THE MOTIVES AND CHALLENGES FACING SOUTH AFRICAN VEGANS AND THE NUTRITIONAL QUALITY OF THEIR DIET

By

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ABSTRACT

Introduction: A vegan diet is a voluntarily chosen plant-based diet that excludes all meat and animal products and includes wholegrains and legumes, fruit and vegetables, nuts and seeds and healthy fats. There are many different motives that influence an individual to become vegan including ethical motives, environmental motives and health motives. Internationally, many studies have been conducted to investigate these motives along with the nutritional intake and quality of the vegan diet. This diet is also becoming increasingly popular in South Africa, yet there is a paucity of studies that have been conducted to determine what motivates South Africans to follow this diet, what challenges they face while following the diet and what the nutritional quality of their diet is.

Aim: To determine the motives of South African vegans, challenges faced and the nutritional quality of the South African vegan diet.

Objectives: To determine the demographic characteristics of South African vegans; the motives that influenced the decision to become a vegan; challenges associated with following a vegan diet and how these challenges are overcome; and to determine the nutritional quality of dietary intake compared to recommendations (EARs) consumed and identify the variety of food groups and types of processed food in the vegan diet.

Methods: A cross-sectional study in the form of an online questionnaire was conducted using South African vegans who were part of the South African Vegan Society online group on Facebook. The questionnaire consisted of four sections. Section one obtained information regarding the demographics of South African vegans. Section two obtained information on the main motives for following a vegan diet. Section three obtained information on the challenges experienced while following a vegan diet and how these challenges were overcome. Section four obtained information on the nutritional quality of the vegan diet which included a vegan-specific Food Frequency Questionnaire (FFQ) with 291 food items and one 24-hour recall.

Results: The first two sections of the online questionnaire were completed by 205 respondents, of which 82.4% (n = 169) were female and 17.6% (n = 36) were male. The respondents were predominately White (82.4%, n = 169), resided in the Gauteng province (43.9%, n = 90), were more likely to be single (53.2%, n = 109) and belonged to the 18-29 (29.3%, n = 60) and 40-49 age category (22.0%, n = 45). Most of the respondents had followed a vegan diet for one to less than three years (38.5%, n = 79). A significant number of respondents did not engage in smoking (83.9%, n = 172) but did consume alcoholic beverages less than once a week (60.0%,

n = 123) ($p<0.0005$). Most of the respondents participated in varying amounts and intensities of physical activity (84.9%, n = 174) and made use of nutritional supplements (72.7%, n = 149). There was a significant agreement that ethical concern for animals ($p<0.0005$); followed by protecting the environment ($p < 0.0005$); and the effect of animal product consumption on climate change ($p < 0.0005$) were the main motivating factors for choosing to become a vegan. Most of the respondents reported that their initial motivation to become a vegan had not changed (71%, n = 146) and there was a significant agreement that experimenting with food assisted the respondents during their transition into the vegan diet ($p < 0.0005$).

Section three of the questionnaire was completed by 197 respondents. Over one third of the respondents reported that it was "easy" to transition into the diet (35.1%, n = 72) and their initial emotions were enthusiasm and excitement (29.3%, n = 60). A significant number of respondents reported that they did not experience any financial challenges following the diet (74.6%, n = 176) and that their main challenge was finding vegan meal options in a restaurant ($p < 0.0005$). The respondents in this study overcame any challenges by conducting research on the internet and agreed that vegan recipes were easily accessible ($p < 0.0005$). The respondents significantly agreed that a vegan diet was nutritionally complete and adequate for a healthy lifestyle ($p < 0.0005$).

The FFQ was completed by 113 respondents. Respondents consumed a wide variety of fruit; most often bananas (22.4%, n = 46) at least once a day, leafy-vegetables- most often cooked spinach (24.9%, n = 51) at least once a week, non-leafy vegetables- most often cooked broccoli (36.1%, n = 76) at least once a week. The starches most often consumed were whole-wheat bread (18.0%, n = 37) once a week, grains and cereals- most often white or brown basmati rice (20.0%, n = 41) once a month, peas and beans- most often chickpeas (32.2%, n = 66) at least once a week, fats- most often olive oil (20.5%, n = 42) at least once a day, snacks- most often potato chips (19.0%, n = 39) at least once a month. Desserts most often consumed were egg-less cake (17.1%, n = 35) at least once a month, sweeteners- most often brown sugar (17.1%, n = 35) at least once a day and beverages- coffee decaffeinated or regular (29.3%, n = 60) at least once a day. The most commonly consumed plant-based milk alternative and meat alternative was soy milk (21.0%, n = 43) consumed at least once a day and soya products (28.8%, n = 59) at least once a week respectively.

The 24-hour recall was completed by 134 respondents. The mean total energy of the respondents was 7471.15 kJ (SD = 3093.39). Males had a mean total energy of 7893.76 kJ (SD = 3415.37) and females had a mean total energy of 7374.22 kJ (SD = 3023.43).

All respondents met the estimated average requirement (EAR) for protein (56 g for males and 46 g for females), carbohydrates (130 g) and the percentage of total energy for fat (10 - 35%). The respondents mean intake for protein was 74.73 g (SD = 52.28), carbohydrates 190.40 g (SD = 190.40) and fat 62.34 g (SD = 62.34), which contributed 18.5%, 47.36% and 33.7% respectively, of total energy in the diet. Females consumed significantly greater amounts of added sugar than males (M = 20.51 g) vs (M = 13.18 g). Both gender categories met their EARs for fibre, iron, vitamin C, vitamin B6, vitamin A, thiamine, riboflavin, folate and vitamin K. The respondents had a decreased intake of cholesterol, saturated fat and mono-unsaturated fatty acids and higher intakes of poly-unsaturated fatty acids. Females met their EARs for zinc and niacin, 9.02 mg and 15.32 mg respectively, while males were below their EAR, consuming 9.8 mg and 15.59 mg respectively. Males met their EAR for vitamin E consuming 20.32 mg, while females were below their EAR, consuming 13.56 mg of vitamin E. The respondents were shown to be lacking in calcium, sodium, vitamin D and vitamin B12.

Conclusion: This study revealed that although veganism is widespread in South Africa, White females living in Gauteng were more likely to be following this lifestyle and be members of the South African Vegan Society online group on Facebook. Their main motive for following the diet was preventing cruelty towards animals and protecting the environment and its resources. This suggests that South African vegans are concerned about animal rights and the environment and their knowledge about veganism should be further investigated. The main challenge faced by the respondents was finding vegan options in restaurants. Therefore, restaurants that are vegan-specific or have vegan options available are recommended to list their restaurants online and upload their menus to assist vegans, as the internet was commonly used for research among this group. Major retail supermarkets are recommended to increase their stock and variety of options of vegan products especially plant-based milk and meat alternatives as these products are widely consumed. Research has shown that the vegan diet is linked to many potential health benefits, yet there is concern regarding whether the diet leads to nutrient deficiencies over time.

As veganism is growing in South Africa, this study highlights the need for fortified food products and nutritional supplements to reduce nutrient deficiencies in the vegan diet.

Longitudinal studies will also assist in examining trends and sustainability of a vegan diet in South Africa as well as determine whether nutrient deficiencies develop over time.

PREFACE

The work described in this dissertation was carried out in the School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, from July 2018 to April 2020, under the supervision of Dr Nicola Wiles.

Signed: Sansha Kohidh Date: 22 September 2020

As supervisor of this candidate, I agree to the submission of this dissertation.

Signed: Date: 22 September 2020

Dr Nicola Wiles (Supervisor)

DECLARATION OF ORIGINALITY

I, Sansha Kohidh, hereby declare that:

i. The research reported in this dissertation, except where otherwise indicated, is my original research.

ii. This dissertation has not been submitted for any degree or examination at any other university.

iii. This dissertation does not contain other persons' data, pictures, graphs or other information unless specifically acknowledged as being sourced from those persons.

iv. The dissertation does not contain other authors' writing unless specifically acknowledged as being sourced from other authors. Where other written sources have been quoted, then:

a. Their words have been rewritten but the general information attributed to them has been referenced;

b. Where their exact words have been used, their writing has been placed inside quotation marks, and referenced.

c. This dissertation does not contain text, graphics or tables copied and pasted from the Internet, unless specifically acknowledged, and the source being detailed in the dissertation and in the Reference section.

