (Mathers, 2008; Alwan, 2011).

There are not many studies available that report the dietary intake of young (aged 20-30 years old) South African adults and therefore this study will contribute to the dietary intake data of young South African adults. The evidence regarding dietary differences between the black and white South African populations as well as the different SES groups, living in the same region, are still limited and therefore this study will contribute to the evidence.

The study of dietary intake has evolved into studying dietary patterns or combinations of foods and nutrients (Moeller, 2007). A study done by Mikkilä *et al*., (2005) concluded that dietary patterns do change over the years, even if it is just a small change (Mikkilä *et al.*, 2005). These changes can be due to the change in environment, culture and food variety (Mikkilä *et al.*, 2005). Another study done by Hu *et al.,* (2000) aimed to determine if certain diet patterns can predict the incidence of coronary heart disease (CHD). They found two major dietary patterns; the prudent pattern and the Western pattern (Hu *et al.*, 2000). It was concluded that with an increase in the prudent pattern, the risk of CHD decreases and with an increase in the Western pattern, the risk of CHD also increases (Hu *et al.*, 2000).

Compared with food or dietary pattern analysis, there has been limited work done on nutrient pattern analysis (Moskal *et al.*, 2014). Dietary patterns are easier to translate into public health recommendations, but in an international context, nutrient pattern studies have several advantages (Moskal *et al.*, 2014). However, limited evidence is available regarding nutrient

patterns in the South African population, and therefore this study will contribute to the evidence in this regard.

1.2 Rationale for the study

NCDs are a rising problem in South Africa. The dietary intake of an individual plays an important role in the development of NCDs. The African-PREDICT study (African **Pr**ospective study on the **E**arly **D**etection and **I**dentification of **C**ardiovascular **D**isease and Hyper**T**ension) aims to understand the early pathophysiology accompanying disease development, and to identify novel early markers or predictors for the development of CVD in South Africans. This knowledge will contribute to our understanding of disease development in order to equip scientists to develop and implement intervention programmes, especially in SA, to be significantly more successful than at present.

In this study, we will determine the dietary intake of the black and white ethnic populations in the North West province of South Africa in order to describe the baseline dietary intake data. Comparisons between the different ethnic groups and between the different socioeconomic groups will give us a better understanding of the dietary intake differences. The baseline dietary intake of the population will firstly be described before any associations with other outcomes of the African-PREDICT study are made in the future.

1.3 Research aim

The aim of this study is to determine the dietary intake of the African-PREDICT study population.

1.4 Research objectives

(i) Determine the demographic, anthropometric characteristics and blood pressure of the respondents.

(ii) To determine the nutrient and food intake of the African-PREDICT study population.

(iii) To determine the nutrient patterns of the African-PREDICT study population.

(iv) To compare the nutrient and food intake between the different socioeconomic groups and ethnic groups.

(v) To compare the different nutrient patterns between the different socioeconomic groups and ethnic groups.

1.5 Ethical approval

The African-PREDICT study was approved by the Health Research Ethical Committee (HREC) of the North-West University (NWU), Potchefstroom campus (NWU-0001-12-A1). Approval for this MSc study was obtained from the HREC of NWU Potchefstroom campus (NWU-00023-17-S1) (Appendix D).

1.6 Dissertation outline

This mini-dissertation is presented in an article format according to the NWU postgraduate manual. All referencing used in this mini-dissertation is in accordance with the NWU Harvard style, with the exception of Chapter three.

This mini-dissertation is divided into four chapters:

Chapter one consists of a brief introduction to this study and why this study is important. It also includes the contributions of the study team.

Chapter two is a detailed literature review of the available literature regarding NCDs (part 1) and the role of ethnicity and socioeconomic status (part 2), as well as dietary and nutrient patterns (part 3).

Chapter three consists of an article titled *"Dietary intake differences between two ethnic groups and socioeconomic status (SES) groups in a South African population (The African-PREDICT study)".* This article will be submitted for publication to the Nutrients – Open Access Human Nutrition Journal. The headings, numbering and the referencing style are according to the guidelines of the Nutrients – Open Access Human Nutrition Journal. The article will, however, only be submitted for publication after the rest of the baseline data have been added to analyses by the end of 2017.

Chapter four summarises the findings of this study in a main conclusion. Limitations as well as recommendations are also provided.

1.7 Research outputs

"The dietary intake differences between two ethnic groups and socioeconomic status (SES) groups in a South African population (The African-PREDICT study)"

Nutrients – Open Access Human Nutrition Journal

1.8 Research team

Table 1.1: Contributions from the research team

Title	Initials and Surname	Affiliation	Role in this study
Prof	A. Schutte	Hypertension in Africa Research Team (HART)	Principal investigator of the African-PREDICT study. No scientific contribution to this study.
Dr	T. van Zyl	Centre of Excellence for Nutrition (CEN)	Supervisor of C.K. Jordaan. Guided the student in the writing of the protocol and the mini-dissertation and assisted with the statistical analysis and interpretation of the data.
Prof	E. Wentzel-Viljoen	Centre of Excellence for Nutrition (CEN)	Co-supervisor of the student. Assisted in the interpretation of the data.
Ms	M. Cockeran		Assisted with the statistical objectives in the protocol of the study.
Ms	R. Laubscher	South African Medical Research Council (SAMRC) – Biostatistics Unit	Assisted with the nutrient analysis of the dietary data.
Ms	C.K. Jordaan	Centre of Excellence for Nutrition (CEN)	Postgraduate student. Responsible for the writing of the protocol, literature review, statistical analysis, interpretation of the data and writing up of the mini-dissertation.

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CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

South Africa is currently in a health transition characterised by the occurrence of a rise in NCDs (WHO, 2013b). This health transition is the result of lifestyle as well as dietary intake changes (Steyn *et al.*, 2012). These dietary changes consist of increased fat and saturated fat consumption, added sugars and added salt in the diet, while the fibre content of the diet is decreasing (Steyn *et al.*, 2012).

The term “nutrition transition” (NT) describes a change in the diet of an individual, usually as a result of economic development, an increase in wealth, urbanisation and modernisation (Misra & Bhardwaj, 2014). It can also be defined as the reflection of dietary and physical activity changes as nutritional outcomes (e.g. changes in average body composition or stature) (Popkin, 2003b). These changes include population size and age composition, disease patterns and dietary and physical activity patterns (Popkin, 2003b). The NT can be divided into five stages: (1) collecting food/ hunter; (2) famine; (3) receding famine/ end of famine; (4) nutrition-related NCDs and (5) behavioural change (Misra & Bhardwaj, 2014). Most low-to-middle income countries (LMIC) are moving rapidly from pattern 3 to pattern 4. One of the key contributors to this rapid change is the fact that individuals are shifting their diets from the more traditional diet to a westernised diet (Misra & Bhardwaj, 2014). These changes in diet, together with lower physical activity levels, are detrimental to health as they can lead to NCDs (Steyn *et al.*, 2012).

NCDs, otherwise known as chronic diseases, are diseases with slow progression and are generally of long duration (WHO, 2013a). NCDs are medical conditions or diseases which are classified as being non-infectious and non-transmissible among people (Kim & Oh, 2013). The four main types of NCDs are CVDs, T2DM, CRDs and cancer. According to the Global Burden of Disease Study, together with the WHO, NCDs causes 40 million deaths each year, which accounts for 70% of all deaths globally. Between the ages of 30 and 69, 15 million people die from NCDs annually and about 80% of these deaths occur in LMIC (Forouzanfar *et al.*, 2015). The four main NCD disease clusters account for approximately 80% of all NCD-related deaths (Lozano *et al.*, 2012).

There are four common, modifiable risk factors that are associated with the four main NCD disease clusters. These risk factors include diet, tobacco use or smoking, the use of alcohol and physical inactivity (Table 2.1) (Hunter & Reddy, 2013)

Table 2.1: Risk factors for NCDs

Risk factor	CVDs*	T2DM*	CRDs*	Cancer
Diet	X	X		X
Smoking	X	X	X	X
Alcohol consumption	X	X		X
Physical inactivity	X	X		X

*** CVDs = *Cardiovascular Diseases*; T2DM = *Type 2 Diabetes Mellitus*; CRDs = *Chronic Respiratory Diseases*.**

2.2 Risk factors contributing to NCDs

The dangerous effects of behavioural and dietary risk factors have been established in several different studies (Ezzati *et al.,* 2002; Danaei *et al.,* 2009; Ezzati & Riboli, 2013). The four main risk factors (diet, tobacco use or smoking, alcohol use and physical inactivity) play a large part in the global disease burden, either directly or through conditions such as high blood glucose levels or hypertension (Ezzati & Riboli, 2013).

Tobacco use/ Smoking

Tobacco use or smoking contributes to all four of the main NCDs. There are more than one billion smokers globally, the majority of these smokers (80%) living in LMIC; however, the prevalence of smoking in sub-Saharan Africa (SSA) is relatively low (Ezzati & Riboli, 2013). There are approximately 7.7 million adult tobacco users in SA, 6.3 million of these adults smoking cigarettes (TISA, 2016). Tobacco use contributed to about 6 million deaths, globally, between 2008 and 2011 and the death toll due to tobacco use might increase to 7.5 million in 2020; this is 10% of all deaths (Mathers, 2008; Alwan, 2011). Tobacco use already kills more than 7 million people, globally, each year – 6 million of these deaths are from direct tobacco use while 890 000 deaths are of non-smokers who have been exposed to second-hand smoke (WHO, 2017).

Alcohol use

Alcohol consumption contributes to CVDs, T2DM and cancer. Heavy episodic/ binge drinking can cause an increased risk of injuries as well as of CVDs and liver disease (Ezzati & Riboli, 2013). Alcohol abuse is responsible for 2.7 million annual deaths and contributes 3.9% to the global disease burden. The major contributors to the alcohol-attributable disease burden are cancers, chronic liver disease, unintentional injuries, alcohol-related violence, neuropsychiatric conditions and CVDs (Ezzati & Riboli, 2013).

Physical inactivity

Physical activity provides several health benefits, such as strengthening your heart and improving lung function, reducing the risk factors for CHD and reducing the risk of a heart attack (Ezzati & Riboli, 2013). Over the years, physical activity has drastically declined. This reduction in physical activity is because there are now longer periods of sedentary conditions, especially in the high-income and urban countries (Ezzati & Riboli, 2013). Physical inactivity contributes 3 million or 8% of all deaths, annually, from NCDs (Wagner & Brath, 2012). However, activity levels are still high in rural areas where individuals engage in agricultural activities as well as travelling long distances by bicycle or on foot (Ezzati & Riboli, 2013). Physical inactivity has increased over the last few years in SA from 43% for men and 47% for women in 2002-2003 to 46.4% for men and 55.7% for women in 2011 (Guthold *et al.,* 2008; WHO, 2011).

Dietary intake

Dietary intake plays an important role in the development of NCDs. Because of the NT individuals are shifting from a traditional diet to a more westernised diet. This westernised diet is low in vegetables and fruit, whole grains, nuts and seeds and are high in salt (Ezzati & Riboli, 2013). A diet that is high in saturated and trans-fats, salt and sugar is contributing to at least 14 million deaths – 40% of all deaths annually, from NCDs (Wagner & Brath, 2012).

Unhealthy dietary choices lead to various metabolic conditions, such as hypertension, high glucose levels, high cholesterol levels, cancer-associated infections and overweight, all that are related to NCDs (Mathers, 2008; Alwan, 2011).

Hypertension is a major risk factor for CVDs and stomach cancer and is responsible for about 7.5 million deaths (12.8%), annually (Mathers, 2008; Alwan, 2011). A high salt intake contributes to 30% of all hypertension cases and therefore increases the risk of stroke, other CVDs, chronic kidney disease and kidney cancer (Ezzati & Riboli, 2013). Increased cholesterol levels contribute to 2.6 million deaths, therefore increasing the risk of heart disease and stroke (Mathers, 2008; Alwan, 2011).

These dietary changes are responsible for adding from 1.5% to more than 4% to the global disease burden (Ezzati & Riboli, 2013) and, along with physical inactivity, are also contributing to obesity. The risk of developing heart disease, stroke or T2DM increases steadily with an increase in body mass index (BMI). In 2008, 35% of all adults 20 years and older were overweight; this is more than 5%-10% of urban and rural populations in all countries (WHO, 2009). In 2010 obesity contributed to 3.4 million deaths and in 2015, 603.7 million adults, globally, were obese (Ng *et al.,* 2014; GBD, 2017). Excess body weight and different measures of adiposity are associated with a higher rate in total mortality as well as an increased risk of

disease or even death from T2DM, ischaemic heart disease and stroke, chronic kidney disease, multiple types of cancers and osteoarthritis. In 2013, excess body weight was responsible for 3.4 million deaths (annually) and contributed 3.8% to the global disease burden (Ezzati & Riboli, 2013). The WHO stated in 2014 that more than 1.9 billion (39%) adults were overweight and of these, more than 600 million (13%) were obese (WHO, 2016). In SSA, SA has the highest obesity and overweight rates – up to 70% of women and a third of men are classified as overweight or obese (HSFSA, 2016). Obesity is a leading risk factor for diseases such as T2DM, heart disease, stroke, hypertension, certain cancers and joint pain.

Labadarios *et al*., (2011) measured the dietary diversity (DD) in South Africans aged 16 years and older. Respondents were from all specified ages, provinces (all nine provinces of SA), geographic localities (urban – formal and informal; formal rural; tribal) and socioeconomic strata. The dietary data were collected by means of a face-validated 24-hour recall and a dietary diversity score was then calculated by counting each of the nine food groups. The study results showed that, overall, the majority of the South African population consumed a diet which was low in dietary variety. The tribal and informal urban areas (especially Limpopo and the Eastern Cape) were the worst affected, consuming a diet limited in variety. In the whole country, the foods least consumed were legumes, eggs and vegetables and fruits rich in vitamin A.

Few studies reporting on the dietary intake of young (aged 20-30 years) South African adults, of various ethnicities, are available. This study will therefore contribute to the body of knowledge about the dietary intake data of this population group.

2.3 Dietary intake and ethnicity

Dietary intake differs between the South African ethnic groups as indicated in the national representative study done by Steyn & Labadarios (2011). Their results showed that in SA the consumption of street or fast foods differs between the ethnic groups – 19% of black South Africans (1 in 5) consume street food on a regular basis (> 2x week), while the white SA population had a much lower (2.9%) consumption of street food (Steyn & Labadarios, 2011). The results for the consumption of fast foods, however, were reversed: the white population had the highest (12.5%) consumption of fast food, whereas the black population had the lowest (5.4%) consumption (Steyn & Labadarios, 2011).

The most common food items purchased by the black population from street vendors were fruit, cold drinks, savoury snacks, biscuits and cooked food (pap and fried meat) (Steyn & Labadarios, 2011). These foods are usually high in sugar and fat and have a high salt content (Steyn & Labadarios, 2011).

South Africans have a very low DD despite the Food-Based Dietary Guidelines encouraging the population to “eat a variety of food” (Labadarios *et al.*, 2011). The white population had the most diverse diet of all of the populations in SA and the black population had the most monotonous diets in the country. Nearly 40% of the latter group consumed only one to three different food groups – a cereal, meat or chicken and a vegetable not rich in vitamin A (Labadarios *et al.*, 2011). The foods that were the least consumed were legumes, nuts, fruit and vitamin A-rich vegetables (Labadarios *et al.*, 2011). The difference in DD among the different ethnicities in SA gives a clear indication of the difference in dietary intake. The black population with a low diversity has a diet which is not rich in vegetables and fruit whereas the white population consumed more of these products (Labadarios *et al.*, 2011).

Dietary habits play an important role in the morbidity and mortality of chronic diseases, as well as in health inconsistencies in a population (Abu-Saad *et al.*, 2012). A study done by Abu-Saad *et al.,* (2012) aimed to determine whether there was a difference in dietary patterns between the Jewish and Arab populations living in the same region. The study results showed that there were significant differences between these populations. Because of the process of acculturation, the Jewish immigrants adopted the food choices of their host country, Israel, where the food environment is rich in fresh vegetables and fruit as well as olive oil, and therefore their dietary habits improved (Abu-Saad *et al.*, 2012). The Arab population, however, adopted the western diet style of the bigger population because ethnic minorities usually relate to the dietary habits of the majority. Therefore, the Arab population experienced a decrease in the quality of their diet (Abu-Saad *et al.*, 2012). Another study found that Arab men and women had 1.6 and 2.4 times higher rates, respectively, of CHD mortality and 2.3 and 3.4 times higher rates of T2DM than their Jewish counterparts (Na’amnih *et al.*, 2010). The reason for these differences could be the socioeconomic, demographic and ethno-cultural differences between the populations, which all affect their dietary habits and therefore their exposure to chronic diseases (Na’amnih *et al.*, 2010).

However, the evidence regarding the dietary differences between the black and white South African populations living in the same region is still limited and therefore this study will contribute to the evidence.

2.4 Dietary intake and socioeconomic status

Socioeconomic status (SES) is one of the biggest determinants of health in high-income and LMIC (James *et al.,* 1997; Wagner & Brath, 2012; Mayén *et al.,* 2014). In high-income countries, individuals with a high SES tend to consume a healthier diet consisting of whole grains, fish, lean meats, vegetables and fruit and low-fat dairy products (Darmon & Drewnowski, 2008;

Giskes *et al.*, 2010). Individuals with a lower SES tend to consume more fats and less fibre (Darmon & Drewnowski, 2008; Giskes *et al.*, 2010).

SES development accompanies the NT with a shift from a traditional diet rich in fibre and grain to one rich in fat and sugar (Drewnowski & Popkin, 1997; Popkin, 2003a; Popkin, 2004). This change most probably occurs first in the urban areas and then in the rural areas (Drewnowski & Popkin, 1997; Popkin, 2003a; Popkin, 2004). The NT usually first affects individuals with high-SES status in LMIC, which is consistent with the high prevalence of obesity in these individuals (Popkin, 2004). Four out of five NCD deaths occur in the LMIC (Wagner & Brath, 2012) and it is expected that the NCD burden in these countries will rise even more (Schmidhuber & Shetty, 2005).

Several studies (Cade *et al.,* 1999: Drewnowski, 2004; Drewnowski *et al.,* 2004; Drewnowski & Darmon, 2005; Jetter & Cassady, 2006) conducted in France and the United States of America (USA) showed that economic status may put pressure on people from a lower class to buy the more unhealthy foods. Unhealthy foods, such as refined starches and foods with added fats and sugars are generally cheaper than the healthier foods, such as lean meats and fish, vegetables and fruit (Drewnowski, 2004; Drewnowski & Darmon, 2005; Drewnowski *et al.*, 2004).

Healthy food choices are usually available in stores. The cost of these foods, however, is very high and is therefore one of the reasons South Africans with a lower class have nutritionally inferior diets (Temple *et al.*, 2011). A cost analysis of healthier food options revealed that, for 33 out of 42 price comparisons, the healthier food option was more expensive (Temple *et al.*, 2011). The cost analysis of an overall healthier diet showed that, on average, the healthier diet cost R10.20 more per day – that is 69% more (Temple *et al.*, 2011). These results show that economic factors do have an influence on the food choices that an individual makes (Temple *et al.*, 2011).

The intake of dietary fibre in the USA is far below the recommendations for all genders, ages and ethnicities (Storey & Anderson, 2014). Certain populations have lower dietary fibre intake when compared with other ethnicities, and living in poverty or having a low income are also associated with lower fibre intake (Storey & Anderson, 2014). This is probably because individuals living in poverty have a low consumption of vegetables. When buying food, 91% of women claimed that they would rather buy fresh vegetables because it is healthier. However, the availability of vegetables in the home has decreased from 2007 (98%) to 2014 (94%) (Storey & Anderson, 2014). This decrease can be due to the cost of vegetables, as 63% of women said that cost is the most important factor when shopping for food (Storey & Anderson, 2014). Mothers that did not have any vegetables in their homes said that it was too expensive (Storey & Anderson, 2014). Even though consumers know that vegetables are the healthy

choice, affordability is a great barrier, especially for those with a lower income (Storey & Anderson, 2014).

It has been found that, to meet the *Dietary Guidelines for Americans* regarding vegetable and fruit intake, low-income households have to spend 70% of their food budget on vegetables and fruit (Cassady *et al.*, 2007; Monsivais *et al.*, 2011). This is far more than the 15%-18% that the average household spends (Cassady *et al.*, 2007; Monsivais *et al.*, 2011). Results from the Prospective Urban Rural Epidemiology (PURE) study showed that because of these increased costs of vegetables and fruits related to household income, the consumption thereof is reduced, especially in LMIC such as SA (Miller *et al.,* 2016).

The Transition and Health during Urbanisation in South Africa (THUSA) study, conducted in the North West province, noted that there is a significant difference between the dietary intakes of different SES groups (Vorster *et al.*, 2007). The dietary intake of the high SES group differed from that of the low SES group and more foods containing nutrients that contribute to the development of CVDs were included in the diet of the high SES group (Vorster *et al.*, 2007). The low SES group had a diet deficient in various nutrients (Vorster *et al.*, 2007). The survey done by Labadarios *et al*., (2011) also noted a lower dietary diversity in the low SES group when the living standard measure was used as a grouping variable. The THUSA study also examined the determinants of hypertension in a population which was in transition in SA (Van Rooyen *et al.*, 2000). The study population was divided into five strata: Stratum 1 – rural tribal areas; Stratum 2 – rural farm areas; Stratum 3 – informal settlements; Stratum 4 – established townships with full access to water and electricity and Stratum 5 – western-type housing in upper-class suburbs. It was found that the people living in rural areas, especially those in stratum 3, had higher stress levels, which contribute to higher blood pressure. The study team concluded that the manifestation of hypertension depends on lifestyle factors, cultural factors and socioeconomic factors (Van Rooyen *et al.*, 2000).

2.5 Dietary patterns

The traditional approach to studying diet and chronic disease correlations involves examining the relationships between food groups or individual nutrients and certain chronic diseases (Moeller, 2007). Dietary intake research has evolved to studying dietary patterns or combinations of foods and nutrients (Moeller, 2007).

Diets are complex because of multiple nutrient interactions, which make it difficult to isolate the role of individual nutrients or foods in relation to specific disease outcomes (Ndanuko *et al.*, 2016). It has, therefore, been recommended that dietary pattern analysis can be used as an additional method to provide a better understanding of the relationships between diet and

chronic diseases (Ndanuko *et al.*, 2016). Dietary pattern analysis examines the effects of the overall diet instead of simply looking at single foods or nutrients. Therefore, it has been argued that nutrition interventions which focus on dietary patterns have been more effective when it comes to changing the dietary intake of a population because they are easier to understand and interpret for the public (Hu, 2002). Dietary patterns may be a more suitable approach for analysing the nutritional data of large populations (Michels & Schulze, 2005). They also represent a valuable approach to understanding human dietary practices and the effects they have on health because they take into account the joint combination of many consumed foods and nutrients (Hu, 2002).

There are several reasons for examining dietary patterns: (1) the meals that individuals eat consist of complex combinations of nutrients, which are likely to be synergistic or interactive; (2) there are many nutrients which are highly correlated, therefore making it difficult to examine the individual effects; (3) a single nutrient effect may be too small to detect, but the effects of multiple nutrients, in a dietary pattern, may be large enough to detect (Moeller, 2007).

The methods of examining dietary patterns are either data driven, such as Principal Component Analysis, factor analysis and cluster analysis, or determined *a priori* by the investigator, such as dietary scores or dietary indices (Michels & Schulze, 2005).

There is a general belief that nutritional habits or dietary patterns are established during childhood and then persist into adulthood (Mikkilä *et al.*, 2005). Mikkilä *et al*., (2005) aimed to investigate existing dietary patterns in 1980, 1986 and 2001 (21-year time period). The study population consisted of children aged 3-12 years old in 1980 and 1986 (Mikkilä *et al.*, 2005). The study team identified two main dietary patterns. Pattern one was the traditional Finland pattern and consisted of rye, potatoes, butter, sausage, milk and coffee. Pattern two was the health-conscious pattern and consisted of vegetables, fish, cheese, other dairy products and tea (Mikkilä *et al.*, 2005). The following figures (1, 2, and 3) show the difference in diet patterns over the years. *“Each arm of the star in the graphic presentation illustrates the correlation between the patterns (—, pattern 1; - - -, pattern 2) and the different food groups, with a negative correlation (r - 1) at the midpoint and a positive correlation (r + 1) at the outer edge of the constellation. A correlation of zero is indicated by a circle (Mikkilä et al., 2005).”*

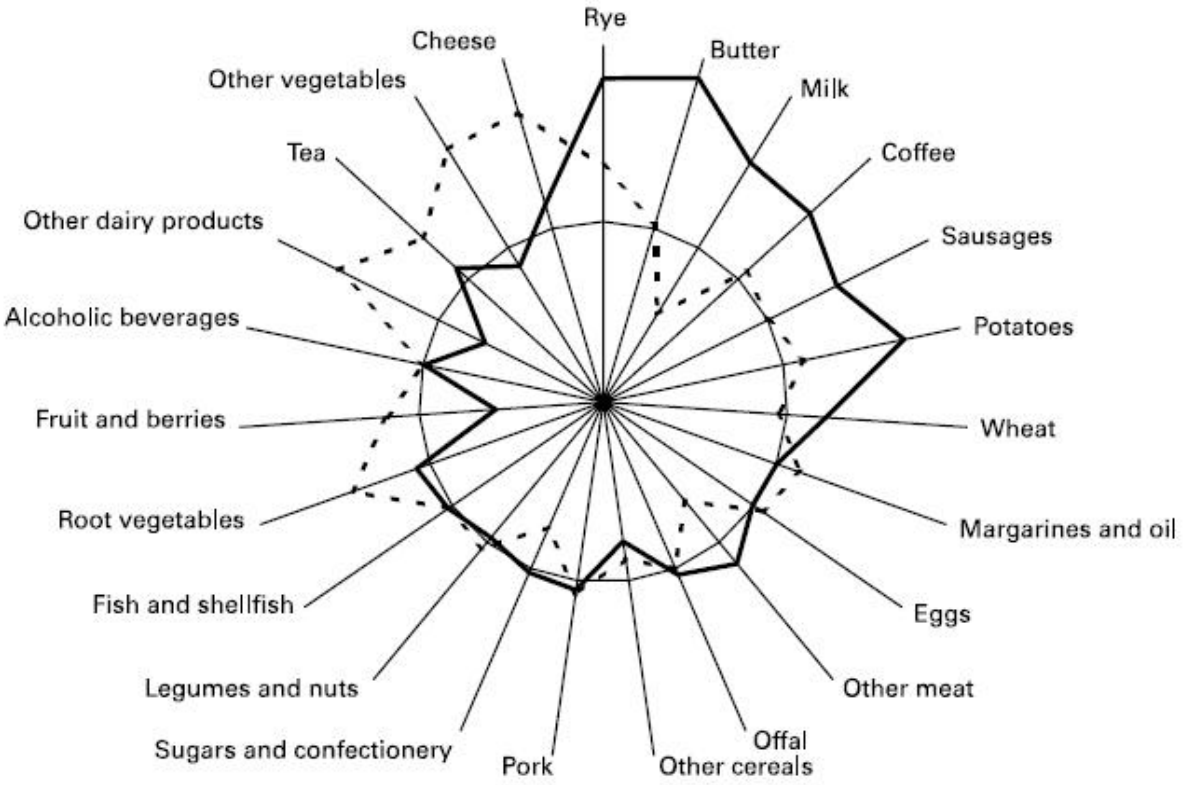

Figure 2.1: Dietary patterns identified among subjects in 1980 (Mikkilä et al., 2005)

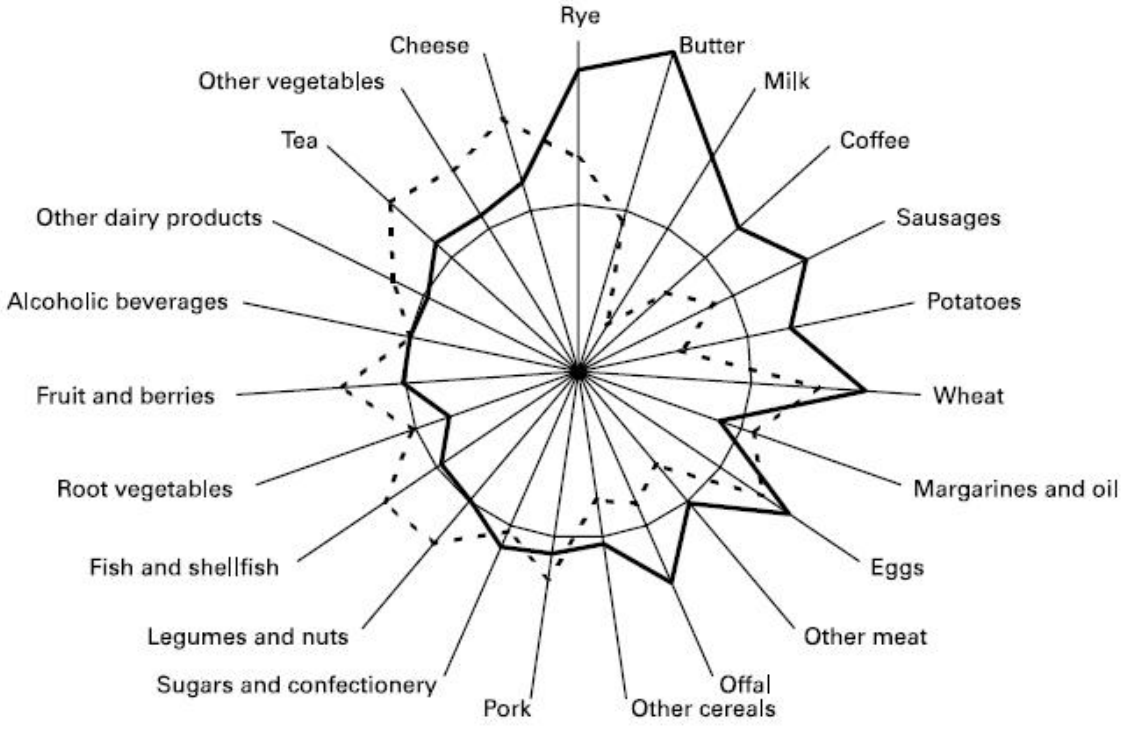

Figure 2.2: Dietary patterns identified among subjects in 1986 (Mikkilä *et al.*, 2005)

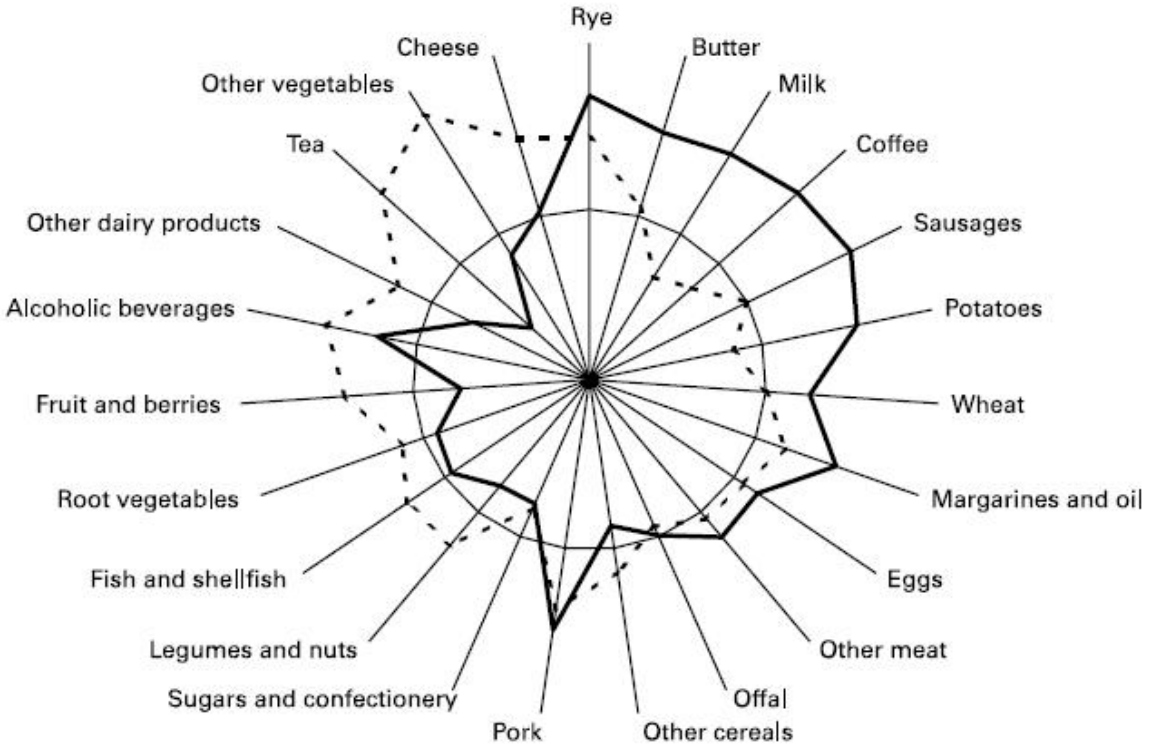

Figure 2.3: Dietary patterns identified among subjects in 2001 (Mikkilä *et al.*, 2005)

From the figures it can be seen that, in pattern one, for example, the consumption of butter has changed over the years; in 1980 the consumption was rather high, in 1986 it increased and was the highest consumed food, but in 2001 it decreased again. In pattern two, for example, it can be seen that the consumption of alcoholic beverages has increased over the years (Mikkilä *et al.*, 2005).

The study team concluded that diet patterns do change, even by a small amount, over the years (Mikkilä *et al.*, 2005). These changes can be due to the changing environment, culture and food variety (Mikkilä *et al.*, 2005). It is therefore important that nutrition education should be given during childhood and the adolescent years as food choices and diet patterns are established during these years (Mikkilä *et al.*, 2005).

In 1986 Hu *et al.,* (2000) aimed to determine whether certain diet patterns can predict the incidence of CHD. The study ended in 1994 (eight-year follow up), and included men aged 40-75 years old (Hu *et al.*, 2000). They found two major dietary patterns: the “prudent” pattern and the western pattern (Hu *et al.*, 2000). It was concluded that with an increase in the prudent pattern the risk of CHD decreased and with an increase in the western pattern the risk of CHD also increased (Hu *et al.*, 2000). These results, together with studies done by Whelton *et al.,* (1992) and Appel *et al.,* (1997), found that changes made to an individual’s dietary pattern are more effective in lowering blood pressure than supplementation with a single nutrient (Hu *et al.*, 2000).

2.6 Nutrient patterns

Compared with food or dietary pattern analysis, there has been limited work done on nutrient pattern analysis (Moskal *et al.*, 2014). Dietary patterns are easier to translate into public health recommendations, but in an international context, nutrient pattern studies have several advantages (Moskal *et al.*, 2014). Dietary patterns have been associated with disease risk, however, their effects are through nutrient intake, therefore it is important to determine the nutrient patterns that are associated with disease development (Salehi-Abargouei *et al.,* 2016). Dietary patterns can also be limited and not applicable across divergent population groups as the food that people eat are influenced by their cultural beliefs and norms (Dekker *et al.,* 2015). Nutrients are, however, universal and can therefore be used to make nutrient pattern associations with disease development across different population groups (Freisling *et al.,* 2010).

Identifying nutrient or food patterns is methodologically less complex and more relevant as they allow analysis of a small number of patterns rather than a large number of individual foods or nutrients, which are usually inter-related (Pisa *et al.*, 2015). The meals that people eat consist of a variety of nutrients, which have synergistic and interactive effects on health. Because of this it is difficult to determine the separate effects of a specific food or nutrient on disease development (Hu, 2002). The nutrient pattern approach is, therefore, a strong complementary way to capture the complexity of the diet, the inter-relationships between the different components and to explore the heterogeneity in food and nutrient patterns which exist within or between populations (Pisa *et al.*, 2015).

Some other advantages include the following: nutrients are universal, to a large extent, and may characterise more specific nutritional profiles in an easier way for comparison with different populations; nutrients, unlike foods, show a limited number of non-consumers; nutrient patterns, when compared with dietary patterns, reflect the combination of bioactive nutrients in complex biological mechanisms which relate to disease (Pisa *et al.*, 2015).

However, there has been limited work done on nutrient patterns, especially in Africa (Pisa *et al.*, 2015).

2.7 Nutrient patterns and their effect on NCDs

Chikowore *et al.,* (2017) evaluated the association of nutrient patterns with fasting glucose and glycated haemoglobin levels among an apparently healthy black South African population. Three nutrient patterns were identified among rural women and three similar patterns were identified among rural and urban men and urban women. The three patterns for the rural women were (1) magnesium, phosphorus and plant protein driven nutrients, (2) fat and animal

protein driven nutrients and (3) starch, dietary fibre and B-vitamins, while the three patterns for rural and urban men and urban women were (1) thiamine, zinc and plant protein driven nutrients, (2) fat and animal protein driven nutrients and (3) retinol and vitamin B12 (Chikowore *et al.,* 2017). The 'magnesium, phosphorus and plant protein' pattern, of the rural women, was associated with a trend of increases in fasting glucose and glycated haemoglobin. The 'thiamine, zinc and plant protein' driven nutrient pattern were associated with a positive trend of increased glycated haemoglobin among urban men, while the same pattern was associated with significant reductions in fasting glucose and glycated haemoglobin in rural men. The 'starch, dietary fibre and B vitamins' pattern was associated with reduced levels of fasting glucose and glycated haemoglobin (Chikowore *et al.,* 2017). The study team concluded that plant driven nutrient patterns have beneficial associations with reductions in fasting glucose and glycated haemoglobin.

Pisa *et al.,* (2015) investigated nutrient patterns and their association with socio-demographic, lifestyle factors and obesity risk in rural South African adolescents. The study included 388 participants, aged 11-15 years. A quantified food frequency questionnaire was used to assess the usual diet of the participants (Pisa *et al.,* 2015). Four nutrient patterns, that explained 79% of the total variance, were retained: (1) animal driven nutrients (explained 26% of variance), (2) vitamins, fibre and vegetable oil nutrients (explained 21% of variance), (3) mixed diet driven nutrients (explained 19% of variance) and (4) starch and folate driven pattern (explained 13% of variance) (Pisa *et al.,* 2015).

Energy intake was positively and significantly associated with all four patterns. The low SES group were negatively associated with the animal driven nutrient pattern (pattern 1) but positively associated with the starch and folate driven pattern (pattern 4) (Pisa *et al.,* 2015). Pattern 1 was positively associated with BMI for age which was consistent and comparable to those for western diet driven patterns (Pisa *et al.,* 2015). The four nutrient patterns that were identified were related to various socio-demographic and lifestyle factors, including BMI (Pisa et al., 2015). Pisa *et al.,* (2015) concluded that looking at the identified nutrient patterns and certain lifestyle behaviours, the households with poorer SES and more improving SES are placing their young adults at risk for obesity.

The evidence regarding nutrient patterns are however still very limited in the South African population; this study will therefore contribute to the evidence available. This study will however only focus on determining nutrient patterns in the study population and not on any associations with any health outcomes as this is beyond the scope of the study.

2.8 Assessing dietary intake

Various tools are available to determine the dietary intake of populations. Four different dietary assessment tools, screeners (SCR), food frequency questionnaires (FFQs), food records and 24-hour dietary recalls (24hr), will be discussed in the following paragraphs; the differences between the tools are shown in Table 2.2

Table 2.2: Difference between four dietary assessment tools

		24hr	FR	FFQ	SCR
Study design	Cross-sectional	√	√	√	√
	Retrospective			√	√
	Prospective	√	√	√	√
	Intervention	√		√	√
Scope of interest	Total diet	√	√	√	
	One/few components			√	√
Captures contextual details regarding food preparation, timing of meals, location of meals, etc.	Yes	√	√		
	No			√	√
Time frame of interest	Short term	√	√		
	Long term			√	√
Can be used to query diet in distant past	Yes			√	√
	No	√	√		
Allows cross-cultural comparisons	Yes	√	√		
	No			√	√
Major type of measurement error	Random	√	√		
	Systematic			√	√
Potential for reactivity	High		√		
	Low	√		√	√
Time required to complete	<15 minutes				√
	>20 minutes	√	√	√	
Memory requirements	Specific	√			
	Generic			√	√

		24hr	FR	FFQ	SCR
	Does not rely on memory		√		
Cognitive difficulty	High			√	√
	Low	√	√		

(DietaryAssessmentPrimer, 2017)

Screeners

The purpose of screeners, also called short dietary assessment instruments, is to get basic information about a limited number of food and beverage items consumed or about dietary practices over a certain period of time, usually the past month or year (DietaryAssessmentPrimer, 2017). There are two approaches that can be used for screeners: (i) a shortened FFQ, without portion size questions, (ii) a behavioural questionnaire about general dietary practices. The questionnaire for both approaches is self-administered but it can also be interviewer-administered and will take 15 minutes or less to complete (DietaryAssessmentPrimer, 2017).

When the fruit and vegetable intake of a population was assessed by Yaroch *et al.,* (2012), dietary screeners were found to be a cost-effective way to obtain gross estimates; however, screeners are not recommended when assessing precise intake levels of a population. When evaluating household food supplies it was found that screeners are a feasible tool (Martin-Biggers *et al.*, 2015).

FFQs

The purpose of a FFQ is to obtain the frequency of consumption as well as the portion sizes of food items and beverages over a certain period of time, usually the past month or year (DietaryAssessmentPrimer, 2017). A FFQ consists of a list of food and beverage items, usually ranging from 100-150 items; it takes approximately 30-60 minutes to complete (Shim *et al.*, 2014). A FFQ can be self-administered or completed with the help of an interviewer when the literacy of the respondent is low (Shim *et al.*, 2014).

FFQs can be used to assess the total dietary intake and/or specific aspects of the diet. The information obtained from the FFQ can indicate either the usual frequency of consuming certain foods or the total amount of foods usually consumed (if portion sizes are determined) (DietaryAssessmentPrimer, 2017). This method assesses long-term dietary intakes in a relatively simple, cost-effective and time-efficient way (Shim *et al.*, 2014)

Food record

The purpose of a food record is to get detailed information about all the food and beverage items that a respondent has consumed over a period of one or more days (DietaryAssessmentPrimer, 2017). This is an open-ended tool; therefore, there is no limit to the number of food or beverage items that can be reported for the time period. The respondents are asked to do "real-time" accounting of the food and beverage items that they have consumed throughout the day and can take up to 15 minutes to complete the record (DietaryAssessmentPrimer, 2017).

The use of food records have been associated with weight loss in behavioural studies. Adherence is a challenge, however, and completion of the food records usually declines over time (Burke *et al.*, 2011). Respondents are provided with a recording form and instructions/ guidelines to help them give a detailed record of all the food and beverage items, brand names and preparation methods. The portion sizes can be estimated by means of food models and photo manuals or can be measured by means of a scale or volume measures. It has been shown that if a trained interviewer checks the completed record, the quality of the report increases (DietaryAssessmentPrimer, 2017).

Young women participating in an online food record study indicated that it was better to complete food records on a computer or a smartphone rather than on paper. However, further research is necessary regarding the use of technology when completing food records (Hutchesson *et al.*, 2015).

For this research project, multiple 24-hr dietary recalls (three) were used to collect the dietary data. The definition of this method is given and its relevance described in the following paragraphs.

24-hour dietary recall

The purpose of a 24-hr dietary recall is to do an informal, qualitative, structured interview and get detailed information on all the food and beverage items consumed on one given day, usually from midnight to midnight the previous day (DietaryAssessmentPrimer, 2017). The respondent is asked to provide detailed information when doing a 24-hr recall, such as preparation methods, the type of food (e.g. type of bread), time of the day and source of the food, brand names and portion sizes (UCLA, 2003; ACAORN, 2010; DietaryAssessmentPrimer, 2017).

The 24-hr dietary recall can be administered "face-to-face" or telephonically and it can be done in any setting, including a clinical setting, the participants' home or in a community setting (UCLA, 2003; ACAORN, 2010). It is usually administered by a trained interviewer but

automated self-administered tools are available. A 24-hr recall can take 20-60 minutes to complete (DietaryAssessmentPrimer, 2017).

For a 24-hr dietary recall to be effectively used in research it is important to have quality control procedures regarding the following aspects: the selection and training of the researchers/ interviewers; the interview or the data, both before the data collection and during the collection process; data entry – in terms of the coding and classification of the foods; the data calculation and data analysis (UCLA, 2003; ACAORN, 2010; Faber, 2016). The interviewer that will be conducting the 24-hr dietary recalls needs to be well trained. It is preferred that a nutritionist or a dietitian conduct the 24-hour dietary recall (Faber, 2016).

The data from the 24-hr recall can be used to assess particular aspects of a respondent's diet as well as the total dietary intake. If the data are linked to a nutrient composition database, the nutrient intake of the food and beverage items can be determined. If the data are linked to a database that can translate the food and beverage items into groups, the component ingredients can then be converted to equivalent amounts of relevant food groups; this provides information on the consumption of different food groups, such as total intake of fruits. The 24-hr recall can also provide contextual information such as the consumption of food and beverage items from home and away from home and meal and snack patterns (DietaryAssessmentPrimer, 2017).