Signed: ……. Date: 22 September 2020

Sansha Kohidh (candidate)

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CHAPTER 1: INTRODUCTION, THE PROBLEM AND ITS SETTINGS

1.1 The importance of the study

Vegans are a sub-group of the population who voluntarily decide to follow a diet that excludes meat and animal products. They are also labelled as "strict vegetarians" (Kerschke-Risch 2015). Foods that are consumed in a vegan diet are mainly plant-based and have documented health benefits. These foods include vegetables, fruit, wholegrains, nuts and seeds, legumes and healthy fats (Key, Appleby & Rosell 2006; Spencer, Appleby, Davey & Key 2002). These health benefits include lowering blood pressure (Pettersen, Anousheh, Fan, Jaceldo-Siegl & Fraser 2012) and cholesterol levels (Bradbury, Crowe, Appleby, Schmidt, Travis & Key 2014), a reduced cardiovascular disease risk (Satija & Hu 2018) and preventing diabetes (Tonstad, Stewart, Oda, Batech, Herring & Fraser 2013).

American researchers Dyett, Sabate´, Haddad, Rajaram, & Shavlik (2013) noted that individuals who follow a vegan diet may decide to do so for various reasons, and this in turn affects their food and lifestyle decisions. These reasons can include a concern for the: environment, health reasons, ethics surrounding animal rights, sensory aversion to animal meat and influence from others. Qualitative and quantitative research revealed that the most common reasons for following a vegan diet were ethical and health reasons (Dyett, Sabaté, Haddad, Rajaram & Shavlik 2013, Ruby 2012). Interestingly, "ethical motivated vegans" continued with the diet significantly longer than "health motivated vegans" (Radnitz *et al* 2015, Hoffman, Stallings, Bessinger, & Brooks 2013).

Even though foods included in a vegan diet are mainly plant-based, it does not require the individual to consume only whole foods or restrict the intake of refined sugar and fat (Tuso, Ismail, Ha & Bartolotto (2013). An American qualitative study that interviewed self-defined ethical motivated vegans, found that when a vegan diet is followed it is not necessarily a health-based decision (Greenebaum 2012). Many vegans consume processed foods in the form of vegan alternatives for dairy, cheese and meat. Hence, an individual who consumes meat products in moderation can still be considered "healthy" whereas a vegan who consumes mostly processed "junk" food can be considered "unhealthy". This calls into question whether the health benefits of following a vegan diet result from the elimination of meat products, or from a general concern for one's health that results in the selection of nutritious food and being involved in other health-promoting activities such as regular physical activity (Radnitz *et al* 2015).

At the time of this study, there were over 10,000 vegan recipe books available for sale on the Amazon website (Amazon 2019). Most of these books mainly addressed vegan health, fitness and lifestyle issues (as evident in most titles) and hence did not address the original ethical and political motives of vegans. This suggests that the books target a broader spectrum of individuals. This indicates a change of image from a theory-based vegan to following a vegan-based lifestyle (Kerschke-Risch 2015). Theory-based vegans use information from research to drive their actions in society, expand their knowledge and understand the deeper meanings of veganism (Frawley 2017).

Moreover, in recent years, many exclusively vegan supermarkets and retail stores have opened internationally. This shows a correspondingly greater and economically attractive consumer population for vegan products (Kerschke-Risch 2015), as vegans follow a lifestyle avoiding the use of products associated with animal cruelty and are not just following a predominantly plant-based diet. Although individuals who are following a vegan diet signify only a minor portion of the population, there is a reason to believe that their general consumption trends will influence and develop the food segment (Radnitz *et al* 2015). While there is an increase in international research on veganism and vegan diets, there is yet to be a study completed on the vegan diet in South Africa. At the time of data collection (August 2019), The South African Vegan Society (SAVS) Facebook page had over 9 819 members.

South African vegan-specific restaurants are on the rise, while other popular restaurants are adding vegan options to their menus. Major retail stores around the country are adding more variation of vegan food products to their shelves. The launch of *The Vegan Life* magazine in South Africa by Media24 in 2017 and 163 vegan published books by South African authors available locally (Amazon 2020) shows that there is a growing interest in vegan diets in South Africa. This may be due to greater awareness of animal abuse, research on the health benefits of vegan diets and an increase in the accessibility of dairy and meat alternatives.

The following questions therefore arise:

- What are the demographic characteristics of South African vegans?
- What motivates South Africans to follow a vegan diet?
- What are the challenges that South African vegans face and how are these challenges addressed?
- Is the diet of South African vegans nutritionally diverse?

- Which food items are most frequently consumed in the diet of South African vegans?
- Do South African vegans reach their daily nutritional requirements while consuming this diet?

1.2 Statement of the problem

To determine the motives and challenges faced by South African vegans and the nutritional quality of their diet.

1.3 Research objectives

The objectives of the study are as follows:

1.3.1 To determine the demographic characteristics of South Africa vegans.

1.3.2 To determine the motives for following a vegan diet.

1.3.3 To determine the challenges associated with following a vegan diet and how these challenges are overcome.

1.3.4 To determine the nutritional quality of dietary intake compared to recommendations (EARs) and to identify the variety of food groups and types of processed food consumed in the vegan diet.

1.4 Hypotheses

The following hypotheses were proposed:

1.4.1 Females with a higher level of education would be more likely to follow a vegan diet.

1.4.2 Ethical reasons would be the main motive for becoming a vegan.

1.4.3 The main challenge that South African vegans face would be to find suitable vegan menu items when eating out.

1.4.4 South African vegans would not meet their estimated average requirement (EAR) for vitamin B12, vitamin D and calcium.

1.5 Inclusion and exclusion criteria

The following respondents were included:

- South African citizens who were currently living in South Africa at the time of data collection.
- Able to access Facebook and complete an online survey.
- Practising a vegan diet for at least 6 months.
- From both male and female gender groups.
- From all South African race groups.

- From all age groups.
- Provided informed consent to participate in the study.

Respondents were excluded if they were:

- Non-vegan or partially vegan.
- South African citizens currently living outside of South Africa.

1.6 Definition of terms

24-hour recall:	A method of dietary assessment that involves respondents being requested to provide estimates of their complete food and beverage intake, during the previous 24 hours or through a midnight to midnight time period (Gibson 2005).
Added sugar:	Sugar which is naturally present in syrups and honey and added to foods during manufacturing or by the consumer (Kaartinen, Similä, Kanerva, Valsta, Harald & Männistö 2017).
Body mass index:	The metric currently used for defining anthropometric characteristics of height and weight in adults. The index is calculated using body weight (kilograms) divided by height (meters) squared (Nuttall 2015).
Challenges:	For the purpose of this study a challenge is a character or nature that serves as a call to make a special effort, a demand to explain, justify or a difficulty in an undertaking a particular situation (Gamez-Gutierrez & Saiz-Alvarez 2019).
Cross-sectional study:	A study that is conducted at one point or completed in a short period of time. This study is generally conducted to estimate the prevalence of the outcome of interest for the population under study (Levin 2006).

Demographic characteristics:	Demographic characteristics include qualities such as age, sex, family status, education level, income, occupation and race (Shimasaki 2014).
Environmentally motivated vegans:	Vegans that are motivated to follow the diet because of concerns for the environment such as pollution caused by animal farming and land degradation caused by animal grazing (Fox & Ward 2008).
Ethical motivated vegans:	Vegans who centre their nutritional choices on concerns surrounding animal care including the use of growth stimulants and antibiotic use in animals (Craig 2009).
Food Frequency Questionnaire:	A questionnaire which presents a list of food items, which a respondent has to specify how frequently each food item is consumed, such as how many times per day, per week or per month. It should be noted that the foods included in the questionnaire are usually chosen for a specific purpose and may not assess the total diet of the respondent (Margetts & Nelson 1997).
Health motivated vegans:	Vegans who are motivated to follow the diet because of the health benefits associated with consuming a diet which is free of animal meat and milk (Howie 2018).
Nutritional quality:	This describes the health or biological value of different produce including taste, shelf-life, freshness and fragrance, ratio of beneficial to harmful substances as well as the risk of pathogenic contamination. These important quality characteristics govern consumer behaviour (Köpke, Krämer & Leifert 2007).
Nutrition transition:	This occurs when

	populations implement a more contemporary lifestyle during acculturation, urbanisation and social and economic development which includes modifications in dietary patterns and intake of nutrients (Vorster 2002).
Omnivorous diet:	For the purpose of this study, an omnivorous diet consists of food from both plant and animal origin (Zhang, Wang, Chen, Wei, Li, Zhao & Lu 2014).
Plant-based diet:	A diet that encourages whole grains, nuts and seeds, vegetables and fruit while limiting the intake of animal foods, oils and processed food. This diet is usually low in fat (Dinu, Abbate, Gensini, Casini & Sofi 2017; Tuso *et al* (2013).
Polyphenol:	A compound comprised of an extensive variety of molecules, and are generally divided into non-flavonoids and flavonoids. Flavonoids can be found in fruit and vegetables and identified in beverages that are plant-derived such as tea and wine (Daglia 2012).
Processed food:	Any foods other than raw agricultural commodities and these foods can be classified by the extent of changes which occurred in foods as a result of processing (Poti, Mendez, Ng & Popkin 2015).
Reliability:	Is the accurateness of a measure. The degree to which an apparatus will consistently have the same outcome if it is used on repetitive occasions during the same condition (Heale & Twycross 2015).
Restrictive diet:	Dietary patterns that restrict high energy consumption and increases the intake of healthful

	diet components (fruits, vegetables, whole grains, and low-fat dairy) and decreases components of an unhealthy diet ("empty calories" and saturated fat) for health benefits (Boutté, Turner-McGrievy, Wilcox, Hutto, Muth & Hoover 2018).
Supplements:	Supplements can be defined as "a form of complementary and alternative medicine that include amino acids, biological/animal extracts, herbals, minerals, and vitamins" (Smolinske 2017).
Validity:	The degree to which an idea or concept is precisely measured in a quantitative study (Heale & Twycross 2015).
Vegan:	An individual who follows a strict lifestyle whereby all animal-derived products are avoided as much as possible in all aspects of life (Jallinoja, Vinnari & Niva 2018).
Vegan diet:	A diet that excludes all food substances that are derived from animals (Dinu *et al* 2017).
Vegan lifestyle:	A lifestyle exclusively comprising of vegan practices. Products made from animals and those that have been tested on animals such as household items, toiletries and clothing are avoided (Cherry 2015).
Vegetarian:	A person who follows a diet that excludes any poultry, seafood or meat products, but may contain dairy and eggs (Cofnas 2018).

1.7 Abbreviations

AI: Adequate Intake

ALA: Alpha-linolenic Acid

BMI: Body Mass Index

BMD: Bone Mineral Density

BV: Biological Value

CHD: Coronary Heart Disease

CVD: Cardiovascular Disease

DHA: Docosahexaenoic Acid

DRI: Dietary Reference Intake

EAR: Estimated Average Requirement

EPA: Eicosapentaenoic Acid

FBDG: Food Based Dietary Guideline

FFQ: Food Frequency Questionnaire

GI: Glycaemic Index

HDL: High-Density Lipoprotein

kCal: Kilocalorie

kJ: Kilojoule

KZN: KwaZulu-Natal

LA: Linoleic Acid

LDL: Low-Density Lipoprotein

MUFA: Mono-Unsaturated Fatty Acid

NCD: Non-Communicable Diseases

PBD: Plant-Based Diet

PBMA: Plant-Based Milk Alternative

PDCAAS: Protein Digestibility-Corrected Amino Acid Scores

PETA: People for the Ethical Treatment of Animals

PoPI: Protection of Personal Information

PUFA: Poly-unsaturated Fatty Acid

RDA: Recommended Dietary Allowance

SAVS: South African Vegan Society

SSB: Sugar-Sweetened Beverage

UL: Tolerable Upper Intake Level

USA: United States of America

WHO: World Health Organization

1.8 Assumptions

The following assumptions were made:

- All respondents were vegan.
- All respondents were computer literate.
- Respondents were able to read and understand the English language.
- All respondents were honest when completing the questionnaire.

1.9 Summary

Veganism has substantially increased internationally in the last few years. There is now a greater focus on protecting animals from abuse, an accumulation of scientific research on the health advantages of following a vegan diet and an increasing availability of dairy and meat replacements in the market (Radnitz *et al* 2015). The motives behind following a vegan diet have a strong influence on the dietary preferences, food choices and duration of following the diet, as seen in many studies. Due to the growing trends of following a vegan diet in South Africa, including an increase in vegan food products and vegan-specific restaurants, there is a need to investigate how easy it is for South African vegans to be able to follow this diet. The research conducted in this dissertation is aimed to determine the demographic characteristics of South African vegans, their motives and challenges and the nutritional quality of their diet. Therefore, it is anticipated that the objectives of this study will shed light on the statement of the problem.

1.10 Dissertation Overview

This dissertation consists of six chapters. The first chapter provides information on the importance and relevance of the study, outlining the objectives, hypotheses and scope of the study. Chapter two outlines the current literature in relation to the research topic and objectives. The third chapter provides details on the methodology used in the study and the fourth chapter will present the results following the statistical analyses of the data. Chapter five discusses the results of the study in relation to previous studies presented in chapter two.

The sixth chapter outlines the conclusions obtained from the study and provides recommendations for future research.

1.11 Referencing style

This dissertation has been written using the referencing style compiled by the Discipline of Dietetics and Human Nutrition at the University of KwaZulu-Natal, Pietermaritzburg.

CHAPTER 2: REVIEW OF THE RELATED LITERATURE

2.1 Overview

This chapter will address the literature regarding the history and background of plant-based diets and how the vegan diet has become popular worldwide. The main motives for following a vegan diet will be presented and the benefits of following a vegan diet will also be addressed. The chapter will include insight into the challenges faced by vegans in society and a proposal as to how these challenges can be overcome. It will also include the definition and nutritional composition of a vegan diet and common plant-based alternatives that can be found commercially. The chapter will conclude with plant-based diets and veganism from a South African perspective.

2.2 Introduction and background to plant-based diets

The global demand for food is increasing due to population growth and nutrition transitioning, resulting from a rise in income, which are associated with an increased prevalence of non-communicable diseases (NCDs) (González-García, Green, Scheelbeek, Harris & Dangour 2020). Currently, the world has seen a remarkable shift in dietary behaviours, physical activity and patterns of inactivity, body composition and NCDs. This shift is especially evident in low to middle income countries, where the growth of agriculture, modern retail and food systems, urbanisation and access to mass media are some underlying factors of the transition. This shift is related to the nutrition transition which is associated with changes in the consumption of food and beverages as well as reduced physical activity. There is a dietary shift toward including higher amounts of refined carbohydrates, oils, added sweeteners, animal products and a reduced amount of fruit, vegetables and legumes. This leads to most countries seeing an increase in body mass index (BMI), waist circumference, overweight and obesity. The implications of diets and body composition changing rapidly eventually results in increased NCDs (Popkin 2016). Globally, the most common NCD is cardiovascular disease (CVD), which includes both stroke and coronary heart disease (CHD). This disease has led to an estimated 17.8 million deaths globally in 2017, mainly in low to middle income countries (Global Burden of Disease Study 2017 Causes of Death Collaborators 2018).