The 24-hr dietary recall has several advantages: it is an inexpensive method; it is relatively quick; it can be administered "face-to-face" or over the telephone; dietary information is easily obtained from the participant; it is a good method to obtain new nutritional data if it is the first data collected for a specific participant; reactivity is reduced when using a 24-hr dietary recall as the participant will not have time to change his or her diet (reactivity can occur when an individual changes his behaviour because he is aware that his behaviour is being recorded); there is no requirement for literacy (the interviewer must be literate); it is applicable to broader populations, including different ethnicities; random sampling is possible; and it is suitable for larger studies (UCLA, 2003; ACAORN, 2010; Faber, 2016).

Although the 24-hr dietary recall includes several advantages, there are also some disadvantages when using this method: it relies on the memory of the participants; the data obtained can be very limited and may not give a clear picture of the participants' intake – it is not a long-term representation of food intake because the recall is only for a single day (within-person day-to-day variation); dietary intake is also often overestimated (usually with the use of a FFQ) or underestimated (usually with the use of a 24-hr) - adult participants tend to underestimate their energy intake by 10%; probing is needed for certain foods, e.g. salad dressings, candies, sauces etc.; to do a recall for a weekend day is a challenge; the participants

may find it difficult to estimate the quantity of food that they have consumed, as well as the specific ingredients; biases can be caused by errors in the participants' memory; there may be distortions in their conceptualisation and perception of the food portions or sizes; it will also be difficult to obtain correct information if the participant has eaten at a restaurant; and the coding of the 24-hr recalls can be burdensome and can increase the personnel cost (UCLA, 2003; ACAORN, 2010; Faber, 2016).

The monitoring of dietary changes in a low-fat intervention study compared the advantages of using a 24-hr dietary recall versus food records (Buzzard *et al.*, 1996). The study included 290 postmenopausal women with localised breast cancer. The dietary data were collected at baseline, six months and twelve months. The 24-hr dietary recalls were unannounced and were conducted by telephone shortly after baseline, six months' and twelve months' data collection (Buzzard *et al.*, 1996). One of the major limitations of the 24-hr dietary recall was the fact that it relies on the participant's memory. In spite of this limitation, it was nevertheless concluded that, for monitoring dietary change in intervention studies, multiple days of unannounced 24-hour dietary recalls may be preferable to multiple days of food records (Buzzard *et al.*, 1996).

According to Gibson (2005), validity describes the adequacy with which any measurement, index or indicator reflects on what it is intended to measure.

Gibson (2005) maintains that it is not necessary to validate the 24-hr dietary recall *per se* for the following reasons: a 24-hr dietary recall is appropriate for most populations and has a relatively low response burden, which leads to a lower risk of non-response bias; fieldworkers are trained and make use of a dietary kit and a standardised method to complete the 24-hr dietary recalls, which leads to a reduction in possible errors; and three 24-hr dietary recalls are completed with each participant to take into account the within-person variability.

According to Gibson (2005), multiple single-day 24-hr dietary recalls, on different individuals, can give a valid measure of the intake of a group/population.

Gibson (2005) has listed a selection of different methodologies to measure the nutrient intakes, to meet four possible levels of objectives. Multiple 24-hr dietary recalls can be used to analyse level 1, 2 and 3. These objectives and the preferred approaches are described in the Table 2.3:

Table 2.3: The levels of objectives and the preferred approaches

Level	Desired information	Preferred approach
1	The mean/average nutrient intake of a group.	Single 24-hr dietary recall/weighed/estimated food record per person ➔a large number of subjects and adequate representation of all days of the week – therefore equally represented. *Size of the study group:* Depends on precision required and within-subject variation.
2	Proportion of the population "at risk".	Replicate observations on each individual or a subsample (30-40) using 24-hr recalls/weighed/estimated 1-day food records. This should be done for non-consecutive days. If this is not possible, it should be done for three consecutive days.
3	Usual intakes of nutrients in individuals for ranking within a group.	Multiple replicates of 24-hr recalls/food records/semi-quantitive FFQs.
4	Usual intakes of foods/nutrients in individuals for counselling or for correlation or regression analysis.	An even larger number of 24-hr recalls/records for each individual. Alternatively, a semi-quantitive FFQ/a dietary history can be used. The number of replicates depends on whether ranking/correlation is used, and on within-subject variation.

(Gibson, 2005)

For the purpose of this study, the method of completing three 24-hr dietary recalls with each participant was chosen to ensure that analysis at levels one to three could be executed.

A study conducted by Shamah-Levy *et al*., (2016) in an urban Mexican population, aimed at identifying whether it was better to estimate both the prevalence and intake of nutrient inadequacy based on a three-day 24-hr dietary recall rather than a one-day 24-hr dietary recall. They found that using three days of 24-hr dietary recalls allowed for a more accurate estimation of an individual's usual intake, reducing the measurement error that can compromise the results and conclusions (Shamah-Levy *et al.*, 2016).

Energy intake is usually underreported on the first 24-hr dietary recall and it appears that three 24-hour dietary recalls are optimal for estimating energy intake (Ma *et al.*, 2009). However, Rankin *et al.,* (2012) found that four 24-hr dietary recalls would be sufficient to provide acceptable reproducibility regarding reported food groups and nutrient intakes among peri-urban African adolescents (Rankin *et al.*, 2012).

Three 24-hr dietary recalls were chosen to ensure better compliance and feedback from the participants.

2.9 Summary

As we can see from the literature review, NCDs are a rising problem in SA and the diet of an individual definitely plays a role. Therefore, to control this rising epidemic, proactive public health interventions should be implemented at a population level (Ogah & Rayner, 2013). This is where the African-PREDICT study comes in. The main aim of the African-PREDICT study is to understand the early pathophysiology accompanying disease development, and to identify novel early markers or predictors for the development of CVD in South Africans. To achieve this aim, detailed cardiovascular and novel biomarker measurements, as well as behavioural and biopsychosocial assessments, will be performed every five years in order to identify and understand the early changes in cardiovascular function, as well as specific predictors contributing to the development of hypertension and target organ damage. The rationale of the African-PREDICT study is not only to be one of very few longitudinal hypertension studies in SSA but also to be as advanced and internationally competitive as possible in terms of science. Similar research programmes have never been done in SA, or internationally, to the best of our knowledge.

In this study, the baseline dietary intake data of the African-PREDICT study will be described. Comparisons between the different ethnic groups and the comparisons between the different socioeconomic groups will give a better understanding of the dietary intake differences in this study population.

The 24-hr dietary recall interview was chosen as the preferred method for this study as it is an inexpensive method, relatively quick and can also be administered over the telephone if necessary. It is also a good method to use when obtaining new nutritional information from a participant as they do not have time to change his or her diet. It is also a good method as no literacy is required from the participants and it can be used for larger populations, such as different ethnicities.

The nutrient pattern approach was chosen as the evidence regarding nutrient patterns in SA is still very limited. Nutrient pattern studies can also be used in an international context as nutrients are universal where food groups differ between cultures and SES groups.

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CHAPTER 3: ARTICLE

Title:

Dietary intake differences between two ethnic groups and socioeconomic status groups in a South African population (The African-PREDICT study)

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Running title: The dietary intake of the African-PREDICT study population

Abbreviations used: PREDICT, Prospective study on the Early Detection and Identification of Cardiovascular Disease and Hypertension; HART, Hypertension in Africa Research Team; SA, South Africa; NT, nutrition transition; NCDs, non-communicable diseases; SES, socioeconomic status; DM, diabetes mellitus; CVDs, cardiovascular diseases; CRDs, chronic respiratory diseases; WHO, World Health Organisation; LMIC, low-to-middle-income countries; 24hr, 24-hour; SAMRC, South African Medical Research Council; BMI, body mass index; SD, standard deviation, DRIs, dietary reference intakes.

ABSTRACT

Background: Ethnicity and socioeconomic status (SES) contribute to the dietary intake of individuals, which, in turn, plays an important role in the development of non-communicable diseases (NCDs). The nutrition transition (NT) causes individuals to shift to a westernised lifestyle, consisting of unhealthier dietary choices. These unhealthy dietary choices then lead to various metabolic conditions related to NCDs. Comparisons between the different ethnic groups and the different SES groups will give a better understanding of the dietary intake differences of these groups.

Objectives: The aim of this study was to determine the difference in dietary intake between the different SES groups and the two ethnic groups of the African-PREDICT study population.

Design: The African-PREDICT study is a prospective observational study which stretches over a follow-up period of 10 years. Data included in this study are the baseline data collected from 2013-2016 and include 904 participants.

Methods: Each participant completed three 24-hour dietary recall interviews after which the food items were coded and converted to grams. Each participant also completed a SES questionnaire and underwent anthropometric measurements (weight, height and waist circumference) and blood pressure measurements.

Results: There were clear differences between the dietary intake of the black and the white population across all SES groups. The white population had higher intakes of the majority of nutrients, indicating a more diverse diet, while the black population's diet was very monotonous. SES also plays a role in the food choices of individuals, as there was a difference in the food group intake between the individuals from the different SES groups. The high SES groups had a higher intake of vegetables and fruit, as well as milk and milk products, whereas the low SES groups had low intakes of vegetables and fruit and higher intakes of refined starches and carbonated cold drinks.

Conclusion: There were clear differences between the black and the white populations, as well as between the different SES groups. The high SES groups follow a diet consisting of healthier options, whereas the low SES groups tended to buy the cheaper products, which were also the less healthy options. These unhealthy dietary choices may contribute to various metabolic conditions, such as hypertension or overweight/obesity, all related to NCDs and contributing to the disease burden of SA.

Key words: South Africa, 24-hour recall dietary interview (24hr), nutrient intake, dietary intake, nutrient patterns, nutrition transition, ethnicity, SES.

Introduction

South Africa (SA) is currently in a health transition characterised by a quadruple burden of non-communicable diseases (NCDs), communicable diseases, and perinatal- maternal- and injury-related disorders (1, 2), as well as experiencing a nutrition transition (NT) (3). In 2015, the total number of deaths in SA was 460 236.The three leading causes of death were tuberculosis (TB), diabetes mellitus (DM) and cardiovascular diseases (CVDs) (4). According to the World Health Organisation (WHO) the proportional mortality (including total percentage of all deaths, from all ages and both genders) in SA (2014) was 18% from CVDs, 7% from cancers, 3% from Chronic Respiratory Diseases (CRDs) and 6% from Type 2 DM (5). NCDs contributed to 43% of the total deaths in SA (5).

Dietary intake is an important part of the current health and NT in SA as it contributes to the development of NCDs (6). The NT is causing individuals to shift from a traditional diet to a more westernised diet, consisting of low intakes of vegetables and fruit, whole grains, nuts or seeds and higher intakes of fat (especially saturated fat), salt and sugar (7). These unhealthy dietary choices lead to various metabolic conditions (hypertension, hyperglycaemia, hypercholesterolaemia, overweight/ obesity and cancer-associated infections) related to NCDs (8, 9).

The food and nutrient intake of the different population groups in SA is not the same (10). The white population shows a more diverse diet while the black population has a more monotonous diet (11). According to Labadarios *et al.,* (2011), the foods that were least consumed by the population were legumes, nuts, fruit and vitamin A-rich vegetables (11). According to a review of dietary surveys done by Mchiza *et al.,* (2015), there is limited, to no national data available on the dietary intakes of South African adults. Some of the key findings in the review were that there is still a high prevalence of micronutrient deficiencies among South African adults and that the most commonly deficient food groups are dairy and vegetables and fruit (12).

SES is one of the major determinants of health in all countries, and therefore plays a role in the dietary choices of individuals (13-15). Individuals with a high SES tend to consume a healthier diet consisting of whole grains, fish, lean meats, vegetables and fruit and low-fat dairy products, whereas individuals with a lower SES tend to consume more fats and less fibre (16, 17). Several studies (18-22) that were conducted in France and the United States of America (USA) showed that economic status may put pressure on individuals from a lower SES to buy the more unhealthy foods. Although healthy food choices are usually available in stores, the cost of these foods may be too high and therefore contribute to the reason why individuals, especially South Africans with a lower SES, have nutritionally inferior diets (23).

An alternative method of examining the relationship between diet and chronic diseases is to analyse nutrient patterns (24). However, in comparison with dietary pattern analysis, there has been limited work done on nutrient patterns (25, 26). Nutrients are, to a large extent, universal and therefore it is one of the advantages of studying nutrient patterns (25). To identify nutrient or food patterns is, methodologically, less complex and more relevant as it allows analysis of a small number of patterns rather than a large number of individual foods or nutrients (26). This approach is therefore a strong complementary way to capture the complexity of the diet and the inter-relationships between the different components, as well as to explore the heterogeneity in food and nutrient patterns which exist within or between populations (26). Chikowore *et al.,* (2017) identified nutrient patterns in an older (<35 years) South African study population (40) whereas Pisa *et al*., (2015) conducted nutrient patterns analysis in a much younger (11-15years) population and these were used to determine associations with health outcomes. However, little evidence is available regarding nutrient patterns in this specific age group and different ethnicities in South Africa. Nutrient patterns will only be described in this study.

Different factors, such as ethnicity and SES, contribute to the dietary intake of individuals, which, in turn, plays an important role in the development of NCDs. Therefore, in this study, the baseline dietary intake data from the African-PREDICT study population will be described. Comparisons between the different ethnic groups and between the different SES groups will give a better understanding of the dietary intake differences in this study population in order to identify deficiencies and risk factors for disease.

Methods

Study design and participants

The **African Pr**ospective study on the **E**arly **D**etection and **I**dentification of **C**ardiovascular **D**isease and Hyper**t**ension (**African-PREDICT**) is a 10-year longitudinal prospective study aimed at identifying and understanding the early pathophysiological changes in cardiovascular function as well as specific predictors which contribute to the development of hypertension and target organ damage. Baseline data collection started in 2013 at the Hypertension in Africa Research Team (HART) clinic at the North-West University, Potchefstroom, South Africa. Study participants were recruited from Potchefstroom and the surrounding areas via active contact via fieldworkers, access through the workplace and advertisements. The participants included young, healthy black and white individuals, aged 20-30 years, with a brachial blood pressure of <140 and 90 mmHg, HIV-uninfected, not pregnant or breastfeeding and with no previous diagnosis or use of medication for chronic disease. In this sub-study the baseline data were used in an observational, cross-sectional manner.

Procedures

- **Dietary data collection**

Three 24-hour (24hr) dietary recall interviews (Appendix F) were conducted with each participant once they had been screened and included in the study population. The first 24hr dietary recall interview was conducted on the same day that they were included in the study. Two follow-up interviews were then arranged with the participant within the next week, including at least one week-end day. The fieldworkers were trained to use the five-step multiple-pass approach in conducting a 24hr recall (27). Each fieldworker used a standardised dietary collection kit containing example pictures, packages, measurement tools and food models.

After all three 24hr dietary recalls had been collected, they were coded according to the South African Medical Research Council's (SAMRC) Food Composition Tables (28) and the SAMRC's Food Quantities Manual (29) was used to convert household measures to grams. If the foods were not available, they were purchased, weighed and recorded for future use. Before analysis, the codes and amounts of each 24hr dietary recall were checked against the original 24hr dietary recall to ensure that the data were coded and captured correctly.

Nutrient and food analysis of the baseline dietary data was conducted by the SAMRC at the Biostatistics Unit, using the food composition tables for South Africa (28).

The dietary intakes of the two ethnic populations within the different SES groups were also analysed to determine which foods were mostly consumed by the different groups. Different food items were grouped together to form new food groups (Appendix B). The food groups that were consumed by 10% or more of the whole population were included in Table 3.3. The results are reported as the percentage of consumers per group for each food item.

- **Socioeconomic status**

To classify the SES of the participant, a questionnaire adapted from Kuppuswamy's socioeconomic scale (30) was used (Appendix G). The scale consisted of three categories: skill level (occupation), education of the head of the household and monthly household income. The participants' level of SES was classified as level 1 (lowest), level 2 (middle) or level 3 (upper) for the three categories combined.

- **Other measurements**

Clinic blood pressure measurements were taken at brachial artery twice on both the left and the right arm (DINAMAP, GE Healthcare, Buckinghamshire, UK). The mean of the four readings was used for all of the subsequent analysis. Trained anthropometrists took the anthropometric

measurements. Weight (kg) was measured to the nearest 0.01kg, height (cm) was measured to the nearest 0.1cm and waist circumference was measured in triplicate to the nearest 0.1cm. The median of the three recordings was then used in subsequent analysis. Body mass index (BMI) was then calculated using weight and height (kg/m^2) and waist-to-height ratio were calculated using the waist circumference and the height (waist circumference/height) (31).

- **Statistical analysis**

The Statistical Software Package, SPSS 24, (Inc. Chicago, IL, USA) was used for all statistical analysis. Normally distributed data are reported as mean ± standard deviation (SD) and not normally distributed data are reported as the median (25^{th} and 75^{th} percentiles). Categorical values are expressed as percentages and frequencies. For the comparison between the two populations within the three SES groups, the Mann-Whitney U test was used, while the Kruskal-Wallis test was used for the comparison of the three SES groups within the two populations. A p-value of <0.05 was taken as significant.

The nutrient patterns were developed in order to reduce the number of observed nutrients (variables) to a smaller number of nutrient patterns (factors). (1) The exploratory factor analysis was conducted (24 nutrients) to develop a number of nutrient patterns that would explain most of the variances in the observed nutrients and also to reduce the number of observed nutrients to a smaller number of nutrient patterns. (2) The factor analysis was applied with the covariance matrix. The reliability of the factor analysis was verified through using the Kaiser-Meyer-Olkin (KMO) test. (3) In order to decide how many nutrient patterns (factors) should be retained for the next step, the factor reduction tool (eigenvalue) was used. Factors were retained and then interpreted for further analysis based on their natural interpretation and eigenvalue of >1.00. (4) To define the extent to which each of the input nutrient variables contribute to the meaning of each of the factors, the nutrients (at least three variables) with absolute loadings greater than or equal to 0.40 on a given factor were retained and provide a nutritional interpretation. (5) In order to maximise the loading of each variable on one of the extracted factors and to make the results easier to understand and interpret, the factors were rotated with the orthogonal rotation method named the Varimax rotation with Kaiser Normalisation. (6) Finally, the factor score (a new variable) was computed for each factor (nutrient pattern) by summing up the intakes of nutrients by their factor loadings. All participants received a factor score for each identified nutrient pattern and were categorised based on tertiles of factor scores.

The exploratory factor analysis procedure was confirmed as an appropriate multivariate reduction technique to apply in this sample, as it is statistically demonstrated by the KMO measure of sampling adequacy (0.85) and the Bartlett's test of sphericity ($p < 0.000$).

Twenty-four factors were extracted (equal to nutrient variables), which were then reduced to three nutrient patterns (explained 63.3% of the variance of nutrient consumption). The three patterns were named according to the nutrients (variables), with the higher loadings on each one of the factors, where the loading represents the correlation between the nutrient pattern and the nutrient.

Results

The subjects

The study population consisted of 904 healthy participants, of which *56%* were from the black ethnic group while *44%* were from the white ethnic group. There were significant differences between the two populations in age, BMI, WC, mean systolic blood pressure (SBP) and mean diastolic blood pressure (DBP) (Table 3.1).

Table 3.1: Characteristics of the population

Population characteristics	**Baseline data (2013-2016)** **N = 904**	**Baseline data (2013-2016)** **Black** **N=505**	**Baseline data (2013-2016)** **White** **N=399**	**P**
Age (years)	24.8 (3.1)	24 (3)	25 (3)	0.000
Gender: *Men (nr/%)* *Women (nr/%)*	 *376 (42%)* *528 (58%)*	 204 *(40%)* 301 *(60%)*	 172 *(43%)* 227 *(57%)*	0.412
Ethnicity: *Black (nr/%)* *White (nr/%)*	 *505 (56%)* *399 (44%)*	 *505*	 *399*	
SES Class: *Low (nr/%)* *Middle (nr/%)* *High* (nr/%)	 *363 (40%)* *234 (26%)* *307(34%)*	 293 *(58%)* 134 *(27%)* 78 *(15%)*	 70 *(18%)* 100 *(25%)* 229 *(57%)*	
BMI (kg/m^2)	24.4 (21.0-28.3)	24.1 (20.3-28.3)	24.7 (21.7-28.4)	0.037
WC (cm)	77.8 (70.3-88.0)	76.4 (69.5-85.0)	80.5 (71.2-91.4)	0.000
Mean SBP (mmHg)	117.7 (11.6)	119 (11.4)	117 (11.9)	0.015
Mean DBP (mmHg)	78.6 (7.8)	80 (7.7)	77 (7.7)	0.000

Nutrient intakes

The dietary intake for 36 nutrients was analysed. The white population had the highest intake of most nutrients, while the black population had the lowest intake. There were significant differences between all groups except for niacin, thiamine, zinc, total iron and fibre (Appendix

A). The high SES groups also had the highest intake, followed by the middle SES group and the low SES group (Table 3.2).

Table 3.2 illustrates the comparison of the SES groups within ethnicities: the high SES group of the black population had significantly higher intakes of calcium ($p<0.05$), potassium ($p<0.05$), copper ($p<0.05$), manganese ($p<0.05$) and vitamin C ($p<0.05$) and lower intakes of vitamin B6 ($p<0.05$), folate ($p<0.05$) and vitamin E ($p<0.05$) compared with the other two SES groups. The low SES group of the black population had significantly higher intakes of vitamin B6 ($p<0.05$), folate ($p<0.05$) and vitamin E ($p<0.05$) and lower intakes of calcium ($p<0.05$), potassium ($p<0.05$), copper ($p<0.05$), manganese ($p<0.05$) and vitamin C ($p<0.05$). The black high SES group consumed significantly more energy from sugar than the other two SES groups and consumed significantly less energy from added sugar than the other two groups.

The high SES group of the white population had significantly higher intakes of total fat ($p<0.05$), saturated fat ($p<0.05$), magnesium ($p<0.05$), phosphorus ($p<0.05$), potassium ($p<0.05$), copper ($p<0.05$), manganese ($p<0.05$), vitamin B12 ($p<0.05$) and vitamin C ($p<0.05$). The middle SES group of the white population had significantly higher intakes of calcium ($p<0.05$), riboflavin ($p<0.05$) and biotin ($p<0.05$) and lower intakes of vitamin B6 ($p<0.05$). The low SES group of the white population had significantly higher intakes of vitamin B6 ($p<0.05$) and lower intakes of total fat ($p<0.05$), calcium ($p<0.05$), magnesium ($p<0.05$), phosphorus ($p<0.05$), potassium ($p<0.05$), copper ($p<0.05$), manganese ($p<0.05$), riboflavin ($p<0.05$), vitamin B12 ($p<0.05$), biotin ($p<0.05$) and vitamin C ($p<0.05$). The macronutrient intake of these SES groups was very much the same, with no significant differences.