Diets closely link the health of humans and sustainability of the environment (Tilman & Clark 2014). In order to prevent the scarcity of energy resources, fresh water and land for crops, it has been suggested that more people should follow a plant-based diet (Pimentel & Pimentel 2003), rather than an omnivorous diet. For the purpose of this study an omnivorous diet can be

defined as a diet which includes food from both plant and animal origin (Larsson & Johansson 2002). Lately, people in developed countries such as the United States of America (USA) and Europe, have consumed increased amounts of meat products in larger proportions in their diet (Stoll-Kleemann & Schmidt 2017). A study by Sans & Combis (2015), conducted in France, investigated the world meat consumption patterns over the last fifty years (1961-2011). This study found that meat consumption increased from 23.1 kg per person per year in the year 1961 to 42.20 kg per person per year in the year 2011. The most developed countries have therefore achieved on average an animal-based protein consumption that exceeds their requirements. However, according to the 2015 Dietary Guidelines Advisory Committee, a healthy dietary pattern should include a high amount of fruit, vegetables, whole-grains, seafood, legumes and nuts, non-fat or low-fat dairy and a moderate intake of alcohol. The diet should be low in refined grains, sugar sweetened food products, processed and red meat (Tapsell, Neale, Satija & Hu 2016). Therefore, guidelines in reducing meat consumption and consuming more plant-based diets (PBDs) has become a key feature in addressing challenges associated with health and sustainability (Graça, Godinho & Truninger 2019). A PBD can be defined as a diet that mainly consists of minimally processed and fresh plant foods. The diet limits the intake of dairy products, eggs and meat sources. When compared to a diet which includes meat sources, there is an increased intake of vegetables, fruits, seeds and nuts, legumes and a range of grains in a PBD (Key, Appleby, Davey, Allen, Spencer & Travis 2003; Li, Sinclair, Mann, Turner, Ball, Kelly, Abedin & Wilson 1999). There are many important benefits to following a PBD, particularly health-related, as the diet increases fibre intake and decreases unhealthy fat consumption (Lea, Crawford & Worsley 2006).

The increased intake of plant foods reduces the risk of NCDs (Montonen, Knekt, Järvinen, Aromaa, Reunanen 2003; Hu 2003; Bazzano, He, Ogden, Loria, Vupputuri, Myers & Whelton 2002; Messina 1999; Dwyer 1999; World Cancer Research Fund and American Institute for Cancer Research 1997; Rottka 1990). People who reduce their intake of meat and increase the amount of vegetables in their diet, tend to have lower systolic blood pressure, lower blood levels of low-density lipoprotein (LDL) and a lower BMI (Yang, Zhang, Sun, Wang, Yan, Liu, Zhang & Li 2011). In addition, a strict PBD results in reduced micro-inflammation and oxidative stress when compared to an omnivorous diet (Sebeková, Boor, Valachovicová, Blazícek, Parrák, Babinská, Heidland & Krajcovicová-Kudlácková 2006). Besides disease prevention, a PBD improves quality of life, health status and assists with weight control (Zunft, Friebe, Seppelt, Widhalm, de Winter, de Almeida, Kearney & Gibney (1999). There are also non-

health related benefits such as animal and environmental welfare (Lea *et al* 2006). When compared to omnivorous diets, PBDs are more sustainable as the diet uses significantly less amounts of natural resources and therefore has less harmful effects on the environment (Sabate´ & Soret 2014). A number of dietary patterns fall under the umbrella of plant-based diets. These diet patterns include vegan, vegetarian, semi-vegetarian and pesco-vegetarian (Tonstad *et al* 2013). It should also be noted that the term PBD is occasionally used interchangeably with the words vegan or vegetarian diets. These diets can be adopted for religious or ethical motives which may or may not be health-related. It is therefore important to understand the definition of these diets as presented in Table 2.1. A key difference in diets that restrict animal products is that even though most of the diets are defined by the foods that are excluded in the diet, a PBD is defined by what is included in the diet (Tuso *et al* 2013).

Table 2.1: Definition of different vegetarian and vegan diets (after Turner-McGrievy, Mandes & Crimarco 2017; Tuso *et al* 2013)

Dietary group	**Definition of diet patterns**
Vegan diet	Does not contain any animal products (meat, fish, poultry, eggs, or dairy) but emphasises plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans.
Vegetarian diet	Does not contain meat, fish, or poultry but does contain eggs and dairy, in addition to plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans.
Pesco-vegetarian diet	Does not contain meat or poultry but does contain fish and shellfish, eggs, and dairy, in addition to plant-based foods, such as fruits, vegetables, whole grains, and legumes/beans.
Semi-vegetarian diet	Contains all foods, including meat, poultry, fish and shellfish, eggs and dairy, in addition to plant-based foods, such as fruits, vegetables, whole-grains and legumes/beans. However, red meat and poultry are fairly limited.
Plant-based diet	Encourages plant foods in their whole form, especially vegetables, fruits, legumes, and seeds and nuts (in smaller amounts). For maximum health benefits this diet limits animal products. Total fat is generally restricted.

The more extreme forms of PBDs are the vegetarian and vegan diet. In contrast to PBDs, these diets may provide an inadequate consumption of energy and protein, as well as vitamins and minerals. Vegans and vegetarians have lower serum levels of vitamin B12, vitamin D (25-hydroxyvitamin D2 and D3), total cholesterol, as well as low plasma levels of beta-carotene and alpha-tocopherol compared to omnivorous diets (Elorinne, Alfthan, Erlund, Kivimäki, Paju, Salminen, Turpeinen & Voutilainen & Laakso 2016). During the last few years, there have been a vast number of studies published on the vegetarian diet; however, there is limited research on the vegan diet (Waldmann *et al* 2003).

2.2.1 History of veganism and the vegan diet

According to Williams (1896), for many years in different countries and cultures, the consumption of animal flesh was thought to be ethically wrong and unhealthy. In 1847 in Britain, a national Vegetarian Society was formed to propagate the ideology of the consumption of non-animal foods (Twigg 1982). Both British vegetarians and the Vegetarian Society defined vegetarianism as an acceptable intake of eggs and dairy products, provided that animals were not killed to attain them (Leneman 1999).

In 1946, the editor of *The Vegan* newspaper, Donald Watson, stated that it was "strange that for ninety years vegetarian literature contained nothing to question either morally or physiologically the use of animal foods other than flesh" (The Vegan, p3, 1946). Watson then formed an entirely new society named the *Vegan Society* as it seemed like a positive decision to have a separate group for those individuals who avoided all animal products. His original word, *vegan*, had become internationally recognised and understood and now appears in dictionaries worldwide. The Vegetarian Society has continued to claim that their main priority is to convince the greater population to omit poultry, fish and flesh from their diet. There has been a rise in the number of food products that are animal-free and an increase in the number of restaurants that prepare such food as well as strong health arguments about the diet (Leneman 1999).

2.2.2 Veganism as a social movement

Veganism refers to a philosophy or movement that supports and promotes avoidance from the consumption of any animal product such as dairy, eggs and meat. It stands against both the prevention of animal abuse and exploitation. Veganism varies from vegetarianism because although vegetarianism promotes avoiding the consumption of meat products, it does not

advocate against the intake and use of other animal products such as eggs, dairy products and honey (Ulusoy 2015).

According to Linderman & Stark (1999), veganism is known to be an alternate diet, a choice in the food that is consumed, a lifestyle as well as a social movement. This provides a setting for consumers to express and reflect on their own individualities and life choices. Cherry (2006) stated that many social movements, more especially cultural movements, do not have goals or adversaries which are conventionally identified. A good example of this is the vegan movement. Since veganism focuses on omitting all animal sources from their lifestyle and diet, it is often considered as the only goal or tactic of the animal rights movement (Munro 2005). Although, veganism is closely associated with both the environmental and animal rights movements, there are social movement organisations which exist that are dedicated to spreading information on veganism (Vegetarian Resource Group 2006).

In the year 2016, the number of adult vegans in the United States were approximately 3.7 million, however, there are only tens of thousands of vegan individuals who are part of social movement organisations. Therefore there are more practising vegans than members of a particular vegan organisation (Vegetarian Resource Group 2016). This suggests that while many vegans may be engaging in moral protests and activism, some are not associated with a particular vegan organisation. Therefore, it is essential to consider veganism as a broader movement rather than simply members as part of an organisation (Cherry 2006). Haenfler, Johnson & Jones (2012) stated that while there are multiple organisations that exist such as the Vegan Society or the Vegan Outreach, one does not need to join an organisation to become a vegan. It is more important to engage in everyday actions of following a vegan lifestyle and avoid being associated with the abuse of animals, than to become an associate of a movement organisation. Both local and national organisations can only assist an individual in providing the required social support for vegans and vegetarians who follow their own dietary lifestyle (Maurer 2002).

2.3 Motives for following a vegan diet

Motivation is an influential source for understanding what drives consumer's decisions and actions (Solomon, Bamossy, Askegaard & Hogg 2006). Dyett *et al* (2013), stated that individuals who follow a vegan diet, may do so for different reasons and this will affect their overall food and lifestyle decisions. A study conducted in the United Kingdom by Beardsworth & Keil (1991), found that motives for becoming vegetarian or vegan were usually "multi-

stranded" with the main reason for transition being for the improvement of health, spiritual or moral, taste or texture or ecological reasons. The food choices made by a vegan may depend on their motive for following the vegan diet, which could be for health reasons or the ethical welfare of animals (Orlich, Jaceldo-Siegl, Sabaté, Fan, Singh & Fraser 2014). According to literature, the motives for following a vegan diet which frequently emerge include health-related, ethical, environmental, religious practices and taste preferences. Ethical or moral reasons involve concern surrounding the welfare of animals, animal suffering during farming processes, animal rights and speciesism (Radnitz *et al* 2015; Dyett *et al* 2013). Ecological or environmental reasons were occasionally included as ethical reasons (Rothgerber 2013), while it was separated in other studies.

According to Rose, Heller, Willits-Smith & Meyer (2019), environmental concerns include climate change, shortages of fresh water, land degradation, water pollution as well as a loss of biodiversity. The aspects of health-related motives include the perception that vegan diets are beneficial for one's body and health when compared to an omnivorous diet. In addition, vegan diets can prevent disease and illness (Radnitz *et al* 2015; Rothgerber 2013; Timko, Hormes & Chubski 2012; Beardsworth & Keil 1991). In other studies, weight-loss related and health-related studies might have been grouped together as health-related motives. Beardsworth & Keil (1992) stated that when ethical and environmental motives were compared to health-related motives it was assumed to be linked to self-interest by a larger extent.

Most studies revealed that health-related and ethical motives make up the largest proportion of the main motives for following a vegan diet. Environmental-related motives remain rather unclear. Some studies show that environment-related motives have a minor contribution to overall motives (Dyett *et al* 2013; Izmirli & Phillips 2011; Waldmann *et al* 2003), whereas global warming concerns were the second most significant motive in a study done in Germany (Kerschke-Risch 2015). Environmental-related and animal-related motives were not investigated separately in other studies (Radnitz *et al* 2015; Rothgerber 2013). The distaste for animal and meat products (Waldmann *et al* 2003) and following religious customs (Dyett *et al* 2013) formed part of less common motives. Other reasons such as social and hygiene motives played a smaller role (Waldmann *et al* 2003). With regards to different backgrounds of motives, some authors divided vegans into those motivated mainly by ethical concerns and those by health and personal well-being (Radnitz *et al* 2015; Dyett *et al* 2013; Rothgerber 2013).

Greenebaum (2012) found that vegans that were motivated by ethics separated themselves from those vegans, who were motivated by health. The reason for this was because ethically-motivated vegans thought that health-motivated vegans followed veganism mainly as a dietary pattern rather than regarding it as a lifestyle. In other studies, health and ethical motivated vegans constituted the two biggest groups. Although, some authors proposed the separation into these two groups were somewhat basic as there might be a variety of motives supplementing and supporting each other (Rothgerber 2013; Beardsworth & Keil 1992). Figure 2.1 shows an international model of motives for following a vegan diet.

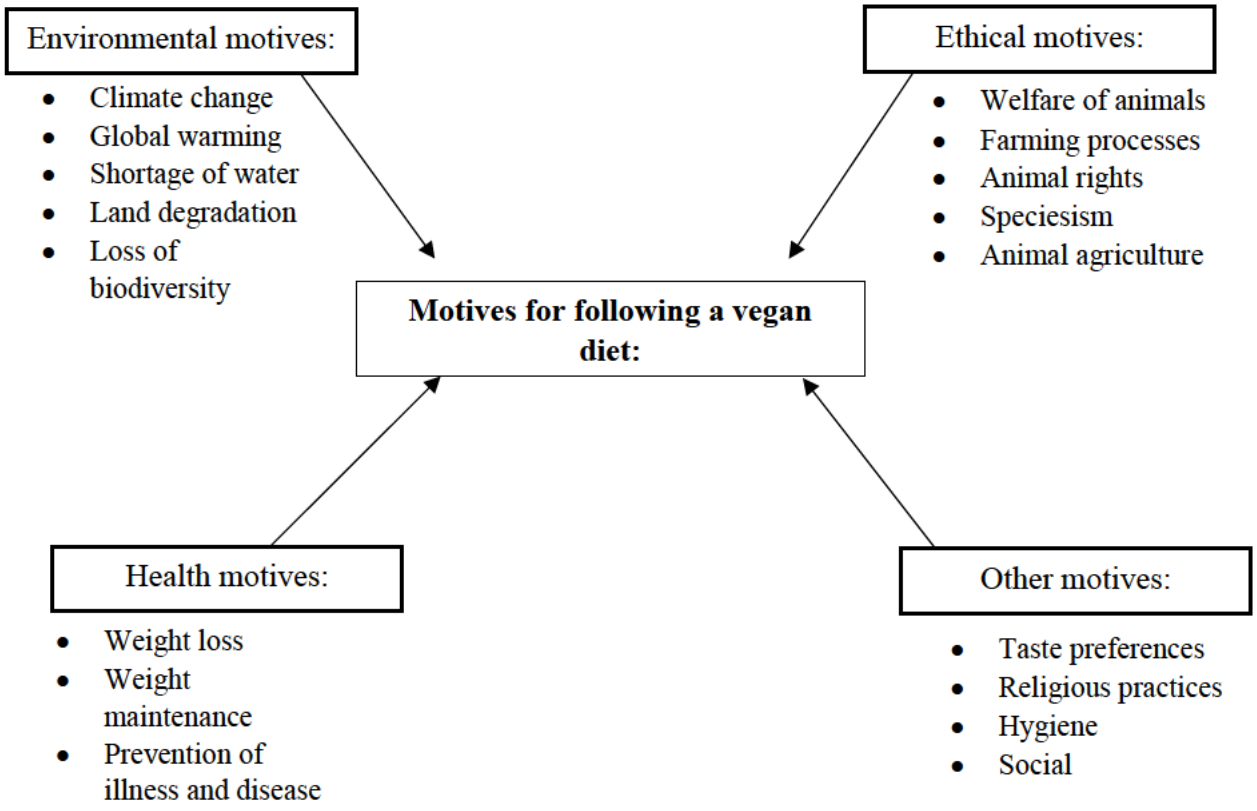

Figure 2.1: Model of international motives for following a vegan diet (after Rose *et al* 2019; Radnitz *et al* 2015; Dyett *et al* 2013; Turner-McGrievy, Barnard & Scialli 2007; Barnard, Scialli, Turner-McGrievy, Lanou & Glass 2005; Kerchchke-Riscch 2005; Waldmann *et al* 2003)

2.3.1 Ethical motives

The avoidance of consuming meat and meat products is a well-recognised phenomenon in Western cultures (Lund, McKeegan, Cribbin & Sandoe 2016). Most individuals generally care for the well-being of animals. However, they are also expected to use animals for specific

reasons which compromise their well-being, this includes the use of animals for food. The "meat paradox" is maintained by psychological and cultural instruments which lessens this conflict (Loughnan, Bastian & Haslam 2014; Plous 1993). According to Joy (2009), carnism can be defined as the practise of eating meat and the main ideology involves the continuation of animals to be used as food, by keeping welfare concerns of present structures of farming invisible and meat farming as natural, common and essential. The consumption of meat is also associated with masculinity in many cultures (Rothgerber 2013).