Table 3.2: Nutrient intakes of the black and the white populations within the different socioeconomic status groups

	High SES *(n=307)*				Middle SES *(n=234)*				Low SES *(n=363)*			
	White *(n=229)*		Black *(n=78)*		White *(n=100)*		Black *(n=134)*		White *(70)*		Black *(293)*	
		%		%		%		%		%		%
Energy (kJ)*	8289 (6652-10087)[c]		7186 (5869-9030)[c]		8029 (6388-10423)		7445 (5370-10180)		7352 (5721-9269)		7236 (5519-9040)	
Total Protein (g)*	78.6 (59.2-101.1)[c]		59.4 (46.3-85.7)[c]		73.3 (58.5-94.9)[b]		61.2 (46.1-82.5)[b]		71.8 (52.8-89.6)[a]		59.1 (45.5-79.4)[a]	
Total Fat (g)*	81.5 (55.3-103.6)[c, e]		58.6 (44.5-84.4)[c]		80.2 (61.2-105.4)[b, e]		59.4 (38.6-79.8)[b]		73.1 (46.0-92.2)[a, e]		55.5 (40.1-77.4)[a]	
Saturated fat (g)*	26.4 (18.8-34.1)[c, e]		18.4 (12.4-24.8)[c]		26.3 (20.4-37.7)[b, e]		16.8 (10.0-24.1)[b]		21.0 (13.8-29.0)[a, e]		16.9 (10.6-23.6)[a]	
MUFA fat (g)*	28.0 (20.0-36.5)[c]		20.3 (14.3-29.2)[c]		26.7 (20.3-37.0)[b]		19.5 (12.5-27.9)[b]		26.0 (15.6-32.2)[a]		19.2 (12.9-26.7)[a]	
PUFA fat (g)*	16.1 (10.7-24.8)[c]		12.7 (8.6-18.9)[c]		16.0 (10.2-24.8)[b]		12.7 (8.1-20.0)[b]		14.3 (7.3-22.7)		13.2 (8.5-19.9)	
Total Carbohydrate (g)*	213.2 (168.5-263.7)		215.6 (165.7-301.0)		212.7 (157.2-285.5)[b]		242.2 (178.3-346.2)[b]		217.4 (154.2-261.6)		231.7 (173.8-298.3)	
Total Fibre (g)*	13.2 (9.9-18.6)	100	13.1 (9.6-19.2)	100	11.6 (8.6-17.6)	100	14.5 (9.2-18.7)	100	12.7 (8.9-16.0)	100	12.0 (8.2-16.2)	100
Calcium (mg)*	615.6 (430.5-839.7)[c, e]	72.3	324.8 (204.9-533.2)[c, d]	95.9	665.6 (400.5-924.8)[b, e]	67.4	269.2 (159.2-410.3)[b, d]	93.9	427.4 (264.7-679.5)[a, e]	84.3	245.0 (149.5-423.2)[c, d]	95.1
Total Iron (mg)*	12.5 (9.5-16.9)	14.1	11.2 (9.0-15.3)	15.1	11.8 (9.0-18.0)	15.3	11.6 (8.4-15.9)	18.3	11.3 (9.5-15.0)	17.1	11.9 (8.6-16.1)	17.5
Magnesium (mg)*	237.6 (192.7-307.4)[c, e]	72.3	184.8 (141.6-226.9)[c]	87.7	221.9 (163.9-319.0)[b, e]	71.4	187.0 (138.8-251.8)[b]	83.2	211.2 (157.3-240.9)[a, e]	87.1	177.8 (135.2-230.7)[a]	88.1

	High SES *(n=307)*				Middle SES *(n=234)*				Low SES *(n=363)*			
	White *(n=229)*		Black *(n=78)*		White *(n=100)*		Black *(n=134)*		White *(70)*		Black *(293)*	
		%		%		%		%		%		%
Phosphorus (mg)*	1121.8 (904.1-1377.7)[c, e]	4.1	759.4 (575.0-983.2)[c]	27.4	1064.4 (813.1-1492.2)[b, e]	7.1	756.9 (534.8-1010.7)[b]	28.2	948.0 (662.6-1278.8)[a, e]	17.1	712.4 (541.3-968.8)[a, e]	32.9
Potassium (mg)*	2336.9 (1892.5-2863.3)[c, e]	3.9	1687.8 (1291.3-2187.0)[c, d]	6.4	2173.2 (1670.0-2818.3)[b, e]	2.0	1479.6 (1065.6-2118.0)[b, d]	2.2	1814.6 (1391.4-2481.3)[a, e]		1417.8 (1011.4-184.6)[a, d]	2.4
Zinc (mg)*	10.2 (8.1-13.8)	21.4	9.1 (7.2-12.8)	30.1	10.8 (8.1-13.7)	21.4	10.2 (7.4-14.3)	22.9	10.4 (7.6-13.4)	27.1	10.4 (7.1-13.4)	29.7
Copper (mg)*	1.0 (0.8-1.3)[c, e]	100	0.9 (0.6-1.1)[c, d]	100	0.9 (0.7-1.3)[b, e]	100	0.8 (0.6-1.0)[b, d]	100	0.9 (0.7-1.1)[a, e]	100	0.7 (0.6-1.0)[a, d]	100
Manganese (µg)*	1996.6 (1415.8-2586.5)[c, e]		1592.4 (1152.3-2264.4)[c, d]		1694 (1172.6-2403.1)[b, e]		1352.1 (949.4-1893.7)[b, d]		1306.1 (885.7-1896.2)[a, e]		1124.8 (834.9-1688.2)[a, d]	
Vitamin A (RE) (µg)*	598.0 (399.2-910.2)	42.7	531.5 (312.8-944.2)	50.7	600.3 (388.4-956.4)	40.8	573.5 (307.7-904.5)	45.8	544.9 (399.4-837.0)	54.3	471.1 (304.1-675.1)	61.5
Thiamine (mg)*	1.3 (1.0-1.7)	22.7	1.2 (0.8-1.6)	32.9	1.4 (1.0-1.7)	23.5	1.4 (0.9-1.8)	22.9	1.2 (1.0-1.6)	18.6	1.3 (0.9-1.7)	27.3
Riboflavin (mg)*	1.8 (1.4-2.4)[c, e]	10.5	1.3 (0.9-1.9)[c]	27.4	2.0 (1.2-2.7)[b, e]	12.2	1.1 (0.7-2.0)[b]	37.4	1.6 (1.1-2.1)[a, e]	20.0	1.3 (0.8-1.9)[a]	34.3
Niacin (mg)*	24.6 (18.5-31.3)	4.6	22.3 (16.4-30.5)	5.5	23.6 (17.6-31.2)	7.1	23.5 (18.1-31.1)	6.1	23.3 (16.9-29.8)		24.3 (17.9-31.2)	8.0
Vitamin B6 (mg)*	2.3 (1.6-3.0)[e]	10.5	2.5 (1.6-3.3)[d]	12.3	2.2 (1.4-2.8)[b, e]	14.3	2.9 (2.0-4.3)[b, d]	6.1	2.6 (1.7-4.0)[e]	7.1	3.2 (2.1-4.5)[d]	5.9
Folate (µg)*	179.9 (126.9-249.4)[c]	90.0	207.7 (144.4-318.2)[c, d]	75.3	213.3 (137.1-292.3)[b]	79.6	258.5 (176.2-408.0)[b, d]	61.8	194.6 (133.1-298.7)[a]	80.0	261.2 (176.3-346.5)[a, d]	67.5

	High SES *(n=307)*				Middle SES *(n=234)*				Low SES *(n=363)*			
	White *(n=229)*		Black *(n=78)*		White *(n=100)*		Black *(n=134)*		White *(70)*		Black *(293)*	
		%		%		%		%		%		%
Vitamin B12 (µg)*	3.9 (2.6-6.1)[c, e]	14.6	2.6 (1.6-4.1)[c]	34.3	3.9 (2.6-5.5)[b, e]	13.3	2.3 (0.9-4.4)[b]	43.5	3.1 (2.1-4.6)[a, e]	24.3	2.3 (1.1-3.8)[a]	44.1
Pantothenic acid (mg)*	5.7 (4.1-8.1)[c]	37.3	4.0 (3.0-6.0)[c]	61.6	5.5 (4.0-7.3)[b]	38.8	4.3 (2.7-6.5)[b]	59.5	4.9 (3.7-6.8)[a]	51.4	4.2 (2.9-6.0)[a]	62.2
Biotin (µg)*	24.2 (18.1-32.4)[c e]	68.2	17.9 (12.7-22.4)[c]	89.0	24.8 (18.0-32.2)[b e]	70.4	17.1 (12.3-27.1)[b]	82.4	22.2 (13.5-27.2)[e]	88.6	17.8 (12.0-25.5)	81.5
Vitamin C (mg)*	55.3 (27.1-102.1)[c, e]	56.8	34.9 (17.4-84.2)[c, d]	65.8	47.2 (21.7-131.7)[b, e]	53.1	24.5 (10.5-53.0)[b, d]	82.4	24.9 (9.3-62.1)[a, e]	78.6	16.1 (7.1-31.0)[a, d]	89.9
Vitamin D (µg)*	3.2 (1.9-5.7)[c]	92.3	2.1 (1.0-3.5)[c]	95.9	2.9 (1.7-5.3)[b]	93.9	2.2 (0.8-4.2)[b]	94.7	2.8 (1.3-4.9)	97.1	2.3 (1.0-5.3)	91.6
Vitamin E (mg)*	8.3 (5.2-12.5)[c]	71.8	5.6 (4.3-8.9)[c, d]	90.4	8.2 (5.1-11.5)[b]	75.5	6.1 (4.0-10.4)[b, d]	82.4	8.1 (2.9-11.1)	77.1	7.4 (4.5-11.6)[d]	77.6
Macronutrient distribution												
% of TE from protein [#]	17 (4.7)[h]		15 (4.4)[h]		16 (4.2)[g]		15 (3.9)[g]		16 (4.4)[f]		15 (4.4)[f]	
% of TE from fat [#]	37 (8.0)[h]		32 (9.5)[h]		38 (9.0)[g]		30 (9.5)[g]		35 (11.9)[f]		30 (8.9)[f]	
% of TE from saturated fat[#]	12.2 (3.2)		9.7 (3.2)		12.6 (3.9)		8.7 (3.2)		11.3 (4.2)[f]		9.0 (3.1)[f]	
% of TE from MUFAs[#]	12.8 (3.6)		11.1 (4.0)		13.1 (3.9)		10.4 (3.9)		12.3 (5.2)[f]		10.4 (3.5)[f]	
% of TE from PUFAs[#]	8.0 (3.4)		7.5 (4.4)		7.9 (3.7)		7.5 (4.6)		7.3 (4.2)		7.6 (3.8)	
% of TE from carbohydrates [#]	45 (10.0)[h]		54 (10.2)[h]		46 (10.5)[g]		56 (10.2)[g]		48 (14.4)[f]		55 (9.7)[f]	
% of TE from sugar *	15.34 (10.64-20.67)		14.25 (10.40-19.65)[d]		14.21 (9.82-19.84)[b]		12.19 (8.09-17.72)[b, d]		14.38 (10.25-19.22)[a]		11.63 (7.31-16.54)[a, d]	

	High SES *(n=307)*				Middle SES *(n=234)*				Low SES *(n=363)*			
	White *(n=229)*		Black *(n=78)*		White *(n=100)*		Black *(n=134)*		White *(70)*		Black *(293)*	
		%		%		%		%		%		%
% of TE from added sugar *	2.73 (1.23-5.29)		2.01 (0.12-5.09)[d]		3.21 (0.81-6.30)[b]		0.95 (.00-3.17)[b, d]		2.53 (0.76-4.62)[a]		0.71 (.00-3.31)[a, d]	

MUFA – Monounsaturated Fatty Acids, PUFA – Polyunsaturated Fatty Acids, TE – Total Energy. *Data are reported as median (25th and 75th percentiles). “a, b and c” (Mann-Whitney U Test) - comparing nutrient intakes between the two populations within the different SES groups. “e and d” (Kruskal-Wallis Test) - comparing the SES groups within ethnicities. #Data are reported as mean and SD. “f, g and h” (Independent t-test) – comparing nutrient intakes between the two populations within the different SES groups. % - The percentage of participants not meeting the dietary reference intakes (DRIs).

The following results were found when the nutrient intake of the two ethnic populations was compared within the different SES groups:

In a comparison with each other of the intakes of the high SES group of the black and the white populations, the white population had significantly higher intakes of energy (kJ) ($p<0.05$), total protein ($p<0.05$), total fat ($p<0.05$), saturated fat ($p<0.05$), MUFA fat ($p<0.05$) and PUFA fat ($p<0.05$), most minerals (except iron and zinc, of which the difference in intake was not significant across the groups) and most vitamins (vitamin B12, pantothenic acid, biotin, vitamin C, vitamin D, vitamin E) except for folate, which was significantly higher in the black population. Significantly more energy from protein and fat (% E protein and % E fat) was consumed by the white population but more energy from carbohydrates (% E carbohydrates) was consumed by the black population.

In comparing the middle SES group of the black and the white populations with each other, it was found that the white population had significantly higher intakes of total protein ($p<0.05$), total fat ($p<0.05$), saturated fat ($p<0.05$), MUFA fat ($p<0.05$) and PUFA fat ($p<0.05$), most minerals (except iron and zinc) and most vitamins (riboflavin, vitamin B12, pantothenic acid, biotin, vitamin C, vitamin D and vitamin E).

The white population also consumed significantly more energy from protein and fat whereas the black population consumed higher amounts of energy from carbohydrates (% E carbohydrates) in this SES class. Even though the black population had a higher intake of energy form CHO the energy from total sugar was less than what the white population consumed and the energy from added sugar was also less in the black population.

Finally, a comparison of the low SES groups of the black and the white populations with each other indicated that the white population had significantly higher intakes of total protein ($p<0.05$), total fat ($p<0.05$), saturated fat ($p<0.05$), MUFA fat ($p<0.05$) and PUFA fat ($p<0.05$), calcium ($p<0.05$), magnesium ($p<0.05$), phosphorus ($p<0.05$), potassium ($p<0.05$), copper ($p<0.05$), riboflavin ($p<0.05$), vitamin B12 ($p<0.05$), pantothenic acid ($p<0.05$) and vitamin C ($p<0.05$), while the black population had significantly higher intakes of folate ($p<0.05$). Again, significantly more energy was consumed from protein, fat, total sugar and added sugar (% E protein, % E fat, % E total sugar and % E added sugar) by the white population and significantly more energy from carbohydrates (% E carbohydrates) by the black population.

The percentages of participants who did not meet their recommended intakes were calculated and are reported in Table 3.2. Table 3.2 shows that both the black and the white populations did not meet the nutrient recommendation for 18 of the 20 nutrients, except for the low SES group of the white population, which did not meet the nutrient recommendations for 16 of the 20

nutrients. More than 50% of the black population did not meet the recommendations for fibre, calcium, magnesium, copper, vitamin A, C, D and E, folate, pantothenic acid and biotin, while more than 50% of the white population did not meet the recommendations for fibre, calcium, magnesium, copper, folate, biotin, vitamin C, D and E.

Food intake

The white population had the highest intake of the majority of the food groups while the black population had the lowest intake of the majority of the food groups.

Bread was the one food group that was consumed by all of the participants. The white population had higher intakes of coffee and tea; processed meat products; sugar; milk and milk products (cheeses and yoghurt); raw vegetables and salads; samp, rice, pasta; beef; tomatoes; starchy vegetables (with and without added fat); fruit (orange- /yellow- /green- /white-fleshed); margarine; jam, syrup, etc.; sweet cookies, biscuits and rusks; eggs; salad dressings; squash cold drinks and alcohol. The high SES group consumed the most food groups from among these intakes, followed by the low SES group and then the middle SES group.

The black population had higher intakes of chicken (including fried chicken); cooked maize porridge; carbonated cold drinks; savoury snacks; sunflower oil; peanut butter and atchar. The low SES group consumed the most food groups from among these intakes, followed by the high SES group and then the middle SES group.

Table 3.3: Percentages consumed in both the black and the white populations within the different SES groups

Food Name	High SES (n=307)		Middle SES (n=234)		Low SES (n=363)	
	White (n=229)	Black (n=78)	White (n=100)	Black (n=134)	White (n=70)	Black (n=293)
Bread (white, brown, rye, etc.), rolls and “vetkoek” (deep-fried bread)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Coffee and tea	100.0%	94.9%	100.0%	81.3%	100.0%	87.4%
Meat products, e.g. beef sausage, biltong, ham, Viennas, corned meat, salami, frankfurters, patties	100.0%	69.2%	100.0%	81.3%	100.0%	81.2%
Sugar (white and brown)	74.2%	71.8%	79.0%	77.6%	88.6%	81.9%
Milk (full cream, low-fat, etc.)	100.0%	61.5%	100.0%	48.5%	100.0%	62.1%
Chicken, other poultry (turkey, goose and duck), cooked (including Kentucky, etc.)	78.6%	73.1%	69.0%	81.3%	67.1%	88.4%
Raw vegetables and salads	100.0%	60.3%	89.0%	40.3%	100.0%	28.0%
Samp, rice (white and brown), maize and wheat rice, macaroni and spaghetti	59.4%	50.0%	80.0%	62.7%	74.3%	54.3%
Cooked porridge (e.g. maize meal, sorghum, oats, etc.)	27.5%	70.5%	15.0%	87.3%	45.7%	95.2%
Beef and meatballs, cooked	63.3%	47.4%	62.0%	38.1%	82.9%	37.9%
Carbonated cold drinks (Coca-Cola, Fanta, etc.)	44.1%	47.4%	47.0%	50.8%	48.6%	54.3%
Tomatoes (raw and cooked)	53.3%	33.3%	52.0%	34.3%	48.6%	41.6%
Starchy vegetables with added fat, e.g. potato, corn	44.5%	41.0%	46.0%	35.1%	50.0%	40.3%
Fruit - orange/yellow/green flesh, e.g. oranges, bananas, kiwis	62.5%	42.3%	73.0%	18.7%	32.9%	17.8%
Margarine	45.4%	21.8%	39.0%	25.4%	50.0%	38.8%
Jam, syrup, sugar-based sweets	52.8%	35.9%	42.0%	18.7%	31.4%	22.5%
Sweet cookies, biscuits, rusks	50.7%	26.9%	44.0%	20.2%	38.6%	20.8%
Eggs	42.4%	12.8%	39.0%	24.6%	44.3%	33.8%
Savoury snacks, e.g. potato crisps, “Niknaks” and popcorn	34.5%	25.6%	26.0%	30.6%	32.9%	34.8%
Other cheese, e.g. Gouda, Feta, etc.	61.1%	15.4%	39.0%	11.2%	21.4%	21.5%

Food Name	High SES (n=307)		Middle SES (n=234)		Low SES (n=363)	
	White (n=229)	Black (n=78)	White (n=100)	Black (n=134)	White (n=70)	Black (n=293)
Salad dressings, mayonnaise, sandwich spread	41.9%	20.5%	42.0%	14.9%	28.6%	12.3%
Starchy vegetables, e.g. potatoes, sweet potatoes and corn	37.6%	12.8%	30.0%	19.4%	24.3%	14.3%
Cheese, cheddar	33.6%	15.4%	35.0%	11.2%	31.4%	8.2%
Yoghurt	40.6%	12.8%	33.0%	12.7%	22.9%	6.5%
Squash cold drinks, e.g. Oros	23.1%	16.7%	23.0%	18.7%	18.6%	21.8%
Fruit - white flesh, e.g. apples and pears	28.4%	23.1%	17.0%	18.7%	21.4%	13.0%
Alcohol, Wine, Spirit, Sherry and Liqueur	32.3%	5.1%	25.0%	3.7%	22.9%	4.1%
Sunflower oil	8.7%	18.0%	11.0%	17.2%	8.6%	23.9%
Peanut butter	9.2%	14.1%	6.0%	11.2%	2.9%	10.2%
Atchar	0.0%	7.7%	0.0%	14.2%	0.0%	22.5%

Nutrient pattern analysis

The main nutrients that contributed to each of the three nutrient patterns are shown in Appendix C. The first nutrient pattern (factor 1) represents a plant protein, carbohydrate (starch) and folate pattern (42.6% variance). The second nutrient pattern (factor 2) represents a calcium, phosphorus and potassium pattern (13.4% variance), while the third nutrient pattern represents (factor 3) a vitamin E and unsaturated fats (MUFAs and PUFAs) pattern (7.3% variance).

A factor score for each nutrient pattern was identified for all participants and they were categorised based on tertiles of factor scores. Thereafter, the percentage of each group (two ethnic groups split into the three SES groups) which falls within each tertile from each pattern was determined in order to indicate which group falls within which tertile. This serves as an indication of the pattern which explains the most variance within the specific groups.

The middle SES group of the black population had the highest percentage within the plant protein, carbohydrate (starch) and folate pattern (pattern 1) (44.8%), while the high SES group of the white population had the lowest percentage for this pattern (18.3%). The high SES group of the white population had the highest percentage within the calcium, phosphorus and potassium (pattern 2) (58.1%) and the vitamin E and unsaturated fats (pattern 3) (40.2%). The low SES group of the black population had the lowest percentage for pattern 2 (10.2%) and the high SES group of the black population for pattern 3 (17.9%) (Table 3.4).

Table 3.4: Percentages of the three nutrient patterns of both the black and the white populations within the different SES groups

Tertiles	High SES (n=307)		Middle SES (n=234)		Low SES (n=363)	
	White (n=229)	Black (n=78)	White (n=100)	Black (n=134)	White (n=70)	Black (n=293)
Pattern 1: Plant protein, carbohydrate and folate pattern						
1.00	38.9%	29.5%	42.0%	26.1%	42.9%	24.6%
2.00	38.9%	32.1%	35.0%	26.9%	28.6%	30.7%
3.00	**18.3%**	32.1%	21.0%	44.8%	28.6%	42.3%
Pattern 2: Calcium, phosphorus and potassium						
1.00	3.1%	32.1%	10.0%	47.8%	28.6%	57.6%
2.00	34.9%	34.6%	32.0%	35.1%	32.9%	30.4%
3.00	**58.1%**	26.9%	56.0%	14.9%	38.6%	10.2%
Pattern 3: Vitamin E and unsaturated fats						
1.00	26.2%	39.7%	32.0%	41.8%	25.7%	32.4%
2.00	29.7%	35.9%	31.0%	29.9%	40.0%	35.2%
3.00	**40.2%**	17.9%	35.0%	26.1%	34.3%	30%

Discussion

This study aimed to determine the difference in dietary intake between the black and the white populations as well as differences between the high, middle and low SES groups of these two populations. Nutrient and food group intakes, as well as nutrient pattern analysis were done to determine these differences.

From the results it is clear that there were differences between the food and nutrient intakes of the black and the white populations. The white population had the highest intake of most nutrients, indicating a diet consisting of a larger variety, while the black population had the lowest intake, indicating a more monotonous diet. Differences also occurred between the three SES groups. Certain nutrient trends were observed within the SES groups - the low SES groups had the highest intake of vitamin B6 in both populations, as well as the lowest intakes of total proteins, total fat, calcium, magnesium, phosphorus, potassium, copper, manganese and vitamin C. From the food intakes it is clear that these groups had higher chicken and starchy vegetable (such as potatoes) consumption, foods that are good sources of vitamin B6. They also had lower intakes of fruit, raw vegetables and salads and animal products such as meats, milk and cheese (good sources of the nutrients that were consumed least by these groups) (32).

The middle SES groups had the highest intake of thiamine in both ethnic populations. Different meats and starchy foods (such as bread and potatoes) are good sources of thiamine (32) and the middle SES groups showed high intakes of these products. The high SES groups had the highest intakes of phosphorus, potassium, copper, manganese, vitamin B12 and vitamin C and consumed more energy from proteins in both ethnic populations. These nutrients are present in animal products, such as meat, fish, poultry, milk and cheese, as well as in citrus fruits, legumes and teas (32). The high intake of these foods among high SES groups explains why these nutrients are more present in their diet. These groups also had the lowest intakes of zinc and folate and consumed the least energy from carbohydrates.

It is clear that the high SES groups consumed a larger variety of nutrients, followed by the middle SES groups and then the low SES groups. These results concur with the nutrient pattern analysis as the largest percentage of the white population's high SES group fell within the calcium, phosphorus and potassium pattern and the vitamin E and unsaturated fats pattern. According to studies done by James *et al*., (1997), Wagner *et al*., (2012) and Mayén *et al*., (2014), SES is one of the biggest determinants of health (13-15). Individuals with a high SES tend to consume a healthier diet with more variety of foods - consisting of whole grains, fish, lean meats, vegetables and fruit and low-fat dairy products, whereas individuals with a lower SES tend to consume more saturated fats and less fibre (16, 17). The low SES groups had higher intakes of fats added to starchy vegetables, as well as a smaller vegetable and fruit

intake (less fibre). The high SES groups consumed more vegetables and fruit, as well as milk and milk products.

The cost of food is one of the factors which may play a role in the difference in dietary intakes between the various SES groups. Drewnowski *et al*., (2004, 2005) found that when the cost of foods were compared with the cost per kJ (compared on an energy basis), refined cereals and foods with added fats and sugars were lower-cost sources of energy, whereas more nutrient-dense foods, such as lean meats, fish, vegetables and fruit, were more expensive, thus leading to the conclusion that healthier diets are more expensive (11, 20-22, 33, 34). The cost of a typical daily menu, in 2011 in a South African population, was found to be R13.28 and consisted of 10 025 kJ, whereas the cost of a healthier diet, consisting of 8206 kJ, was R24.97, or R11.69 more expensive than the typical diet (23), confirming that healthier food options are more expensive. These findings can be attributed to the fact that products such as refined cereals are subsidised by the South African Government and Value Added Tax (VAT) is not paid on these products and therefore these products are more commonly consumed by the lower SES groups as they are more affordable (35). The top food group intakes of the low SES groups in both ethnicities in this study were of refined cereals, sugary foods and fried foods while the least consumed were vegetables and fruit and leaner meats, foods that are part of a healthy diet. The lowest percentage of the low SES class was present within the calcium, phosphorus and potassium pattern. The assumption can be made that, because they have a lower income, they are forced to purchase more energy-dense foods, leading to a poor diet.

Mchiza *et al*., (2015) stated that vegetable and fruit consumption is considered to be very low in SA (12). This is also true for the population in the African-PREDICT study. The white population had more individuals with higher intakes of vegetables and fruit, especially the high SES class, whereas individuals from the low SES group of the black population had the lowest intake of vegetables and fruit. The high SES class in the black population also had a low intake of orange/ yellow/ green flesh fruit which could possibly be because of the types of fruits included in the group which are not commonly consumed by the black population such as kiwifruit and melons. The reasons for this difference were not investigated in this study. Fruit such as apples and pears were consumed by more comparable percentages in the two ethnicities in the high SES group. These findings also explain the low intakes of fibre, calcium, magnesium, folate and vitamins A, C and E, as vegetables and fruit are good sources of these nutrients (32). The low SES class of the black population had the lowest intakes of these nutrients (Table 3.2), which can be explained by their low intakes of vegetables and fruit (Table 3.3). Vegetables and fruit cost more per unit of energy than bread and maize products and therefore they are not frequently consumed by the lower SES groups (6, 36).

The black and the white populations of the current study population, living in the North West province had a diet consisting of high intakes of tea, maize meal porridge, sugars, bread, starchy vegetables, certain fruit and carbonated cold drinks. This was also found in a review done by Mchiza *et al.,* (2015), where it was reported that the most frequently consumed foods of South African adults were added sugars, maize porridge, coffee and tea, white and brown bread, starchy vegetables such as potatoes, margarine, rice and vegetables and fruit.

Ethnicity also plays a role in dietary intake. The white population had higher intakes of the majority of the food groups while the black population had the lowest intake of the majority of the food groups. These results reflect those seen in the nutrient pattern analysis as the white population represented the highest percentages in two of the three patterns and the black population represented the lowest percentages. The white population, in all three SES groups, had high intakes of processed meat products. These products contain large amounts of salt which can be associated with elevated blood pressure. The black population, in all three SES groups, had low intakes of calcium. This is evident when looking at the food groups as this group had the lowest intakes for milk and milk products, all products which contains calcium.

Staple foods, such as maize porridge, brown and white bread and fat cakes, are frequently consumed foods in both populations (37). These staple foods were seen as vehicles for fortification as they are the most commonly consumed by the whole population (37) and therefore vitamin A, iron, zinc, folate, thiamine, niacin, vitamin B6 and riboflavin have been added to maize meal since 2003 in SA (37). Even though almost all of the individuals in both the black and the white populations consumed these staple foods, there were still more than 50% of individuals who did not meet the DRIs for vitamin A and folate. This can also be a reason why there were no significant differences found for some nutrients (niacin, thiamine, total iron and fibre).

Maize porridge is seen as the staple food of the black population (38). This is an affordable product and is consumed by almost all of the black population's low SES group. The black population also had high intakes of refined starches such as white bread and rice, boiled or fried chicken and sugar-containing foods such as carbonated cold drinks. These results were also found by Labadarios *et al*., (2011), who found that the black population of SA consumed only one to three different food groups – a cereal, meat or chicken and a vegetable (11). Even though most of the individuals of the white population also had high intakes of refined starches and carbonated cold drinks, they had higher intakes of milk and milk products such as cheese, and more complex carbohydrates such as brown bread and vegetables and fruit. The white population is represented in higher percentages in nutrient pattern 2 (animal protein) and nutrient pattern 3 (fat), which concurs with their food intake of meat and milk and milk products, etc.

Other frequently consumed products were coffee and tea, especially within the white population. This high consumption of coffee and tea may have an impact on the absorption of certain micronutrients, especially iron, in the body (39). The high intakes of coffee and tea can also contribute to the high intakes of total sugar and added sugar, especially in the white population, as it is usually added to these hot beverages.

Conclusion

The results of this study clearly indicate there is a difference in dietary intake between the two ethnic groups and the different SES groups. The high SES groups followed a diet consisting of healthier options, such as vegetables and fruit, and also had the highest percentage people falling in the animal protein and vitamin E and unsaturated fats, whereas the low SES groups tended to buy the cheaper product, which is also the less healthy option. These unhealthy dietary choices can lead to various metabolic conditions, such as hypertension or overweight/ obesity, all related to NCDs and contributing to the disease burden of SA.

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Author contributions

CJ was responsible for the analysis and interpretation of the data and wrote the manuscript.

TVZ and EWV made contributions to the context, analysis and interpretation of the data and critically revised the manuscript for important intellectual content.

RL was responsible for the statistical analysis of the data.

Conflict of interest

The authors declare no competing interest.

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CHAPTER 4: CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

The overall aim of this research project was to determine the dietary intake of the black and the white, young adult populations in the North-West Province of SA in order to describe the baseline dietary intake data of these populations. Comparisons between the different ethnic groups and between the different socioeconomic groups will give us a better understanding of the differences in dietary intake between these groups.

This concluding chapter will provide a brief summary of all the main findings, as well as the strengths and limitations of the study. Recommendations for future research will also be made.

4.2 Dietary and nutrient intake differences between ethnicities

There was a clear difference between the food and nutrient intake of the black and the white populations. The white population had a diet consisting of more variety than the monotonous diet of the black population.

The food intake of most individuals of the black populations consisted of high intakes of maize meal, refined starches, chicken and carbonated cold drinks. Even though individuals of the white population also had high intakes of refined starches and carbonated cold drinks, they had higher intakes of milk and milk products, more complex carbohydrates and vegetables and fruit. The white population had higher intakes of fibre, calcium, magnesium, vitamins A, C and E, supporting the higher intakes of vegetables and fruit, as well as milk and milk products. The white population also had a higher proportion of participants that followed the animal protein and vitamin E and unsaturated fats.

The percentage of participants who did not meet their recommended intakes was also calculated and showed that both the black and the white populations did not meet the nutrient recommendations for almost all of the nutrients. More than 50% of the black population did not meet the recommendations for fibre, calcium, magnesium, copper, vitamin A, C, D and E, folate, pantothenic acid and biotin, while more than 50% of the white population did not meet the recommendations for fibre, calcium, magnesium, copper, folate, biotin, vitamin C, D and E. Some of these nutrients, such as vitamin A, iron, zinc, folate, thiamine, niacin, vitamin B6 and riboflavin, are used to fortify the staple foods of SA. Even though almost all of the individuals in both the black and the white populations consumed these staple foods (maize porridge, bread and fat cakes), there were still more than 50% of individuals who did not meet the DRIs for vitamin A and folate.

4.3 Dietary and nutrient differences between SES groups

The lower SES groups of both ethnicities consumed more refined cereals, sugary foods and fried foods and had low intakes of vegetables and fruit, and lean meats, all foods which are seen as part of a healthy diet. The assumption can be made that, because they have a lower income, they are forced to purchase more energy-dense foods, leading to an inferior diet.

4.4 Nutrient patterns

Three different nutrient patterns were identified: a plant protein, carbohydrate and folate pattern, a calcium, phosphorus and potassium pattern and a vitamin E and unsaturated fats pattern. The high SES class of the white population had the largest percentage of the population that adhered to the animal protein nutrient pattern. These patterns (animal protein and vitamin E and unsaturated fats pattern) consist of more expensive food products and this could be the reason why the lower SES groups had a lower percentage of the population that adhered to these two patterns. The black population had a larger percentage of the population that adhered to the plant protein pattern, which could be because of cultural preferences or because plant protein products are cheaper than animal protein products. Food products like meats, fish, poultry, eggs, milk and milk products (animal proteins) are usually more expensive than legumes and beans (plant proteins). Drewnowski *et al*., (2004, 2005) also found that refined cereals and foods with added fats and sugars (such as carbonated cold drinks) were lower-cost sources of energy, whereas more nutrient-dense foods, such as lean meats, fish (animal proteins), vegetables and fruit, were more expensive, thus leading to the conclusion that healthier diets are more expensive (Drewnowski, 2004; Drewnowski & Darmon, 2005; Drewnowski *et al.*, 2004; Labadarios *et al.*, 2011; Shisana, 2014; Vorster *et al.*, 2014).

These results are a clear indication that ethnicity and SES play a role in the food and nutrient intake of individuals. The high SES groups are following a diet consisting of healthier options, such as vegetables and fruit, whereas the low SES groups tend to buy the cheaper products, which are also the less healthy options. These unhealthy dietary choices can lead to various metabolic conditions, such as hypertension or overweight/ obesity, all related to NCDs and contributing to the disease burden of SA.

4.5 Limitations of the research project

These results are not representative of the whole South African population as they are drawn from only one province.

There was currently not an even number of participants in the groups (in both the ethnicities and the SES groups) and this could have had implications for the statistical analysis of the data.

There were a large number of students in the study. This can also be a strength as it shows the eating habits of students away from home.

Only two ethnic populations of SA are included – the Indian and mixed ancestry groups are not included.

The Condensed Food Composition Tables does not include all of the foods and therefore there are no codes for certain foods.

4.6 Public health relevance

In 2014, NCDs contributed to 43% of the total number of deaths in SA. As NCDs consist mostly of lifestyle diseases such as CVDs, T2DM and cancers, it is important to pay attention to the risk factors for these diseases. One of the risk factors is dietary intake. It is important to know and understand the dietary intake of individuals to make appropriate recommendations for policies regarding NCDs.

Nutrients play a role in the development of NCDs. High intakes of fat can lead to a greater risk of CVDs (Gaziano *et al.*, 2010), while nutrients such as calcium, magnesium and potassium play a role in the development of hypertension (Charlton *et al.*, 2005). The current study population had a higher percentage of participants having the vitamin E and unsaturated fats, especially the high SES group of the white population. This population also had the higher percentage of participants having the vitamin E and unsaturated fats. The study population also had low intakes of most vitamins and minerals (50% did not meet the DRIs for some of the nutrients).

4.7 Strengths of the study

There are no national data available on the dietary intake of adults in South Africa, as the only national dietary study was done in children (1999) (Mchiza *et al*., 2015). Because of this lack of data, it is difficult to plan any interventions regarding the fight against NCDs (Mchiza *et al.*, 2015). Mchiza *et al*., (2015) assessed all of the dietary studies performed on South African adults between the years 2000 to 2015 and published a manuscript on the results.

This study reports new data and will therefore contribute to the knowledge regarding the dietary intake of South African adults.

The study includes two ethnic populations, as well as three different SES groups.

4.8 Future research and recommendations

More research regarding the dietary intake of South African adults needs to be conducted, especially in other provinces of the country; this will provide a clearer picture of the adult population's dietary intake and will help with interventions regarding malnutrition.

Dietary intake plays an important role in the development of NCDs. It is important, therefore, to understand the eating habits of individuals to determine whether or not certain foods and nutrients contribute more than others to the NCD risk.

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APPENDIX A NUTRIENT INTAKES OF THE BLACK AND WHITE POPULATION

Table S1: Total nutrient intakes for the black and white population respectively

	Black Population (n=505)	White Population (n=399)
Kilojoules (kJ)	7277.41 (5590.37; 9291.44)[a]	8042.54 (6500.97; 9923.26)[a]
Total Protein (g)	59.70 (45.80; 80.32)[a]	75.57 (58.16; 98.25)[a]
Total Fat (g)	56.83 (40.61; 77.93)[a]	80.51 (55.35; 101.57)[a]
Total Carbohydrates (g)	232.13 (173.24; 305.71)[a]	213.58 (159.94; 267.13)[a]
Protein TE	14.69 ± 4.28[a]	16.58 ± 4.51[a]
Fat TE	30.22 ± 9.11[a]	36.71 ± 9.10[a]
Carbohydrates TE	54.97 ± 9.89[a]	45.87 ± 11.07[a]
Total Fibre (g)	12.64 (8.65; 17.51)	12.95 (9.47; 17.59)
Calcium (mg)	266.14 (158.48; 440.54)[a]	598.58 (395.34; 827.82)[a]
Total Iron (mg)	11.69 (8.63; 15.99)	11.93 (9.30; 17.19)
Magnesium (mg)	180.91 (137.21; 237.83)[a]	229.73 (180.93; 299.51)[a]
Phosphorus (mg)	742.83 (549.14; 978.12)[a]	1076.35 (832.01; 1351.38)[a]
Potassium (mg)	1473.08 (1076.18; 1966.05)[a]	2246.93 (1730.46; 2765.72)[a]
Sodium (mg)	1665.88 (1139.25; 2559.68)[a]	2019.58 (1377.11; 2898.18)[a]
Zinc (mg)	10.16 (7.22; 13.45)	10.25 (8.08; 13.64)
Copper (mg)	0.77 (0.59; 1.02)[a]	0.93 (0.73; 1.26)[a]
Manganese (µg)	1247.66 (899.44; 1851.40)[a]	1724.57 (1231.89; 2457.29)[a]

Vitamin A (RE) (µg retinol equivalents)	504.64 (307.70; 775.45)[a]	592.24 (396.99; 908.16)[a]
Thiamine (mg)	1.29 (0.90; 1.70)	1.33 (0.98; 1.68)
Riboflavin (mg)	1.24 (0.79; 1.92)[a]	1.81 (1.28; 2.42)[a]
Niacin (mg)	23.73 (17.56; 31.13)	23.84 (17.94; 31.11)
Vitamin B6 (mg)	2.97 (2.03; 4.29)[a]	2.31 (1.59; 3.08)[a]
Folate (µg)	256.22 (172.19; 352.67)[a]	186.99 (129.39; 263.52)[a]
Vitamin B12 (µg)	2.36 (1.13; 4.00)[a]	3.83 (2.42; 5.74)[a]
Pantothenic (mg)	4.23 (2.87; 6.21)[a]	5.49 (4.01; 7.46)[a]
Biotin (µg)	17.78 (12.41; 25.29)[a]	23.80 (17.32; 31.09)[a]
Vitamin C (mg)	19.65 (8060; 43.19)[a]	45.55 (22.43; 102.42)[a]
Vitamin D (µg)	2.17 (0.94; 4.49)[a]	3.13 (1.75; 5.47)[a]
Vitamin E (mg)	7.01 (4.35; 10.69)[a]	8.23 (4.95; 12.20)[a]

TE = Total Energy; a = significant difference ($p < 0.05$); b = no significant difference ($p > 0.05$)

APPENDIX B FOOD GROUPS

Cooked porridge, e.g. maize meal, sorghum, oats

4410	Maize meal, super, soft (white, fortified)
4411	Maize meal, super, stiff (white, fortified)
4412	Maize meal, super, crumbly (white, fortified)
4400	Maize meal, special, soft (white, fortified)
3400	Maize meal, special, stiff (white, unfortified)
3450	Maize meal, No. 1 straight run, raw (yellow)
3399	Maize meal, special, soft (white, unfortified)
4401	Maize meal, special, stiff (white, fortified)
4402	Maize meal, special, crumbly (white, fortified)
3239	Oats, rolled or oatmeal, cooked
3437	Mabella corn rice/sorghum, cooked
3241	Maltabella, cooked
3304	Oats, rolled or oatmeal, uncooked
3277	Maltabella, uncooked
3249	Wheat, pearl, cooked, weetrice/stampkoring
3432	Oat bran, cooked
2842	Baby cereal, mixed cereal, dry (Purity)
3240	Tastee Wheat, cooked

Breakfast cereals

3244	Breakfast cereal -Weet-bix
3243	Breakfast cereal - Corn flakes, plain
3303	Breakfast cereal - muesli, commercial
3242	Breakfast cereal - All Bran flakes
3245	Breakfast cereal - Pronutro High Energy
3252	Breakfast cereal - Rice Crispies
3322	Breakfast cereal - Special K
3438	Breakfast cereal - Pronutro Great Start
3436	Breakfast cereal - Pronutro Whole-wheat
3372	Breakfast cereal - puffed rice, sweetened (Coco Pops)

3425	Breakfast cereal - Fruit Loops
3374	Breakfast cereal - Frosties, sugar-coated cornflakes
3376	Breakfast cereal - puffed wheat, sweetened (Honey Smacks)
3378	Breakfast cereal - Hi Bulk Fibre Bran
3325	Breakfast cereal - puffed wheat, plain

Sunflower oil

3507	Sunflower oil

Other oil

3509	Olive oil
4280	Canola oil
3498	Coconut oil
3512	Palm kernel oil
3459	Almond, oil roasted, blanched, unsalted
3510	Maize oil

Samp, maize rice, wheat rice, rice, macaroni, spaghetti

3250	Maize, samp/rice, cooked (white)
3247	White rice, cooked
3262	Macaroni/Spaghetti, cooked
3272	Noodles, egg, cooked
3315	Rice, brown, cooked
3302	Macaroni/Spaghetti, whole wheat, cooked
3433	Rice, fried
3317	Rice, white, cooked, with PUM
3383	Semolina, uncooked
3405	Wheat, crushed/bulgur, cooked

Sugar (white and brown)

3989	White sugar

4005	Brown sugar

Bread, rolls, “Vetkoek” (deep fried bread)

3212	Whole-wheat bread
3416	Bread, pita
3213	Bread, rye
3406	Bread, health loaf/granary
3278	Bread, maize meal (WM, HM)
3396	Bread, home-made with onion soup, buttermilk and cheese
3210	White bread (fortified)
3211	Brown bread (fortified)
3257	Vetkoek, homemade (cake flour, water)
3409	Hot cross bun
3358	Roti, made with sun oil
3256	Date loaf (HM)
3421	Banana loaf (LFM, HM)
3333	Banana loaf (WM, HM)
3370	Banana loaf (SM, PUM)
3306	Pastry/Crust, flaky (HM)

Chicken, turkey, goose and duck, cooked (including Kentucky etc.)