Different methods on the basis of justifying the consumption of meat are most likely reinforced by general values and research has shown that meat eaters are more socially dominant than vegans and vegetarians. Many vegans and vegetarians are presumed to follow a framework based on ethics (Lund *et al* 2016). According to Fox & Ward (2008), ethical motivated vegans and vegetarians tend to make their decisions within a "philosophical, ideological or spiritual framework". But according to quantitative (Rothgerber 2015) and qualitative studies (Hirschler 2011; Larsson, Ronnlund, Johansson & Dahlgren 2003; McDonald 2000), attitudes towards animal rights and welfare plays a significant role in the conversion to a diet which is ethically motivated. However, it is unclear if there are other animal ethical structures and how these structures differ among vegans and vegetarians.

Sandoe, Christiansen & Holst (2008) presented five main ethics concepts or principles, contractarian, utilitarian, animal rights, relational and respect for nature. These five views or concepts assist with providing the answers to questions surrounding the abuse of animals. The contractarian view focuses only on human self-regard and this view does not object the use of animals for any particular reason. The utilitarian view states that is it acceptable to breed animals for slaughter, provided that their welfare is considered and intensive production procedures should be avoided. The animal rights view states that all living beings should be treated with respect and animal rights are not overruled by the interest of humans. The relational view highlights the relationship of humans and animals and the strength of this bond. Therefore, there is acceptance of animal use provided that the animal-human bond is still preserved. Views regarding the respect for nature involves speciesism, preserving the health of ecosystems, integrity of genetics and other matters. The main focus of this view is the effect that animal production has on biodiversity, where the consumption of animal meat may be an issue of concern due to the substantial detrimental effects on the environment during livestock production (Sandoe *et al* 2008).

A study by Rothgerber (2015) conducted in the USA, with 556 respondents, consisted of 18% conscientious omnivores (n = 98), 8% ethical omnivores (n = 45), 16% health motivated vegetarians (n = 88), 21% ethical motivated vegetarians (n = 118), 14% health motivated vegans (n = 80) and 23% ethical motivated vegans (n = 127). Conscientious omnivores consume meat products or fish only when certain ethical standards are followed. For example, conscientious omnivores may have concerns about hormones or chemicals added to farmed meat from factories, as opposed to concerns about the unethical treatment of factory farmed animals (Rothgerber 2015). The study supported the assumption that obligation toward animal rights is crucial in diet transformation. This shows that vegans adopt stronger views about animal rights to a greater degree than vegetarians, who are more focused on animal rights than conscientious omnivores, who are defined as those individuals who only consume meat from farms that treat animals humanely. It is unclear as to what extent and whether commitment to animal rights is required to continue following a vegan or vegetarian diet.

Vegetarianism, especially ethical vegetarianism has been categorised as a "moralisation process" whereby the motivation behind the diet should be continuously strengthened (Rozin, Markwith & Stoess 1997). Therefore, it is acceptable to hypothesise that vegans and vegetarians who have stronger animal rights views tend to follow the diet for a longer duration (Lund *et al* 2016). It is shown from theory and evidence based studies, that those who consume meat have diverse views on animal ethics when compared to vegans and vegetarians. It is also evident that the viewpoints of meat-eaters are less consistent (Rothgerber 2015).

Janssen, Busch, Rödiger & Hamm (2016), investigated the motives of consumers who follow a vegan diet and their attitudes towards animal agriculture and found that 89.7% of vegan respondents followed the diet related to animal motives. Vegans in this study believed that animals and humans have similar feelings and that animals should have a natural death. Interestingly, some vegans supported that humans should not keep animals as pets. The study also had implications for the producers and retailers of vegan food products. It was identified that there are a variety of consumer segments according to the different motives for following a vegan diet, therefore vegan food is strategically positioned in the market. Since the majority of vegan consumers are motivated by animal-related reasons for following the vegan diet, it is advisable to mention that "no animals were harmed" in any communication strategy for vegan food products. Companies can decide if they are targeting consumers in search of healthy diets, protecting animal agriculture, improving health or all of these aspects (Janssen *et al* 2016).

2.3.2 Health motives

Plant-based diets are well-recognised to have reduced levels of fat especially saturated fat and cholesterol. These diets offer more folate, vitamin C, fibre and phytochemicals from the increased consumption of whole grains, legumes, nuts, fruit and vegetables, which are all vital in preventing disease and providing optimum health and well-being (Dyett *et al* 2013). A well-planned vegan diet can be healthy, nutritionally adequate and provide the essential health benefits in the treating and preventing certain disease conditions (Craig 2009).

Individuals following these plant-based diets, particularly vegetarian or vegan diets have reduced risks of certain cancers and have shown a reduction in body weight when compared to meat-eaters (Key, Appleby, Spencer, Travis, Roddam & Allen 2009). Both vegan and vegetarian diets have been known to effectively assist with weight loss (Barnard *et al* 2005; Ornish, Scherwitz, Billings, Gould, Merritt, Sparler, Armstrong, Ports, Kirkeeide, Hogeboom & Brand 1998) and maintaining weight (Turner-McGrievy *et al* 2007) as well as slowing the progress of the initial stages of prostate cancer (Ornish *et al* 2005).

A limited number of studies assess and compare vegan, vegetarian and omnivorous respondents as individual investigational groups. Therefore, it is difficult to identify if the health advantages associated with the vegan diet could possibly be generalised to all vegetarians or even to restrictive meat eaters who follow a healthy diet (Glick-Bauer & Yeh 2014). A case-controlled study by Goff, Bell, So, Dornhorst & Frost (2005) conducted in the United Kingdom, compared the profiles of omnivores (n = 25) and vegans (n = 24) who were matched by BMI, age and gender and found that 21 vegans had lower blood pressure readings and reduced glucose and fasting triacylglycerol concentrations when compared to the 25 omnivores. The biochemical profile of vegans also showed to be both beta-cell and cardio protective. Similarly, a cross-sectional study by Fontana, Meyer, Klein & Holloszy (2007), found the health profiles of twenty one sedentary vegans in the USA, following a raw long-term vegan diet to be comparable to those who participated in endurance exercises. These respondents were found to have reduced BMI, insulin, glucose, blood pressure, lipoproteins, lipids and C-reactive proteins when compared to the twenty one respondents who followed an omnivorous diet.

The Adventist Health Study-2 consisted of a total of 41 387 respondents, including Black (n = 7171) and non-Black respondents (n = 34 216) from the USA and Canada, who were diabetes-free and provided demographic, anthropometric, lifestyle and dietary data. This study provided a different platform for the comparison of not just vegetarians to omnivorous respondents

(reference group), but also to differentiate which of the four groups of vegetarian diets; known as vegan, pesco-vegetarian, lacto-ovo vegetarian and semi-vegetarian, increases the incidence of diabetes. A follow-up questionnaire after two years indicated that Black respondents had an increased incidence of diabetes when compared to non-Black respondents. The vegetarian diets were found to be advantageous when compared to omnivorous diet; however, vegan diets show a specific advantage in lowing the risk of diabetes (Tonstad *et al* 2013; Tonstad, *et al* 2009) and overall mortality (Orlich, Singh, Sabaté, Jaceldo-Siegl, Fan, Knutsen, Beeson & Fraser 2013). The risk ratios for developing general and female-specific types of cancers were found to be lower in individuals following a vegan diet. Vegans in this group were shown to have the lowest range of BMI when compared to other diet forms (Rizzo, Jaceldo-Siegl, Sabate´ & Fraser 2013), however, researchers had shown that there was an inadequate consumption of nutrients by respondents who followed strict vegetarian diets (Glick-Bauer & Yeh 2014).