4375	Chicken (with skin), curry
3025	Chicken, dark meat, frozen, cooked - moist
3027	Chicken, dark meat, frozen, cooked - dry
4301	Chicken, skin, frozen, cooked - moist
4306	Chicken, dark meat, fresh, cooked - moist
4307	Chicken, dark meat, fresh, cooked - dry
4299	Chicken, skin, fresh, cooked - dry
4302	Chicken, white meat, fresh, raw
4380	Chicken (without skin), curry
2926	Chicken, meat and skin, frozen, boiled
3018	Chicken, batter dipped, fried

2925	Chicken, meat and skin, frozen, roasted
3029	Chicken, white meat, frozen, cooked - dry
2964	Chicken, white meat, frozen, cooked - moist
2963	Chicken, meat only, frozen, boiled
2950	Chicken, meat only, frozen, roasted
4304	Chicken, white meat, fresh, cooked - dry
4300	Chicken, skin, frozen, cooked - dry
4303	Chicken, white meat, fresh, cooked - moist
2982	Turkey, roasted (meat and skin)
2928	Pheasant, roasted (meat only)
2981	Turkey, roasted (meat only)
4283	Ostrich, cooked

Yellow and red vegetables, e.g. red peppers, carrots (raw and cooked), pumpkin and beetroot

3734	Pepper, sweet, red, raw
4152	Pepper, sweet, red, boiled
4153	Pepper, sweet, yellow, raw
3709	Carrot, raw (flesh and skin)
3818	Carrot, boiled, with sugar
3822	Carrot, cooked with potato, onion and brick margarine
4111	Carrot, frozen, boiled
3820	Carrot, candied, with polyunsaturated margarine
3721	Carrot, raw, with sugar
3824	Carrot, cooked with potato, onion and sun oil
3819	Carrot, candied, with brick margarine
3757	Carrot, boiled (flesh and skin)
3889	Pumpkin, baked (breadcrumbs, sugar, brick margarine)
3784	Pumpkin fritter, fried in sun oil
3893	Pumpkin, candied, with brick margarine
4164	Pumpkin, boiled
3698	Beetroot, boiled with skin (flesh only)
3728	Squash, butternut, boiled, with sugar

3759	Squash, butternut, boiled
4273	Squash, butternut, candied, with brick margarine

Coffee and tea

4037	Coffee
4054	Rooibos tea
4038	Tea
4053	Tea, herb, brewed

Other cooked vegetables, e.g. parsnips, mixed vegetables, green beans and peas

4269	Mixed vegetables, stir-fry, frozen, stir-fried in sun oil
4265	Mixed vegetables, frozen, boiled (cauliflower, carrot, green beans etc.)
3836	Mixed vegetables, boiled, with polyunsaturated margarine (carrots, etc.)
3835	Mixed vegetables, boiled, with brick margarine (carrot, corn, etc.)
3727	Mixed vegetables, frozen, boiled (carrot, corn, peas, green beans etc.)
3794	Green beans, cooked with potato, onion and sun oil
3789	Green beans, boiled, with polyunsaturated margarine
3933	Green beans, cooked with potato, onion, no shortening
3788	Green beans, boiled, with brick margarine
3696	Green beans, boiled
3792	Green beans, cooked with potato, onion and brick margarine
4123	Green beans, frozen, boiled
3177	Peas, split, cooked
3720	Peas, frozen, boiled, with sugar
4146	Peas, frozen, boiled
3719	Peas, boiled
3732	Parsnip, boiled
3773	Onion, boiled
3775	Pepper, sweet, green, boiled
3730	Onion, sautéed in sun oil
3841	Mushroom, sautéed in sun oil
3729	Mushroom, boiled

3846 Onion, batter-coated, fried in sun oil
3716 Cauliflower, boiled
3774 Celery, boiled
4116 Cauliflower, frozen, boiled
3695 Asparagus, green, boiled
3703 Brussels sprouts, boiled
3802 Brinjal, fried in sun oil
3865 Pepper, sweet, green, cooked with tomato, onion and sun oil
3919 Artichoke, Jerusalem, boiled
4179 Squash, marrow, boiled
3754 Squash, gem, boiled, with sugar
4171 Squash, baby marrow, boiled
4274 Squash, Hubbard, candied, with brick margarine
4144 Peas, raw
4117 Cauliflower, dehydrated, raw
3950 Onion rings, breaded, French fried, frozen, heated in oven
3839 Mushroom, sautéed in brick margarine
3760 Squash, gem, boiled (flesh only)
3844 Onion, sautéed in brick margarine

Green leafy vegetables, e.g. spinach, coleslaw, cabbage and broccoli

3898 Spinach (Swiss Chard), boiled, with brick margarine
4170 Spinach (Swiss Chard), frozen, boiled
3913 Spinach (Swiss Chard), boiled
3761 Spinach (small leaved), boiled
3786 Spinach (Swiss Chard), cooked with potato, onion, sun oil
3901 Spinach (Swiss Chard), cooked with potato, onion, brick margarine
3707 Salad: Coleslaw, commercial
3705 Salad: Coleslaw (mayonnaise, raisins)
3813 Cabbage, cooked with potato, onion and brick margarine
3810 Cabbage, sautéed in brick margarine
3815 Cabbage, cooked with potato, onion and sun oil
4107 Cabbage, dehydrated, boiled

3812	Cabbage, sautéed in sun oil
3756	Cabbage, boiled
3701	Broccoli, boiled
4102	Broccoli, frozen, boiled
3939	Okra, boiled
3980	Leaves, amaranth, boiled
4167	Spinach (small leaved), raw
3957	Fenugreek, leaves, raw

Tomatoes (raw and cooked)

4189	Tomato, sun-dried
4191	Tomato, whole peeled/diced, canned
3751	Tomato, raw, with sugar
3750	Tomato, raw
3752	Tomato, boiled
3925	Tomato and onion, stewed (no sugar)
4192	Tomato and onion, canned
3767	Tomato, fried in sun oil
3910	Tomato and onion, stewed (with sugar)
8010	Tomato and onion, in oil

Canned fish, e.g. pilchards, sardines, tuna

3055	Pilchard in brine
3102	Pilchard in tomato sauce
3087	Sardine, canned in tomato sauce (drained)
3056	Tuna, canned in oil (fish and oil)
3093	Tuna, canned in oil (drained solids)
3054	Tuna, canned in water (drained solids)
3101	Salmon, red, canned (drained solids)

White flesh fruit

4223	Apple, Starkling, raw
4221	Apple, Golden Delicious, raw
3582	Pear, raw
4222	Apple, Granny Smith, raw
3532	Apple, average, raw

Other fruit

4233	Raisins, sultanas, bleached, raw
4245	Date, raw
3566	Blueberry, raw
4231	Raisins, hanepoot, seeded, raw
4232	Raisins, hanepoot, seedless, raw
4224	Grape, sultana, raw
3552	Raisins, Thompson seedless, raw

Starchy vegetables, e.g. potatoes, sweet potatoes and corn

3737	Potato, boiled without skin
4155	Potato, boiled with skin (flesh and skin)
3736	Potato, baked in skin (flesh and skin)
3970	Potato, baked in skin (flesh only)
3903	Sweet potato (White-fleshed), boiled without skin
3748	Sweet potato (Orange-fleshed), baked with skin (flesh only)
4160	Potato, microwaved in skin (flesh and skin)
4161	Potato, mash, dehydrated, dry form
4162	Potato, mash, dehydrated, reconstituted
3725	Mealie, sweet corn, boiled
4132	Mealie, sweet corn, frozen, boiled
3726	Mealie, sweet corn, cream style, canned
3942	Mealie, sweet corn, whole kernels, canned
3254	Sweet corn fritter

4133	Mealie, sweet corn, baby, whole, fresh/frozen, boiled

Beef and meatballs, cooked

4363	Beef, brisket/regular mince, cooked - moist
2921	Beef, topside/lean mince, cooked - moist
3020	Beef, stew, with vegetables
2945	Beef, chuck, cooked - moist
2943	Beef, rump, cooked - dry
2946	Beef, loin, cooked - dry
2987	Beef, mince (lean), savoury (tomato, onion)
2933	Beef, fillet, cooked - dry
2941	Beef, rib, prime, cooked - dry
3006	Beef, stew, with cabbage
2960	Beef, rib, wing, cooked - dry
4361	Beef, silverside, cooked - moist
4364	Beef, neck, cooked - moist
4365	Beef, shoulder, cooked - moist
4366	Beef, thin flank, cooked - moist
4368	Beef, fore shin, cooked - moist
4370	Beef, C age, cooked
2965	Meatball (lean mince, with egg)
2966	Meatball (lean mince, without egg)
2976	Oxtail, stewed (meat only, salt added)
2983	Schnitzel, veal, pan-fried (breaded)
4331	Veal, chuck, cooked - moist
2979	Steak and kidney, stew
2913	Venison (buck/deer), roasted

Pork

2992	Schnitzel, pork chop (crumbed)
2930	Pork, loin, grilled (chop)
3010	Pork, spareribs, braised

2958	Pork, leg, roasted
3046	Pork, thick rib/breast, braised
3044	Pork, loin, lean (meat only), braised

Beer, commercial and homemade

4047	Beer, alcohol free
4031	Beer, average (alcohol 4.6% v/v; 3.6% w/w)
4039	Beer, sorghum (alcohol 2-3% w/w)
4048	Beer, stout (alcohol, 6.1% v/v; 4.7% w/w)
4057	Cider, sweet (alcohol 3.7% v/v; 2.9% w/w)

Non-dairy creamer, milk blend

2751	Creamer (coffee and tea)/Non-dairy powder

Milk

4308	Milk FF/Whole, UHT
2772	Milk, low fat/2% fat, fresh
2718	Milk, FF/Whole, fresh
2775	Milk, skim, fresh
2737	Milk, soy

Yoghurt

4324	Yoghurt, frozen
2732	Yoghurt, fruit, low fat, sweetened
2734	Yoghurt, plain, low fat
2723	Yoghurt, fruit, low fat, sweetened
2727	Yoghurt, fruit, fat free, artificially sweetened
2756	Yoghurt, drinking, low fat, flavoured, sweetened

Other milk products

2733	Melkkos/-snysels, whole milk (no sugar)
3499	Cream, canned
2780	Malted milk beverage (LFM, no sugar), e.g. milo
2826	Milk powder, low fat, reconstituted
3480	Cream, fresh, whipping (min 35% fat)
2770	Milk blend, powder
2781	Melkkos/-snysels, low-fat milk (no sugar)
2794	Milk powder, blend, medium fat (Numel)
4415	Milk, evaporated, low fat, unsweetened
4325	Ice cream, low fat
3492	Orley Whip (no sugar added)
4251	Cream, sour
3520	Cream, fresh, coffee (12% fat)
2774	Milk, flavoured, low fat
3483	Ice cream, regular (10% fat)
3518	Ice cream, soft serve (13% fat)
2788	Milk shake, vanilla, purchased
3519	Ice cream, rich (16% fat)
3481	Cream, fresh, dessert (min 20% fat)
4287	Drinking chocolate, reconstituted
2735	Malted milk beverage (WM, no sugar), e.g. Milo
2714	Milk, condensed, full fat, sweetened
3491	Ice cream, sorbet/non-dairy (8% fat)
2750	Milk jelly, whole milk

Eggs

2872	Egg, scrambled (WM only)
2888	Egg, scrambled (LFM, PUM)
2904	Egg, chicken, white, raw
2890	Egg, scrambled (WM, HM)
2901	Egg, chicken, whole, raw
4316	Egg, turkey, whole, raw

2869	Egg, fried in sun oil
2867	Egg, chicken, whole, boiled/poached
2873	Egg, scrambled (WM, sun oil)
2878	Egg, fried in PUM
2877	Egg, fried in HM
2870	Egg, fried in bacon fat
2889	Egg, scrambled (LFM, sun oil)
2882	Omelette, plain (LFM, fried in sun oil)
2871	Omelette, plain (WM, fried in sun oil)
2883	Omelette, plain (WM, fried in HM)

Organ meats, e.g. liver, tripe, kidney, heart, offal, giblets, tongue and lung

2970	Liver, chicken, cooked (simmered)
2920	Liver, beef, fried
2955	Liver, sheep/lamb, fried
2922	Pate, chicken liver
4296	Liver, beef, raw
3003	Offal, cooked (tripe/brawn/brain/tongue)
2969	Heart, sheep/lamb, braised
2998	Chicken, giblets, cooked (simmered)
3014	Chicken, giblets, curried
2990	Ham and tongue loaf
3019	Lung, beef, braised
2997	Chicken, feet, raw
2999	Chicken, head, raw
2918	Brawn/Headcheese, pork

Carbonated cold drinks

3981	Carbonated cold drink

Meat products, e.g. beef sausage, biltong, ham, Vienna's, corned meat, salami, frankfurters, patties

2931	Sausage, beef and pork/boerewors, grilled
2936	Vienna sausage, beef and pork, canned
2949	Sausage, beef, dry
2932	Sausage, pork, grilled
4349	Sausage, beef, grilled
4348	Sausage, smoked, beef and pork
2912	Biltong, game
3021	Biltong, beef (cured, dried)
3008	Ham, sliced/canned, lean
2967	Ham, sliced/canned, regular
2948	Salami, beef/pork (also Russians)
4344	Salami, beer (Bierwurst), pork
3012	Frankfurter, chicken
2937	Frankfurter, beef and pork
2984	Patty, beef, frozen, grilled
3011	Patty, chicken, crumbed/breaded, fried
2940	Beef, corned, canned
4343	Pastrami, turkey
2919	Polony/Bologna, beef and pork
2906	Bacon, cured, pan-fried/grilled
2939	Sausage roll, commercial, baked
3382	Chilli bites (bhadjia) (sun oil)

Hard (brick) margarine

3484	Margarine, brick/hard
3490	Butter and hard margarine, mixed

Other margarine

3521	Margarine, 50% polyunsaturated, Floro
3496	Margarine, polyunsaturated

8006	Flora-proactive
3528	Low-fat spread, polyunsaturated, Floro extra light
3524	Medium-fat spread, polyunsaturated, Floro light
3531	Medium-fat spread, <40% polyunsaturated

Butter

3479	Butter
3529	Butter, unsalted
3523	Butro

Starchy vegetables with added FAT, e.g. potato, corn

3740	Potato chips/French fries, fried in sun oil
3876	Potato, mashed (whole milk, brick margarine)
3749	Sweet potato (white-fleshed), candied, with brick margarine
3873	Potato, sautéed in sun oil
3979	Potato, roasted in sun oil
3875	Potato, mashed (skim milk, polyunsaturated margarine)
3945	Potato chips/French fries, frozen, heated in oven
3735	Potato, roasted in lamb fat
3871	Potato, sautéed in brick margarine
3915	Potato croquette
3973	Potato, baked in skin, with sour cream and chives
3867	Potato, boiled, with brick margarine
3923	Potato, roasted in chicken fat

Beans, cooked haricot, sugar beans, canned baked beans

3176	Beans, dried, canned in tomato sauce (baked beans)
3178	Beans, white kidney, cooked (potato, onion, HM)
3183	Beans, white kidney, dried, cooked
3205	Beans, sugar, dried, cooked
3174	Beans, dried, cooked, bean salad/sousbone (sugar, vinegar)
3206	Beans, sugar, dried, raw

3930	Bean sprouts, alfafa, raw
3203	Lentils, whole, cooked
3198	Chick peas, dried, cooked

Fruit, orange/yellow/green coloured flesh

3660	Kiwifruit, raw (peeled)
4259	Fruit salad, fresh, without sugar (melon, orange, banana)
3560	Orange, raw (peeled)
3588	Fruit salad, fresh, without sugar (pawpaw, orange, banana)
3541	Melon, orange flesh, raw (peeled)
3540	Banana, raw (peeled)
3558	Naartjie/Tangerine, raw (peeled)
3556	Mango, raw (peeled)
3563	Pawpaw, raw (peeled)
3576	Watermelon, raw (peeled)
3622	Gooseberry, Cape, raw
3673	Persimmon, raw (peeled)
3542	Cherry, raw
3545	Granadilla, raw (without peal)
3571	Prickly pear, raw (peeled)
4230	Prune, raw
3534	Apricot, raw
3551	Guava, raw (peeled)
3669	Lemon, raw (without peel)
4228	Nectarine, raw
3595	Raspberry, raw
3650	Pomegranate, raw (peeled)
3570	Plum, raw
3546	Grapefruit, raw (peeled)
3573	Strawberry, raw
3550	Grape, average, raw
3565	Peach, raw
3581	Pineapple, raw (peeled)

Other savoury liquids, e.g. gravy, packet soups, sauces etc.

3120	Gravy, meat (20% fat, stock, thickened)
3119	Gravy, brown, powder, prepared with water
3118	Gravy, brown powder
3121	Gravy, meat (fat-free stock, vegetables, thickened)
3122	Gravy, meat (50% fat, unthicken)
3165	Soup powder, average, reconstituted, prepared with water
3158	Soup powder, average
3154	Soup, minestrone, commercial, prepared with water
3156	Soup, powder, onion
3162	Soup, vegetable, vegetarian, commercial, prepared with water
3150	Soup, chicken cream, commercial, prepared with water
3149	Soup, chicken noodle, commercial, prepared with water
3155	Soup, mushroom cream, commercial, prepared with water
3161	Soup, vegetable and beef, commercial, prepared with water
3144	Soup, asparagus cream, commercial, prepared with water
3160	Soup, tomato cream, commercial, prepared with water
3138	Sauce, sweet-sour
3135	Sauce, mustard (egg and vinegar)
3137	Sauce, pepper/garlic
3115	Sauce, barbeque, commercial
3142	Sauce, white, medium (WM, HM)
3134	Sauce, mushroom, dehydrated, prepared with milk
3164	Sauce, white, medium (LFM, PUM)
3125	Sauce, cheese, medium (WM, HM, cheese)
3143	Sauce, white, medium (LFM, HM)
3163	Sauce, monkey gland
3127	Sauce, cheese, medium (LFM, PUM, cheese)
3116	Sauce, soy
3124	Sauce, cheese, dehydrated, prepared with milk
3126	Sauce, cheese, medium (LFM, HM, cheese)
3131	Sauce, curry (Indian), onion, tomato, masala, garlic, ginger, sun oil
3141	Sauce, white, medium (SM, PUM)
3123	Sauce, barbeque, home-made

3128	Sauce, cheese, medium (SM, PUM, medium-fat cheese)
3140	Sauce, white, dehydrated, prepared with milk
4044	Curry powder
3109	Fish paste
3147	Soup, bouillon, beef
3166	Soup, Jabula, powder
4046	Salt, table
4288	Salt, table, iodised
3168	Chutney, fruit
3114	Chutney, tomato
4029	Bovril, meat and vegetable extract
4030	Marmite, yeast extract
4036	Vinegar
4034	Mustard, yellow, prepared
3153	Soup, lentil (with beef and vegetables)
3159	Soup, soup mix (with beef and vegetables)
4255	Pepper, black

Nuts and seeds (all types)

3458	Peanuts, roasted, salted
3475	Mixed nuts (almond, cashew, peanuts, hazel, Brazil)
3452	Peanuts, roasted, unsalted
3474	Mustard seed, yellow
3457	Sunflower seed, dried
3466	Sesame seed, dried, hulled
3454	Almond, dried, blanched
3463	Pecan nut, dried
3473	Pistachio nut, dried
3455	Walnut, dried
3456	Cashew nut, dry roasted, unsalted
3470	Macadamia nut, dried
3468	Almond, toasted, unblanched

Jam, syrup, sugar based sweets (no fat)

3985	Jam/Marmalade
3988	Syrup, golden
3986	Sweets, hard boiled and soft jelly type
3993	Sweets, chewing gum
4000	Sweets, fruit gum
4001	Sweets, marshmallows
4004	Sweets, peppermint
4010	Sweets, Liquorice Allsorts
4022	Sweets, Super C
4002	Sweets, peanut brittle
4011	Sweets, coconut ice
3984	Honey
4016	Marzipan
3359	Popcorn, sugar coated/candied

Mahewe (non-alcoholic drink)

4056	Mahewu/Magou, liquid

Soya bean products, e.g. Toppers

3196	Toppers, cooked

Atchar

3117	Atchar, mango

Salad dressings, mayonnaise, sandwich spread

3488	Salad dressing, mayonnaise
3487	Salad dressing, French (vinegar, sunflower oil)
3505	Salad dressing, low oil
3489	Salad dressing, salad cream
3493	Salad dressing, cooked, homemade (WM, butter)

3504	Salad dressing, condensed milk, home-made (WM condensed milk)
3522	Sandwich spread

Tomato sauce

3139	Sauce, tomato
3974	Tomato paste
3975	Tomato puree

Mutton, cooked

2927	Mutton, loin, grilled (chop)
2916	Mutton, stew, with vegetables
2947	Mutton, leg (meat and fat), roasted
3036	Mutton, leg and shoulder, lean (meat only), braised
3039	Mutton, curry
3497	Mutton tallow
2974	Mutton, shoulder, braised
3038	Mutton, rib, grilled/roasted
3041	Mutton, mince, cooked
4281	Goat, roasted

Raw vegetables, salads

4271	Salad: Greek (lettuce, tomato, cucumber, olive, feta, no dressing)
3921	Salad: French (lettuce, tomato, cucumber, no dressing)
3699	Salad: Beetroot
3928	Salad: Potato (mayonnaise, egg)
3926	Salad: Mixed fresh vegetables (carrot, tomato, lettuce, no dressing)
3927	Salad; Mixed green (lettuce, cabbage, cucumber, apple, no dressing)
3710	Salad: Carrot, raw (carrot, pineapple, orange, no sugar)
3336	Noodle salad
3057	Tuna salad
4267	Mixed vegetables, frozen, raw (cauliflower, carrot, green beans, etc.)
3916	Salad: Sweet corn (mayonnaise, tomato, onion)

4272	Salad: Sambal (tomato, onion)
3693	Peach salad, curried/atchar/pickles
4266	Mixed vegetables, frozen, raw (carrot, corn, peas, green beans, etc)
4268	Mixed vegetables, stir-fry, frozen, raw (baby marrow, carrot, etc.)
3704	Cabbage, raw
3755	Onion, raw
3842	Mushroom, raw
3787	Amadumbe/Taro, tuber, raw (flesh only)
3723	Lettuce, raw
3656	Avocado, raw (peeled)
3718	Cucumber, raw (flesh and skin)
3932	Bean sprouts, soy, raw
3935	Garlic, raw
3733	Pepper, sweet, green, raw
3768	Gherkins/Cucumber, dill, pickled
3658	Olive, ripe, canned, drained, pitted
4119	Cucumber, English, raw (flesh and skin)
3977	Pepper, chilli, raw

Mixed dishes with beans, e.g. bean soup

3402	Samp and beans, 1:1
3040	Mutton, stew, with green beans
3145	Soup, bean, dried (with beef and vegetables)

Squash cold drinks

3982	Cold drink, squash, diluted
3659	Fruit punch (alcohol free)

Dairy-fruit mix drinks

2791	Dairy-fruit juice mix

Sweet cookies, biscuits, rusks

3216	Cookies, commercial, plain
3217	Cookies, commercial, with filling
3233	Cookies, home-made, plain (HM)
3341	Cookies, home-made, plain (PUM)
3296	Cookies, shortbread (butter)
3265	Cookies, home-made, oat crunchies (HM)
3295	Cookies, home-made, with jam filling (HM)
3329	Rusk, commercial, buttermilk, white
3330	Rusk, commercial, bran
3255	Rusk, home-made, buttermilk, whole wheat (HM)
3215	Rusk, home-made, buttermilk, white (HM)
3380	Rusk, home-made, All Bran, raisins, buttermilk (HM)
3222	Rusk, home-made, white (no sugar, WM, HM)
3364	Rusk, commercial, white/boerebeskuit

Fruit juice (all types)

3683	Mango juice, Ceres
3606	Apple juice, Liquifruit/Ceres
3629	Guava juice, Liquifruit/Ceres
3681	Mango and orange juice, Liquifruit
3554	Guava juice, sweetened
3624	Grape juice, canned/bottled, unsweetened
3627	Grapefruit juice, Liquifruit/Ceres
3670	Lemon juice, canned/bottled
3561	Orange juice, fresh
3562	Orange juice, canned, sweetened
3578	Lemon juice, fresh
3684	Litchi juice, Ceres
3688	Pineapple and mango juice, Liquifruit
3690	Grape/Hanepoot juice, Liquifruit/Ceres
3645	Pear juice, Ceres
3685	Peach and orange juice, Liquifruit