A study by Dyett *et al* (2013), investigated the lifestyle behaviours and dietary motives of one hundred vegans in the USA. Health reasons were the most reported motive for their choice in following a vegan diet (47%). This was followed by welfare of animals (27%), religion (11%) and a reduced percentage of diagnosed chronic diseases (15%). The interest and level of health awareness in such restrictive diets are increasing due to the frequency of chronic illnesses and the widespread prevalence of obesity. According to Lea & Worsley (2003a), people who are health conscious accept vegetarian diets mainly because they recognise meat foodstuffs as unhealthy and plant food products as providing a variety of health benefits. Obesity is known to be a major risk factor in the development of NCDs. However, many vegans may not be at risk of NCDs, especially those with particularly lower BMIs.

Sabaté & Wein (2010), showed that plant-based diets were associated with a reduced BMI and lower obesity risk in both adults and children. There are vegans who follow the vegan diet to either maintain their slimness or to lose weight. Whereas, some individuals may be addressing the issue of obesity from an "image" perspective in their respective society. Weight loss strategies contribute to improving overall health, with the exception of prevalent eating disorders such as anorexia nervosa (Klopp, Heiss & Smith 2003).

With weight management and dieting, there are additional health aspects that appear to be generally linked with the vegan lifestyle and assist in improving the health and well-being of vegans (Phillips 2005). These factors include the intake of little or no alcohol, absence of smoking and partaking in exercise on a regular basis. These factors are known to have a positive

outcome and reduce the likelihood of chronic diseases. The study by Dyett *et al* (2013), showed that the majority of vegans took part in "moderate to vigorous" exercise more than three times a week for at least thirty minutes per work-out session. In the study, 97% of vegans never smoked and had never or rarely consumed alcoholic drinks such as beer, wine and liquor. Certain food-related choices and behaviours can influence health consequences. In the study by Dyett *et al* (2013), home-prepared meals were most frequently consumed by vegans and boiling and steaming were the most common food preparation methods. Deep-fat frying was not selected by any vegans who participated in the study and the use of mainly reduced-fat, non-fat or low-fat food products were reported by 92% of the respondents (Dyett *et al* 2013).

While there are numerous publications with information about vegetarian and vegan diets, there are insufficient data that have broader conclusions on the specific health motives of these diets. The overall outcome is that vegetarians and vegans are generally more conscious about their health and well-being when compared to meat-eaters (for example, avoiding the practice of alcohol consumption and smoking) and because they follow diets that are reasonably healthy (for example, reduced fat composition) (Key, Appleby & Rosell 2006).

Although some vegans are motivated by health reasons and have a desire to be slimmer, reduce their blood pressure and serum cholesterol levels and lower their risk of CVD, the vegan diet may lack certain vitamins and minerals. It is important that all vegans regularly consume foods that are fortified with calcium, vitamin D and vitamin B12. More studies are needed to find the relationship between vegan diets and the risk of certain conditions such as diabetes, cancer and osteoporosis (Craig 2009).

2.3.3 Environmental motives

In many developed countries around the world, an association between the degradation of the environment and agricultural production exists (Goodland 1997). The public should be made aware of various global environmental concerns such as changes in climate (Johnson, Franzluebbers, Weyers & Reicosky 2007), soil erosion (Trimble & Crosson 2000), toxic substances in food and the endangering of certain animal species (Huston 1993). These concerns have motivated sustainable production practices of food products and responsible use of limited resources (Pinstrup-Andersen & Pandya-Lorch 1998). In particular, there is an increased demand for animal products especially for those around the world who are economically advantaged (Heitschmidt, Short & Grings 1996).

Published studies address the problems surrounding food production sustainability and the impact of the environment from human consumption and other related systems (Beeton 2003). Generally, research shows that diets that are plant-based are better for the environment than meat-based diets (Leitzmann 2003; Pimental & Pimental 2003; Rejinders & Soret 2003). An Italian study by Baroni, Cenci, Tettamanti & Berati (2006) evaluated the environmental impact of various dietary patterns in combination with the different food production systems. It was found that the "normal" omnivorous diet which uses conventional farming and agriculture showed the highest impact on the environment, while the vegan diet which is based on organic food production had the least environmental impact. The study further identified the "critical points" of environmental effects and assessed the smallest alterations in eating patterns and how these changes benefit the environment. It was found that people usually showed utmost reluctance to altering their eating patterns, yet changing their way of eating may reverse major environmental issues. Single foods were then analysed along with the effect that these foods had on the environment. Beef in particular was found to have the largest effect on the environment and other high impact foods included milk, fish and cheese (Baroni *et al* 2006).

According to Baroni *et al* (2006), 3 - 4% of the environmental impact is due to eutrophication processes. Eutrophication is the excessive amount of plant growth on the surface of water which results from nutrient enrichment by the activity of humans. This is one of the most noticeable examples of human impact on the biosphere (Smith & Schindler 2009). Eutrophication increases due to chemical-conventional agriculture and other organic production procedures. These procedures include the impact of liquid manure from animal waste products, chemical fertilisers and pesticides on the ecosystem (Baroni *et al* (2006). Moriconi (2001) stated that in Italy alone, 19 million tons of farm animal waste could not be used as fertiliser due to its reduced organic consistency and increased pollutant content. This waste would then be layered on the ground, which in turn would lead to serious nitrogen pollution concerns, polluting waterways, water springs and lead to sea eutrophication. Land use equates to 5 - 13% of environmental impact. Yearly, close to seventeen million hectares of forests are demolished and this is increasing. This land is not only used for cattle rearing, but also for animal grazing, while wood production in the deforestation process has been relatively reduced (Kaimowitz, Mertens, Wunder & Pacheco 2003).

Respiration damage from chemical inorganic substances amount to 15 - 18% of the environmental impact, while 20 - 26% is because of the intake of fossil fuels. This due to the transport and production of food products, energy management and pollution.

If animals are treated as “food production machines”, it is important to note that these machines produce a vast amount of pollution, as they have a very high energy intake (Moriconi 2001). The consumption of water contributes to 41 - 46% of environmental impact. Animal agriculture and farming uses 70% of freshwater, 22% of water is used by industry and 8% of water usage is for domestic reasons (World Watch Institute 2004).

A systematic review by Sanchez-Sabate & Sabate´ (2019), investigated the consumer attitudes towards environmental concerns of meat consumption, found that the consumption of meat contributes greatly to global warming. The greatest challenge is changing the food behaviour of consumers. Food choices are influenced by numerous factors such as social norms, culinary backgrounds and different taste preferences. The results of the review showed that many consumers were aware of the impact that meat processing has on the environment and the planet. Many consumers are willing to considerably reduce or stop the consumption of meat for the benefit of the environment.

It is important to educate individuals residing in developed countries to change their dietary behaviour and attitudes regarding the consumption of meat products and the impact it has on the environment. There should be a shift in eating patterns to directly increase plant food consumption. Therefore, vegan and vegetarian diets could also play an essential role in the reduction of hunger and malnutrition in disadvantaged communities (Fox 1999; Gussow 1994).

2.4 Challenges faced by vegans in society

A vast majority of literature on meat consumption as a substantial part of the Westernised diet continues to be of interest and many studies have attempted to discover the reason why omnivores choose to include meat as part of their diet. For example, scholars have justified the hardship of altering dietary patterns (Pohjolainen, Vinnari, & Jokinen 2015; Lea *et al* 2006), the enjoyment of the taste of meat (Graça, Calheiros, & Oliveira 2015) and the masculine characteristics that are identified when meat is consumed (Rothgerber 2013). The consumption of food in a social setting can be identified as a profound social activity, whereby individuals are categorised according to their food-related social practices (Delormier, Frohlich, & Potvin 2009). There is also a bonding experience among individuals during the process of food sharing (Ochs & Shohet 2006).

Cole & Morgan (2011), found that people usually perceive vegans and vegetarians negatively because they strictly disrupt the social connotations connected to food. Because of the dietary deviation, it is argued that those individuals who follow vegan diets are likely to experience

stigma (Bresnahan, Zhuang & Zhu 2016). Stigma is known as treatment that is biased and involves negative opinions towards those who possess undesirable characteristics or belong to a different status group (Link & Phelan 2001). The bias treatment involves distancing one's self in a social setting from others who are different (Cialdini & Goldstein 2004). The stigma linked to vegans may discourage other individuals to limit their animal product and meat intake and move toward plant-based food products. This occurs because individuals expect the stigma to follow from their unusual behaviour, and therefore they prefer to avoid being "labelled" and treated as part of the stigmatised group (Quinn & Chaudoir 2009; Johnston 2002).