3687	Peach juice, Ceres
3548	Grapefruit juice, fresh
3549	Grapefruit juice, canned, sweetened
3610	Apricot juice, Liquifruit
3626	Grapefruit juice, canned, unsweetened
3636	Naartjie juice, fresh
3680	Granadilla juice, Liquifruit/Ceres
3686	Peach and banana juice, Liquifruit
3689	Apple and blackcurrant juice, Liquifruit
3753	Tomato juice, canned
3638	Orange juice, Liquifruit/Ceres
3654	Strawberry juice, Liquifruit
3539	Apricot nectar

Low calorie cold drinks (carbonated and ready-to-go mix types)

3990	Cold drink, low-calorie/artificially sweetened/diet squash, diluted
4027	Cold drink, Clifton, reconstituted

Savoury snacks, e.g. potato crisps, “Niknaks”

3267	Snack, savoury, average, e.g. Niknaks
3417	Snack, savoury, potato crisps/chips
3418	Snack, savoury, Chipniks
3332	Popcorn, plain

Peanut butter

3485	Peanut butter, smooth style

Fudge, toffee, caramel

3991	Sweets, fudge/toffee/caramel

Fish, cooked

3072	Fish, low fat, battered/crumbed, fried in sun oil
3081	Fish finger/stick, fried/frozen, crumbed, reheated
3060	Fish, low fat, fried in sun oil
4373	Fish, low fat, steamed (hake)
3094	Fish, medium fat, battered/crumbed, fried in sun oil
3079	Fish, low fat, drilled
3089	Fish, medium fat, grilled/steamed
3103	Fish, high fat, steamed, e.g. salmon
3080	Fish cake, commercial, fried
3084	Fish, medium fat, fried in sun oil
3092	Fish, low fat, baked with butter
3064	Fish, medium fat, fried in HM
3058	Salmon, pink, canned (solids and liquid)
3061	Haddock, smoked, steamed
3082	Fish, high fat, grilled, e.g. herring, butterfish

Other seafood

3075	Rollmops/Pickled herring
3085	Mussel, black/blue, boiled
3088	Shrimp/Prawn, canned
3105	Mussel, white/clam, breaded, fried
4138	Mushroom, oyster, boiled
3062	Mussel, white/clam, canned
3086	Shrimp/Prawn, breaded, fried
3070	Shrimp/Prawn, boiled
3100	Snail/Whelk, boiled
3099	Calamari/Squid/Octopus, fried (flour, oil)

Baked sweet foods, e.g. cake, pudding, tart, muffins, scones

3419	Cake, chocolate, plain, home-made (LFM, HM)
3420	Cake, butter, plain, home-made (LFM, HM)

3288	Cake, butter, plain, home-made (WM, HM)
3289	Cake, chocolate, plain, home-made (WM, HM)
3392	Cake, carrot, plain (egg, sun oil)
3292	Cake, sponge, with jam, commercial (e.g. Swiss roll)
3290	Cake, plain, home-made, made with sun oil
3218	Cake, butter, plain, home-made (WM, butter)
3293	Cheese cake, baked (egg and cream)
3219	Cake, sponge, plain, home-made (without fat)
3339	Cake, chocolate, plain, home-made (SM, PUM)
3312	Pudding, baked in syrup, plain batter (WM, HM)
3431	Pudding, baked in syrup, plain batter (LFM, HM)
3221	Pudding, baked, plain batter, no syrup (WM, HM)
3264	Pudding, dumplings/souskluitjies (HM)
3429	Pudding, baked, plain batter, no syrup (LFM, HM)
3263	Pudding, baked custard, e.g. bread-/sago-/rice- (WM, HM)
3282	Pudding, blancmange (SM)
3348	Pudding, baked in syrup, plain batter (SM, PUM)
3434	Tart/Pie, cottage cheese, fruit, crumb crust - PUM
3446	Tart/Pie, milk (SM, crumb crust -PUM)
3445	Tart/Pie, milk (SM, crumb crust - HM)
3365	Tart/Pie, milk (WM, crumb crust - HM)
3411	Scone, plain (LFM, HM)
3413	Croissant
3327	Tart/Pie, apple with batter (WM, HM)
3226	Tart/Pie, lemon meringue, short crust - HM
3224	Tart/Pie, apple, short pastry - HM
3229	Tart/Pie, milk (WM, flaky pastry - HM)
3232	Doughnut, plain
3294	Tart/Pie, cottage cheese, condensed milk, crumb crust - HM
3345	Tart/Pie, apple with batter (SM, PUM)
3352	Tart/Pie, apple, short pastry - PUM
3360	Tart/Pie, milk (WM, short crust - HM)
3439	Tart/Pie, cottage cheese, condensed milk, crumb crust - PUM
3444	Tart/Pie, milk (SM, short crust - HM)

3227	Tart/Pie, lemon, condensed milk, crumb crust - HM
3228	Tart/Pie, coconut, short crust - WM, HM
3246	Tart/Pie, fruit chiffon, crumb crust - HM
3323	Tart/Pie, tipsy
3321	Scone, whole wheat (SM, sun oil)
3351	Tart/Pie, milk (SM, short crust - PUM)
3404	Muffin, oat bran (SM, sun oil)
3422	Doughnut, with icing
3408	Muffin, plain
3407	Muffin, bran
2899	Soufflé, plain (WM, sun oil)
3424	Pancake/Crumpet, plain (LFM, sun oil)
3238	Pancake/Crumpet, plain (WM, sun oil)
3231	Koeksister
3237	Scone, plain (WM, HM)
3344	Pancake/Crumpet, plain (SM, sun oil)

Chocolate and chocolate based sweets

4003	Sweets, chocolate, dark/bittersweet/Albany
3994	Sweets, chocolate coated nuts
4023	Sweets, chocolate, white
3998	Sweets, chocolate coated raisins
3987	Sweets, chocolate, milk
4024	Sweets, chocolate, Kit Kat
3992	Sweets, chocolate, assorted centres
3997	Sweets, chocolate coated bar

Milk products made with full fat milk, e.g. custard

2716	Custard, whole milk (custard powder)
3338	Custard slice

Cheese, cheddar

2722	Cheese, cheddar

Other cheese

2728	Cheese, processed, full fat
2761	Cheese, feta
2790	Cheese, mozzarella
2725	Cheese, cream, full fat
2729	Cheese, cottage, low fat
2730	Cheese spread, full fat
2759	Cheese, cottage, full fat
2773	Cheese, medium fat/reduced fat
2784	Cheese, processed, reduced fat
2793	Cheese, Ricotta
4312	Cheese, Brie
4414	Cheese, cottage, fat free
2726	Cheese, Roquefort (Blaauwkrantz)
2758	Cheese, Camembert

Savoury dishes, e.g. macaroni and cheese, savoury tart, pizza, samosa, spaghetti bolognaise, pies

3259	Macaroni, cheese, egg custard type (WM)
3441	Macaroni cheese, egg custard type (LFM)
3301	Macaroni cheese, white sauce type (WM, HM)
3343	Macaroni, cheese, white sauce type (LFM, HM)
3326	Tart/Pie, savoury (Vienna, short crust, cheese sauce - WM, HM)
3367	Tart/Pie, savoury (asparagus, short crust, cheese sauce - WM)
3448	Tart/Pie, savoury (asparagus, short crust, cheese sauce - SM)
3353	Pizza, with cheese, tomato and olives
3355	Samosa, with mutton filling
3414	Samosa, with vegetable filling
3260	Spaghetti bolognaise (regular mince)

3388	Spaghetti bolognaise (lean mince)
2954	Pie, chicken, commercial, baked
2957	Pie, steak and kidney, commercial, baked
2953	Pie, Cornish, commercial, baked
3009	Cottage pie (lean mince, WM, HM)
3261	Lasagne (regular mince, cheese sauce -WM, HM)
3387	Lasagne (lean mince, cheese sauce - SM, PUM)
3440	Lasagne (lean mince, cheese sauce - LFM, HM)
3023	Bobotie (lean mince, egg, LFM, sun oil)
3258	Spaghetti, canned in tomato sauce

Canned fruit/dry stewed with sugar

3567	Peach, canned in syrup
3664	Fruit cocktail, canned in fruit juice
3648	Pineapple, canned in syrup
4215	Grapefruit, canned in fruit juice
4217	Pineapple, crushed, canned in syrup
3640	Peach, canned in fruit juice
3580	Fruit salad, canned in syrup
3547	Grapefruit, canned in syrup
3537	Apricot, dried, stewed with sugar
3605	Fruit salad, fresh, with sugar (pawpaw, orange, banana)
4216	Apple, pie, canned, unsweetened

Dried fruit

3585	Pear, dried, raw
3593	Fruit salad, dried, raw
3995	Sweets, dried fruit
4237	Fig, dried, stewed without sugar
3536	Apricot, dried, raw
3600	Apple, dried, raw
3651	Prune, dried, stewed without sugar

3620	Fruit salad, dried, stewed without sugar
3655	Fruit roll, dried, mixed
3568	Peach, dried, raw
3596	Prune, dried, raw

Chicken, stewed with potato and/or vegetables

3005	Chicken (with skin), stew, with vegetables
2985	Chicken (with skin), stew, tomato and onion
4378	Chicken (without skin), stew, with vegetables
4379	Chicken (without skin), stew, tomato and onion

Energy drinks

8007	Monster energy drink
8008	Switch energy drink
4007	Cold drink, Lucozade

Other alcohol

4033	Wine, red/white/rose, dry/semi-sweet/sparkling (alcohol 12% v/v; 9.4% w/w)
4035	Spirit, Brandy/Gin/Whisky/Cane/Vodka/Rum (alcohol 43% v/v; 9.4% w/w)
4032	Sherry, sweet/Port/Muscadel (alcohol 17% v/v; 13% w/w)
4055	Liqueur, with cream (alcohol 30% v/v; 22% w/w)
4043	Sherry, dry/medium/Vermouth (alcohol 16.5% v/v; 13% w/w)
4040	Liqueur (alcohol 30% v/v; 22% w/w)
4050	Flavoured grape liquor/cooler (alcohol 7% v/v; 5.5% w/w)

Supplements

8009	USN 100% Premium whey protein
2768	BMS, casein-predominant formula, Lactogen-1 powder
4063	Cambridge diet, reconstituted with water
4065	Ensure, reconstituted (lactose-free enteral feed)/100ml
4084	Shape powder

Pudding

3169	Sauce, caramel
3129	Sauce, chocolate
3266	Pudding, instant (WM)
3328	Pudding, pineapple whip (jelly, evaporated milk)
3395	Pudding, instant (LFM)
4006	Jelly, dessert, with fruit
3983	Jelly, dessert, prepared with water

Savoury snacks: Biscuits

3235	Provita
3331	Crackers, average refined, high fat, e.g. Tuc, Bacon kips
3391	Crackers, whole-wheat, e.g. Harvest Wheat
3236	Rye, crisp bread, e.g. Ry-Vita, Ry-King
3230	Cream cracker

Health Bars

4021	Health bar, energy (e.g. Snacker, Gilly, Noogy)
4028	Health bar, yoghurt/seed
4017	Health bar, Stay Trim
4018	Health bar, energy (PVM)

Canned vegetables

4136	Mushroom, canned (drained solids)
4264	Mixed vegetables, canned
4149	Peas, canned
4126	Green beans, canned

APPENDIX C NUTRIENT PATTERNS

Table S2: Rotated Component Matrix [a]

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 4 iterations. MUFA – Monounsaturated fatty acids; PUFA – Polyunsaturated fatty acids

	Component		
	1	**2**	**3**
Plant Protein	**0.909**	-0.022	0.055
Animal Protein	0.062	0.641	0.488
Saturated Fat	0.162	0.558	0.624
MUFA – Fat	0.217	0.394	**0.715**
PUFA – Fat	0.241	0.055	**0.765**
Cholesterol	0.049	0.321	0.699
Total Carbohydrates	**0.821**	0.152	0.108
Total Fibre	0.740	0.323	-0.033
Calcium	0.039	**0.801**	0.138
Total Iron	0.729	0.374	0.227
Magnesium	0.624	0.608	0.206
Phosphorus	0.331	**0.793**	0.409
Potassium	0.348	**0.740**	0.299
Zinc	0.624	0.376	0.367
Vitamin A (RE)	0.152	0.461	0.020
Thiamine	0.753	0.318	0.292

	Component		
	1	**2**	**3**
Riboflavin	0.276	0.421	0.233
Niacin	0.695	0.381	0.287
Vitamin B6	0.819	-0.054	0.189
Folate	**0.844**	-0.068	0.064
Vitamin B12	-0.039	0.509	0.257
Vitamin C	0.043	0.480	-0.065
Vitamin D	0.058	0.132	0.682
Vitamin E	0.232	-0.042	**0.786**

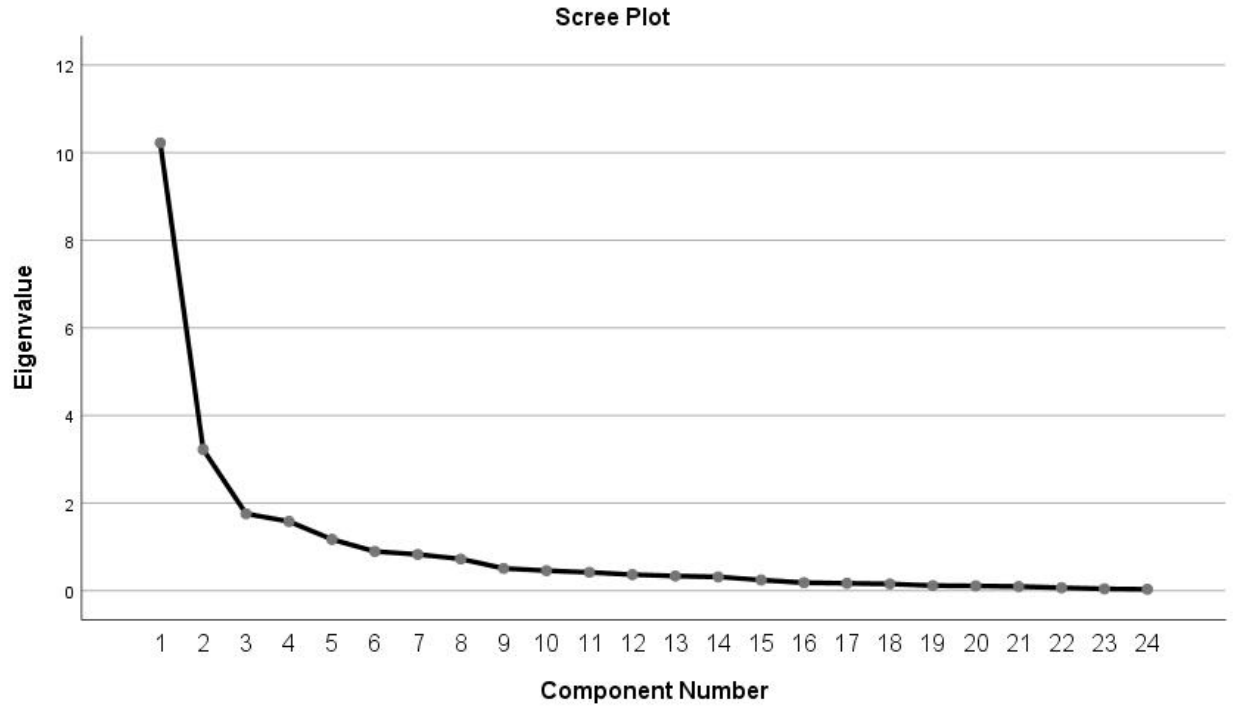

Figure S1: Scree plot of the nutrient pattern

APPENDIX D ETHICAL APPROVAL

NORTH-WEST UNIVERSITY
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Faculty of Health Sciences
Health Sciences Ethics Office for Research, Training and Support
Health Research Ethics Committee (HREC)

Tel: 018-285 2291
Email: Wayne.Towers@nwu.ac.za

28 April 2017

Dr T van Zyl
Nutrition-CEN

Dear Dr Van Zyl

APPROVAL OF YOUR APPLICATION BY THE HEALTH RESEARCH ETHICS COMMITTEE (HREC) OF THE FACULTY OF HEALTH SCIENCES

Ethics number: NWU-00023-17-S1

Kindly use the ethics reference number provided above in all correspondence or documents submitted to the Health Research Ethics Committee (HREC) secretariat.

Study title: Dietary intake of the African-PREDICT study population

Study leader/supervisor: Dr T van Zyl

Student: CK Jordaan

Application type: Single study

Risk level: Minimal

You are kindly informed that your application was reviewed at the meeting held on 16/03/2017 of the HREC, Faculty of Health Sciences, and was approved on 28/04/2017.

The commencement date for this study is 28/04/2017 dependent on fulfilling the conditions indicated below. Continuation of the study is dependent on receipt of the annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation up to a maximum period of three years when extension will be facilitated during the monitoring process.

After ethical review:

Translation of the informed consent document to the languages applicable to the study participants should be submitted to the HREC, Faculty of Health Sciences (if applicable).

The HREC, Faculty of Health Sciences requires immediate reporting of any aspects that warrants a change of ethical approval. Any amendments, extensions or other modifications

to the proposal or other associated documentation must be submitted to the HREC, Faculty of Health Sciences prior to implementing these changes. Any adverse/unexpected/unforeseen events or incidents must be reported on either an adverse event report form or incident report form at Ethics-HRECIncident-SAE@nwu.ac.za.

A monitoring report should be submitted within one year of approval of this study (or as otherwise stipulated) and before the year has expired, to ensure timely renewal of the study. A final report must be provided at completion of the study or the HREC, Faculty of Health Sciences must be notified if the study is temporarily suspended or terminated. The monitoring report template is obtainable from the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-Monitoring@nwu.ac.za. Annually a number of studies may be randomly selected for an external audit.

Please note that the HREC, Faculty of Health Sciences has the prerogative and authority to ask further questions, seek additional information, require further modification or monitor the conduct of your research or the informed consent process.

Please note that for any research at governmental or private institutions, permission must still be obtained from relevant authorities and provided to the HREC, Faculty of Health Sciences. Ethics approval is required BEFORE approval can be obtained from these authorities.

The HREC, Faculty of Health Sciences complies with the South African National Health Act 61 (2003), the Regulations on Research with Human Participants (2014), the Ethics in Health Research: Principles, Structures and Processes (2015), the Belmont Report and the Declaration of Helsinki (2013).

We wish you the best as you conduct your research. If you have any questions or need further assistance, please contact the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-HRECApply@nwu.ac.za.

Yours sincerely

Prof Wayne Towers

HREC Chairperson

Prof Minrie Greeff

Ethics Office Head

Current details: (13210572) C:\Users\13210572\Documents\HREC\HREC - Applications\2017 Applications\Applications 02-16 March 2017\NWU-00023-17-S1\(T van Zyl-CK Jordaan)\NWU-00023-17-S1(T van Zyl-CK Jordaan)-ALI\NWU-00023-17-S1(T van Zyl-CK Jordaan-AL.docm
11 May 2017

File reference: 9.1.5.3

APPENDIX E AFRICAN-PREDICT INFORMED CONSENT FORM

HART

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

HREC Stamp

INFORMED CONSENT FORM FOR THE African-PREDICT STUDY (RESEARCH PHASE):

TITLE OF THE RESEARCH PROJECT: African PRospective study on the Early Detection and Identification of Cardiovascular disease and HyperTension (African-PREDICT)

ETHICS REFERENCE NUMBER: NWU-00001-12-A1

PRINCIPAL INVESTIGATOR: Prof. Alta Schutte (PhD Physiology)

Prof. Schutte and the research team have the expertise and interest in Cardiovascular Physiology, namely to understand the biological processes in humans when high blood pressure and heart disease develop.

ADDRESS: NORTH-WEST UNIVERSITY (Potchefstroom Campus); Hypertension in Africa Research Team (HART); Hypertension Research and Training Clinic Building F11, Office 101.

CONTACT NUMBERS: 018 299 2444 / 018 285 2466 / 018 299 2780

You are invited to take part in the African-PREDICT research study. Please take some time to read the information presented here, which will explain the details of this study. Please ask the researcher or person explaining the research to you any questions about any part of this study that you do not fully understand. It is very important that you are fully satisfied that you clearly understand what this research is about and how you might be involved. Also, your participation is **entirely voluntary** and you are free to say no to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part now.

This study has been approved by the Health Research Ethics Committee of the Faculty of Health Sciences of the North-West University (NWU-00001-12-A1) and will be conducted according to the ethical guidelines and principles of Ethics in Health Research: Principles, Processes and Structures (DoH, 2015) and other international ethical guidelines applicable to this study. It might be necessary for the research ethics committee members or other relevant people to inspect the research records.

What is this research study all about?

You will know already from taking part in the screening phase of the study that heart disease and especially high blood pressure (or hypertension) is a big problem in South Africa. Also, many people are unaware of it, as it has no symptoms. High blood pressure is a very important risk factor which may result in heart disease, kidney disease and stroke. (*When blood stops flowing to the heart, this can cause a heart attack and part of the heart dies. A stroke is when there is a problem with the blood supply to the brain and a part of the brain is damaged.*) That is why many people in South Africa suffer from these diseases resulting in death.

Since heart disease is mostly seen in older people, the purpose of this study is to include and focus on young healthy people to understand how high blood pressure and heart disease develop. It is believed that our lifestyle (e.g. what we eat, drink, and do) may have an impact on whether we will develop high blood pressure and heart disease. Also, it is not well known whether there are perhaps certain measurements (e.g. in your blood or urine) that may predict whether you will develop heart disease when you are older.

The aim of this study is therefore to determine how high blood pressure and heart disease develop in a group of 1200 healthy young South Africans living in and around Potchefstroom, by tracking everyone over 5-20 years. It is therefore of great importance that we take detailed measurements of your lifestyle, and your current health (e.g. heart, blood vessels, eyes, blood and urine). These measurements will be made at the beginning of the study, but it will be most important to repeat these measurements in following visits every 5 years, to see how these health measurements have changed. We expect that some participants will remain healthy with normal blood pressures, and other will develop high blood pressure. Only by tracking the changes in blood pressures and other detailed measurements will be be able to understand the influences of e.g. lifestyle on changes in blood pressure.

If your results show that a certain measurement predicts that high blood pressure will develop later in life, this information could help doctors and nurses to prevent more people in the local community having strokes and heart attacks in the future.

Why have you been invited to participate?

Your screening tests show that you are healthy and suitable to take part in this study. You are also in the most important age group of 20 to 30 years. As we would like to follow you over time it is ideal that you have indicated that you intend to stay in or around or visit Potchefstroom for the next 5 years at least.

It will also be very important for us to be able to keep in touch with you. We kindly ask that you **tell us immediately about any changes of your contact details** (address, telephone number, email address etc.).

Once we have performed all of the measurements as described below, we will have a much better understanding of your health status. If we are not able to obtain important measurements (such as 24-hour blood pressure measurements, or if we are unable to obtain a blood sample, or if we detect a serious health abnormality), you will most likely not be able to take further part in the research project. Once we have completed the measurements, we will discuss your results with you and the way forward.

What will be expected of you?

The research team will make an appointment with you, and if necessary, transport will be provided to bring you to the Hypertension Clinic (Building F12) on the Potchefstroom Campus of the North-West University. Such an appointment will be made for early in the morning, as the measurements will start at approximately 08:00, and in total will take about 5 hours to complete.

To make sure that your results are valid and useful, it is important to take note of the following:

1. **The evening before – Do not eat or drink <u>anything except water</u> after 10pm** or before you come to the clinic in the morning.
2. **On the study day, please wear comfortable clothing** such as trousers and a top that can be easily removed for the tests (please avoid wearing skirts, dresses or tights as we will need to access your bare foot and put a blood pressure cuff around your thigh over your trousers).
3. **Please bring with you:**
    - All medication you currently are taking
    - Your ID document & clinic card/book

- Some good quality sunglasses to protect your eyes after the measurements

4. Let us know if transport should be arranged for you.

If you are happy to participate, we will ask you to sign this consent form stating that you are volunteering to participate in this study and that you understand all the procedures that will be performed. You are free to contact us with any questions should there be any uncertainty about any of the information provided. Then we will take the measures listed in the table below. Tests will be done in the Hypertension Clinic and we will provide you with a meal during the day. You will not be able to bath or shower for 24 hours after your clinic appointment due to the equipment you will be wearing when you leave the clinic.

WHAT TESTS WILL BE DONE?

- **Body composition:** we will measure your height, weight, waist, hip and neck circumference in a private room, while you are wearing your underwear. In another room, while you are clothed and lying down on a bed, we will also measure your body fat percentage by using a device that connects with sensors on your hand and on your foot. This is a completely painless procedure. (the measurements should take about 20 minutes to complete)
- **Biological samples:** early in the morning while you are lying down on a bed, a research nurse will take a blood sample from a vein in your arm by using standard clinical procedures.(10-20 min) We will also ask you to provide a urine sample in the morning, in a private restroom. At the end of the day, we will kindly request that you collect your urine over the next 24 hours (we will give you the containers and detailed instructions for this). These urine and blood samples will be used to test for genetic and a detailed range of biochemical markers (biomarkers) related to high blood pressure, heart disease and diabetes, such as glucose, cholesterol and markers of inflammation. You are more likely to have high blood pressure if one of your parents or a close family member has high blood pressure. This is because high blood pressure can be caused by differences in our genes. Our genes are like a very complicated "manual" in each of our cells that tells the body how to work properly. When there are changes in the genes, it changes the "manual" and the body then does not work as well as it should for example causing high blood pressure. We share our genes with our family because half of the gene "manual" comes from your mother and half from your father. Therefore, if they have high blood pressure due to differences in their genes then it is likely that you will get the same changes in your genes and develop high blood pressure. We would like to find out what these differences are in order to better understand how they cause high blood pressure so that we can find ways to stop it happening.
  Take note that some of your samples may be stored for many years in freezers before we will analyse the samples. We may also need to ship some of your to other local or international expert laboratories for analyses.
- **Blood pressure:** while you are sitting down in a private room, we will measure blood pressure twice on both arms, by placing a cuff around your upper arm. (20 min) Another blood pressure measurement will also be done by placing a small blood pressure cuff around your finger, and upper arm, while you are lying on a bed. We will then test your blood pressure responses when you do a colour word reading test and when you place your hand in cold water for 1 minute. (30 min) At the end of the measurement day, we will fit a portable blood pressure monitor to you which will assess your blood pressure over the next 24 hours, thus over a day and when you are sleeping at night. It is important that the device is not removed during this time to ensure a reliable measurement.
- **Blood vessel & heart health:** in a private room we will again ask you to lie down comfortably on a bed. We will first test your blood pressure at your upper arm, with a device that will also measure the blood pressure at your heart. We will then test how stiff your blood vessels are by using a small pen-like device rested on your neck to register the pulse in your neck on a computer. At the same time another blood pressure cuff will be placed around your thigh. (15 min) Afterwards, in a

semi-dark room we will use a sonar device (usually used during pregnancy) to take some sonar pictures and video clips of the blood vessels in your neck and of your heart on the bare chest. We will provide a blanket or gown for cover. (20 min)

- **ECG** (Electrocardiography test) **for heart health:** while you are lying down on a bed in a private room, we will test the natural electrical activity of your heart by placing several stickers with sensors on your chest. We will take care to ensure your privacy. (10 min)
- **Eye Pressure:** a research nurse will put some eye drops in both eyes and then she will measure the pressure in your eyes with a device that rests lightly on your eye. (10 min) This test will inform us whether you have a condition called glaucoma, which means that the pressure within your eyes are quite high. If so, we will advise you and refer you for necessary treatment. If the pressure is normal, we will continue with the next eye test as described below.
- **Testing the small vessels of the eye:** a research nurse will put an eye drop in one eye, and a researcher will ask you to look into a special camera, named a fundoscope. This is the same device used by ophthalmologists (eye doctors). This camera will shine a light into your eye and we will take some pictures of the small blood vessels at the back of your eye (there will be a camera-like flash). We will also check how well your small blood vessels respond to light flickering, by doing a light-flicker test with this special camera. (20-30 min)
- **Physical activity:** at the end of the measurement day, a researcher will place a small monitor on your chest that will record your activity and movement levels for 7 days. No pain or discomfort is associated with this device, and you are kindly requested not to remove the device before the 7 day measurements were completed.
- **HIV test:** As this test was done during the screening phase, we will not test again for HIV. However, with each follow-up visit every 5 years, will would like to perform this test again.
- **Questionnaires:** during the course of the morning, you will be asked to complete several questionnaires with the help of a researcher. These include a general health questionnaires (with questions about your age, family history of disease, education, occupation, lifestyle habits, 15 min), Berlin sleep questionnaire (asking questions about how well you sleep, 5 min), physical activity questionnaire (to report on how active your lifestyle is, 5 min), dietary questionnaire (with the help of a dietician you will be asked what you ate during the past day (30 min). Within the next week the dietician will contact you again on two occasions to complete the questionnaire again. This should give us the best reflection on your eating habits). Finally, a trained psychologist will help you to complete a number of questionnaires on your personal well-being (including questions on stress and how well you cope with stress , 30-45 min).

Will you gain anything from taking part in this research?

- You will receive direct feedback during each advanced measurement on your health status. All of these advanced clinic tests are provided to you at no cost (worth ±R3 000).
- Should any abnormalities be detected, we will refer you to doctors, clinics or hospitals for further tests or treatment and the test results may assist your doctor in making decisions about further treatment.
- Apart from this personal benefit, your research data will help biomedical health researchers to gain a better understanding on how high blood pressure and heart disease develops, and may help us to develop better programmes to prevent or treat these diseases in our community and elsewhere. The data may also be used to advise the Ministry of Health on changes to the health system that may benefit the broader South Africa.

Are there risks involved in you taking part in this research and what will be done to prevent them?

To help you with a better understanding of the potential risks, and what we are doing to prevent these, please refer to the table below:

Risks	Precautions
• Taking a blood sample at a vein in the upper arm, may cause some pain and discomfort;	• A trained registered research nurse perform all blood sampling and regularly undergo training on clinical measurements.
• Applying an eye drop may cause a slight burning sensation; • Performing the eye pressure test is slightly uncomfortable; • Performing a light flicker test may also be slightly uncomfortable. • After the eye measurement some discomfort may be experienced (similar to a visit to an eye doctor) while waiting for the pupil to constrict.	• She also performs the eye pressure test and apply the eye drop. To ensure correct procedures and minimum participant discomfort she has undergone training at an eye doctor to ensure that she use the safest techniques to make the measurement quickly and correctly. The light flicker test may cause discomfort but the researcher is highly experienced and ensures that the measurement is done quickly and accurately. It does not cause any long term harm and is comparable to standard eye doctor measures. Afterwards, when the pupil is dilated, the eye is sensitive to light. Therefore an eye patch is provided and all lights of the clinic turned off when these assessments start (at the end of the day's measurements). You are also encouraged to bring sunglasses for when you leave the clinic. We also provide transport to you after we are finished as you are not encouraged to drive if your eye has not yet returned to normal.
• Placing the hand in an ice water bucket for 1 minute may cause some pain in your hand.	• Placing the hand in ice water causes some pain due to the very cold water. The time is only for 1 minute to reduce discomfort to a minimum, and a small electric blanket or hot water bottle is provided afterwards to heat up the hand and ensure comfort.
• You may experience some discomfort when having to undress for the body measurements or heart sonar measurements.	• All measurements are done in private temperature controlled rooms. For sensitive measurements a female scientist is trained to perform measurements to ensure especially comfort of female participants. All staff are also trained in these aspects to be highly professional and discreet and to ensure maximum comfort and to avoid any embarrassment. For heart sonars, an expert clinical technologist has vast experience in performing the sonars in a semi-dark room and also provides a blanket should you require this.
• When you complete the psychological questionnaires you may feel uncomfortable when giving personal information, such as feeling depressed or stressed.	• For psychological questionnaires a psychologist is well trained to complete the questionnaires in a private area. All necessary aspects are adhered to to make sure it is done in a professional and comfortable manner. If any abnormality is detected, the psychologist informs the research nurse, who will then privately discuss the results with you.
• All health measurements may cause some anxiety when you are worried about the results of the tests.	• For other health measurments, such blood pressure, the results may be stressful. We will therfore provide you with the information privately and if we note something abnormal, we will ensure that you are referred appropriately for further tests or treatment.
• If a health abnormality is identified, others may become aware of this private information, e.g. diabetes.	• If any health abnormalities was identified, you will meet individually with the research nurse in a private room for a feedback session. She will explain your results to you and provide you with a letter of referral for further testing or treatment. This will also be placed in a

• As measurements take place during the working week you my suffer from a loss of income, or may get into trouble for not being at work due to time spent in the project.	sealed envelope. • If you will lose wages due to your participation in the study, you need to inform the research nurse, who will make sure that communication is taken up with your employer. We will normally discuss your participation with your employer beforehand to make sure there won't be any loss in income. Once your employer agrees that you can attend the study during normal working hours without having to take leave or lose any wages, you can join the study.

There are more gains for you in joining this study than there are risks.

How will we protect your confidentiality and who will see your findings?

Anonymity of your findings will be protected by all of the researchers involved. A number, and not your name, will be assigned to your research results, and all scientists using your data will only note this number, and not your name. Your privacy will be respected by making sure that all the measurements are taken in private rooms and performed by well-trained scientists. Your results will be kept confidential by storing hard copies of your documentation in a locked cupboard within the Hypertension Clinic, and only the Principal Investigator, Head of the Hypertension Clinic and Data Manager having direct access. Electronic files with data are stored and handled by the Data Manager in a password protected online database using the University web-network (with firewall and security features), as well as some backup files on external password protected harddrives. Only the researchers, their postgraduate students and local and international collaborators will be able to look at your findings – however, all findings will be anonymised using your unique participant number. As this is a long term project, your data will be stored for 20 years or longer.

What will happen with the findings or samples?

As indicated above, your research results are safely stored on electronic files, with some results on hard copies, and in the form of blood or urine samples in biofreezers. We will store your data and your blood and urine samples for at least 30 years. Over time the research team will make sure that all of this information is analysed in the utmost detail to create new knowledge on how high blood pressure, heart disease, and related diseases develop over time. It is important to store the data and samples for a long period, as new scientific discoveries on markers of high blood pressure will be made by other scientists or ourselves in the future. It will then allow us to test if these markers are also useful in your (the South African) samples, and whether these can be used throughout South Africa in the future.

Some of your biological samples (from urine and blood) will be analysed immediately, but others will be stored for many years before analyses are performed. Please note that we will perform the biochemical analyses in our laboratories on the Potchefstroom Campus. But we may need to ship some of your samples to other laboratories in South Africa or internationally, when we do not have the funds, skills or the equipment to perform the analyses locally. Samples will be shipped using courier services approved for handling biological samples, to ensure the safekeeping and protection of the samples during transit. We will also ensure that the appropriate approvals from the South African Department of Health (export permit) and the Health Research Ethics Committee are obtained prior to shipping the samples.

Apart from your samples, your anonymised data may also be shared with other national or international collaborators. It is therefore possible that your anonymised results will be reported as stand alone data as part of the African-PREDICT study, or your data may be pooled into other datasets from the province, country or

globally in further research studies on high blood pressure and related health status. Your data will therefore be used to analyse your original state of blood pressure and health – in South Africa and in comparison to other local and international populations – and to analyse how your health status changes over time.

If we were to share your anonymised data or samples with external groups, the external groups will sign confidentiality and data or material transfer agreements with us. This process is overseen by the Legal Services of the North-West University. This will ensure that your information is adequately handled and protected, and that your data is only used for the intended purpose as described in the agreement.

It is also possible that your data may be useful for other purposes apart from the aim of the present study. When the data is to be used for such purposes, new applications will be submitted to the Health Research Ethics Committee, where the Committee will stand in on your behalf.

Findings from the study will be published in scientific journals, and discussed locally and internationally with scientific experts and the Department of Health.

How will you know about the results of this research?

During the course of the day you will receive direct feedback from each research station on your health status and findings. As described earlier, if any abnormalities are detected, a detailed report within a referral letter will be compiled by the research nurse and you will be directed to the appropriate healthcare provider. If at any stage (also after you have visited the clinic) you wish to know any of your research results, you are welcome to contact the researchers at the Hypertension Clinic.

The research team also intends to publish the research findings of the larger study in scientific literature, but also in local media, and perhaps also national media. This will not include you as an individual, but the collective findings of all the research participants. Furthermore, as this is a longitudinal study, the research team may provide you with further results of the study when you return to the clinic during follow-up measurements. As the research team will contact you annually to ensure that your contact details are still correct, we will inform you if any important research findings became apparent that you need to take note of.

Will you be paid to take part in this study and are there any costs for you?

No, you will not be paid to take part in the study, but the research team will provide you with a R50 gift voucher as a token of appreciation for your participation. We hope that the results of the measurements will be useful to you to understand your own health status.

We will provide transport to all participants, and a meal will be served during the course of the morning after you have given a blood sample.

There will thus be no costs involved for you, if you do take part in this study.

To cover all of the research expenses, this study is funded by several local and international funding bodies, including the Department of Science and Technology (National Research Foundation), Medical Research Council of South Africa and the Medical Research Council of the United Kingdom, as well as scientific grants from industry (GlaxoSmithKline, Pfizer, Boehringer-Ingelheidm, Medi-Clinic Hospital Group).

Note* What happens after the study day?

At the end of the study, you may have one eye covered so it is advisable not to drive until you see that your eye has recovered, due to a possible loss of depth perception. You will know that the eye is fully recovered when the black part of the treated eye (pupil) has been reduced to a similar size as the pupil of the untreated eye. In the week following the study day, we will make **three short appointments** with you to collect the blood

pressure monitor, your urine collection and the activity monitor and to do two more short interviews (20-30 minutes) about your diet. We will give you a diary sheet so you can keep track of these appointments and they will be arranged to suit your schedule.

Is there anything else that you should know or do?

- You can contact Sr. Adele Burger (or Prof. Alta Schutte) at 018 285 2261/2446 if you have any further questions or have any problems.
- You can also contact the Health Research Ethics Committee via Mrs Carolien van Zyl at 018 299 1206 or carolien.vanzyl@nwu.ac.za if you have any concerns that were not answered about the research or if you have complaints about the research.
- You will receive a copy of this information and consent form for your own purposes.

Address: Building F11, Potchefstroom Campus, North-West University, Potchefstroom 2520
Tel: 018-285 2261 (Office hours Mon-Fri) Fax: 018-285 2260; Email:adele.burger@nwu.ac.za

Declaration by participant

By signing below, I ..... agree to take part in the research study titled: The African Prospective study on the Early Detection and Identification of Cardiovascular disease and Hypertension (African-PREDICT).

I declare that:

- I have read this information/it was explained to me by a trusted person in a language with which I am fluent and comfortable.
- The research was clearly explained to me.
- I have had a chance to ask questions to both the person getting the consent from me, as well as the researcher and all my questions have been answered.
- I understand that taking part in this study is **voluntary** and I have not been pressurised to take part.
- I may choose to leave the study at any time and will not be handled in a negative way if I do so.
- I may be asked to leave the study before it has finished, if the researcher feels it is in the best interest, or if I do not follow the study plan, as agreed to.

I agree that my blood or urine samples may be sent to laboratories in South Africa or in other countries for analyses (with my personal details removed, and only identifiable by an anonymous number).	**Yes**	**No**

Signed at (*place*) ..... on (*date*) ..... 20....

_____ _____

Signature of participant **Signature of witness**

Declaration by person obtaining consent

I *(name)* ..... declare that:

- I clearly and in detail explained the information in this document to .....
- I did not use an interpreter.
- I encouraged him/her to ask questions and took adequate time to answer them.
- I am satisfied that he/she adequately understands all aspects of the research, as discussed above.
- I gave him/her time to discuss it with others if he/she wished to do so.

Signed at (*place*) ..... on (*date*) ..... 20....

_____ _____

Signature of person obtaining consent **Signature of witness**

Declaration by researcher

I, *Aletta E.Schutte*, declare that:

- I explained the information in this document to the Head of the Hypertension Clinic, Head of Screening, and research assistants.
- I did not use an interpreter.
- I encouraged them to ask questions and took adequate time to answer them.

And that I was available should they want to ask any further questions.

- The informed consent was obtained by an independent person.
- I am satisfied that she adequately understands all aspects of the research, as described above.
- I am satisfied that she had time to discuss it with others if she wished to do so.

Signed at (*place*) ..... on (*date*) ..... 20....

_____	_____
Signature of researcher	**Signature of witness**

APPENDIX F 24-HOUR DIETARY RECALL QUESTIONNAIRE

Interview number:

1. Subject ID:

0	**0**	-				

2. Today's date:

2	**0**								

3. 24-hour recall completed by:

4. Name of participant:

5. Gender: Male ☐ Female ☐

6. What day was yesterday? (tick correct one x)

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday

7. Would you describe the food that you ate yesterday as typical of your usual food intake?

Yes	1	No	2

Greetings!

Thank you for giving up your time to participate in this study. I hope you are enjoying it so far. Here we want to find out what people living in this area eat and drink. This information is important to know as it will tell us if people are eating enough and if they are healthy.

There is no right or wrong answers.

Everything you tell me is confidential. Only your subject number appears on the form.

Is there anything you want to ask now?

Are you willing to go on with the questions?

I want to first ask you a few general questions about your food intake, the preparation of food and the type of food that you use in your home.

Instruction

Circle the subject's answer.

8. **What type of pot do you usually use to prepare food in? (may answer more than one)**

Iron pot	☐ **1**
Stainless steel pot	☐ **2**
Aluminum pot	☐ **3**
Glass ware	☐ **4**
Other (specify)	☐ **5**

9. **Do you eat maize meal porridge?** Yes ☐ **1** No ☐ **2**

If YES, what type do you have at home now?

Brand name:

Don't know: **2**

Grind self: **3**

If brand name is given, do you usually use this brand? Yes ☐ **1** No ☐ **2** Don't know ☐ **3**

Where do you get your maize meal from? (May answer more than one)

Shop	☐ **1**
Employer	☐ **2**
Harvest and grind self	☐ **3**
	☐

Other (specify) **4**

Don't know ☐ **5**

10. Do you eat fat/margarine or use it in the preparation of food?

Yes **1** No **2**

If YES, what type do you have at home now?

Brand name:

Don't know: 2

If brand name is given, do you usually use this brand? Yes **1** No **2** Don't know **3**

11. Do you use oil in the preparation of food? Yes **1** No **2**

If YES, what type do you have at home now?

Brand name:

Don't know: **2**

If brand name is given, do you usually use this brand? Yes **1** No **2** Don't know **3**

What type of oil do you buy for deep frying?

Brand name:

Do you use the same oil more than once? Yes **1** No **2**

If YES, how many times will you use the same oil?

12. What type of salt do you use?

Give brand names:

13. Do you use any of the following?

	Name of product	**Amount per day**
Vitamins/vitamins and minerals		
Tonics		
Health foods		
Body building preparations		
Dietary fiber supplement		
Other: Specify		

I want to find out about everything you ate or drank yesterday, including water or food you pick from the veld. Please tell me everything you ate from the time you woke up yesterday up to the time you went to sleep. I will also ask you where you ate the food and how much you ate.

To help you to describe the amount of food you eat, I will show you pictures and examples of different amounts of the food. please say which picture or example is the closest to the amount you eat, or if it is smaller, between the sizes or bigger than the pictures.

	Time	Place eaten	What food or drink were consumed	How was it prepared? What was added?	Brand name	How much was eaten	Weight equivalent	Food code
Waking up to about 09:00 (breakfast time)								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
Midmorning (09:00-12:00)								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

	Time	Place eaten	What food or drink were consumed	How was it prepared? What was added?	Brand name	How much was eaten	Weight equivalent	Food code
Lunch time (12:00-14:00)								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
Afternoon (14:00-17:00)								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

	Time	Place eaten	What food or drink were consumed	How was it prepared? What was added?	Brand name	How much was eaten	Weight equivalent	Food code
Supper time (17:00-20:00)								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
After supper, at bedtime and through the night								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

APPENDIX G SOCIOECONOMIC STATUS QUESTIONNAIRE

Classification system for Socio-Economic status

Categories (Total 30)

1. Skill level (10 points)
2. Education (10 points)
3. Household income (10 points)

Levels of SES according to above scoring:

- Level 1 (lowest) = Score of 5-18
- Level 2 (middle) = Score of 19-24
- Level 3 (upper) = Score of 25-30

Category 1 – Skill level

- Legislators, senior officials and managers Reference in skill level has not been made 4
- Professionals 4
- Technicians and associate professionals 3
- Clerks 2
- Service workers and shop and market sales workers 2
- Skilled agriculture and fishery workers 2
- Craft and related trades workers 2
- Plant and machinery operators and assemblers 2
- Elementary occupations 1
- Armed forces, occupations unspecified and not elsewhere classified and not economically active persons

Reference in skill level has not been made (1)

Skill level

- 4.5 = 10 points
- 3 = 8 points
- 2 = 5 points
- 1 = 3 points

Category 2 – Education

- University/College/Other tertiary institution = 10
- High School = 8
- ABET = 5
- Primary School = 3
- None = 0

Category 3 – Household income

- >R20 000 = 10
- R10 000-R20 000 = 8

- R5 000-R9 999 = 6
- R1 000-R4 999 = 4
- <R1 000 = 2

Adapted from Kuppuswamy's Socioeconomic Status Scale 2010 *Indian J Pediatr* 2012, 79:395-396.

Isaiah 41:10

“Don’t be afraid, for I am with you. Don’t be discouraged, for I am your God. I will strengthen you and help you. I will hold you up with my victorious right hand.”