In general, literature reveals that individuals treat vegetarians, especially vegans negatively. For example, Cole (2008) explained the detailed terminology used to address vegans. He stated that scholars termed veganism as an "ascetic" practice that is hard to conserve. A study by Potts & Parry (2010) conducted in New Zealand, examined online articles that had been published, along with comments from chatrooms and personal blogs. They found that vegans were described as mentally and physically weak and often oversensitive. Other authors examined other sources of media such as newspapers and films for discussions on veganism and vegans. The prevailing perceptions continued to be negative (Wright 2015; Cole & Morgan 2011). This led Cole & Morgan (2011) to term the negative views as "vegaphobia". However, the study by Rothgerber (2014) which compared the attitudes towards meat and animals among strict vegetarians (n = 157) and semi-vegetarians (n = 57) found that usual attitudes was an exception to the trend. Semi-vegetarians were less likely to dislike meat and to find meat repulsive than were strict vegetarians even when the diet was being followed for health motives.

Yeh (2014) who examined the content of vegetarian magazines also found that vegetarians favoured vegans and their dietary choices. Although this led to positive views, it was from individuals who did not consume meat, and it is not a general view from the omnivorous population. An additional factor may include the fact that some plant-based groups disrupt and attempt to undermine social agreements. For example, although vegans and vegetarians are alike, they do have different motives for the diets that they follow, like environmental or health motives (Radnitz *et al* 2015; Greenebaum 2012; Fox & Ward 2008) and ethical and moral reasons (Ruby 2012). These motives are mainly followed because of the exploitation and suffering of animals, and many vegans take part in social activism and become members of social movement groups (Wrenn 2017; Cherry 2006). Taking this into account, activists of animal's rights share similar views and concerns as ethical/moral vegans (Cherry 2010), and vegans are associated with protesters who support animal rights movements (Cherry 2006).

This may lead to vegans being classified as outspoken activists who are prejudiced and duplicitous for advocating animal rights above the rights of humans (Greenebaum 2012).

McDonald (2000) stated that those individuals who have recently transitioned into the vegan diet, report frequent interrogation from meat-eaters, including their friends and family. The hostile questions are usually accompanied by demeaning and open ridiculing of vegan individualities. This can be seen as illicit or just an impermanent phase (Greenebaum 2012; Hirschler 2011). According to Twine (2014), these negative attitudes commonly cause vegans to experience social relationships that are tense with non-vegan individuals. This is generally characterised by non-vegans refusing to taste or provide vegan dishes. Due to the tension, vegans may lose friendships, have reduced contact with friends and family, be left out from social activities, signifying that the social costs of following veganism can be quite high (Twine 2014; Greenebaum 2012; Hirschler 2011).

It is seen from literature that social stigma plays an important role in preventing change towards a plant-based diet. This is essential in planning public health strategies which are aimed at improving the overall well-being and health status of individuals. Research suggests that plant-based food products should be labelled as meat-free (Apostolidis & McLeay 2016) and health benefits of limiting meat intake should be continuously emphasised (De Backer & Hudders 2014). In order to improve social difficulties, public health interventions should be planned to decrease social stigma and aim at changing general attitudes and beliefs surrounding vegan diets (Mittal, Sullivan, Chekuri, Allee & Corrigan 2012). If personal and social circumstances are made easier, only then will animal product intake be reduced and a plant-based diet be adopted. Until then there may still be substantial resistance along with negative opinions related to those who following a plant-based and meat-free diet (Markowski & Roxburgh 2019).

Other challenges to consuming plant-based options include taste preferences and unwillingness to change dietary patterns (Lea *et al* 2006), as well as the lack of cooking skills related to preparing legumes (Messina 2014). Although studies have found that the consumption of diets which are healthier cost more than less healthy diets (Rao, Afshin, Singh & Mozaffarian (2013), cost has not been shown to be a challenge when adopting a vegetarian or vegan diet (Lea *et al* 2006; Lea & Worsley 2003b).

The study by Turner-McGrievy, Leach, Wilcox & Frongillo (2016) conducted in the USA, investigated the differences in environmental impact and food expenditures of four different plant-based diets and an omnivorous diet among 63 adults for a six months weight-loss

intervention. For this time, the respondents were randomised to follow either a vegan, vegetarian, pesco-vegetarian, semi-vegetarian or omnivorous diet. Respondents were instructed to keep receipts of all food purchases at grocery stores, convenience stores, or other stores where they had purchased their groceries and to provide an accurate total of food expenditure. Respondents were also instructed to keep receipts of dining in restaurants separately. Respondents repeated this for the two month and six month assessments. The study found that baseline expenditure on groceries ($p = 0.31$) or changes in grocery expenditure at 2 months ($p = 0.10$) and six months ($p = 0.10$) did not significantly differ among the diet groups even when eating at a restaurant at any point. It was also found that diets that relied on legumes for protein, can be less expensive that diets that include dairy and legumes, dairy and poultry, dairy and seafood or dairy and red meat.

Dietary interventions should be aimed at shifting individuals to follow a more plant-based eating pattern, educate the public on how to select low-cost foods for the preparation of meals and favouring non-animal protein sources that cost less, such as legumes. Therefore, the adoption of vegan and vegetarian diets could result in reduced spending on meat for vegans; eggs and dairy (Turner-McGrievy *et al* 2016). In order for individuals to continue maintaining following a vegan diet in a society where consuming animal products is a norm, requires an individual to have a conscious behaviour. Vegan consumers have restricted options for spontaneous decisions related to food, especially when eating at a restaurant (Emre 2016). In the study by Katcher, Ferdowsian, Hoover, Cohen & Barnard (2010), conducted in the United States, found that a worksite vegan nutrition program is well-accepted and improves health-related quality of life and work productivity. The respondents were employees from a major insurance company ($n = 113$). One group of respondents were given instructions on how to follow a low-fat vegan diet ($n = 68$) and the other received no dietary instructions ($n = 45$) for 22 weeks. The vegan group reported a reduction in food costs ($p = 0.003$) and an increased difficulty in finding food options when eating out ($p = 0.04$), when compared to the control group.

Vegetarian and vegan diets are increasing, which results in the demand for meatless options (Greenway 2010). It has been commonly argued that restaurants often do not effectively address and utilise this important developing trend, regardless of the financial challenges and increase in competition within the restaurant industry (Shani & DiPietro 2007). The addition of vegetarian and vegan meal options in restaurants is one of the top suggested strategies to improve business. However, it should also be noted that catering to this group of patrons is a

complex task, as it requires managerial skills which are knowledge-based that rely on the comprehensive understanding of the vegetarian segment and its unique characteristics. Restaurant staff are required to become familiar with vegan and vegetarian techniques of cooking, creating recipes that are attractive and the handling of meat-free ingredients (Licata 2009). In South Africa vegan and vegetarian diets are on the rise and the country is also a popular tourist destination, therefore local restaurants should be catering to a wider variety of consumers to address the growing demand and trends toward meat-less food options.

2.5 Definition of a vegan diet and its nutritional components

Vegetarian, semi-vegetarian and vegan diets are becoming progressively more popular. A vegan diet involves the exclusive restriction to consume only plant-based foods, whereby all animal food and derivatives are completely avoided (Richter, Boeing, Grunewald-Funk, Heseker, Kroke, Leschik-Bonnet, Oberritter, Strohm & Watzl 2016). Even though the vegan diet is associated with several good health outcomes, the severity of this strict dietary pattern still remains a concern (Craig 2009). Without a doubt, there are perceptions that the vegetarian diet, particularly the vegan diet is lacking significant nutrients including vitamin B12, iron, calcium and protein (Rizzo *et al* 2013; Deriemaeker, Alewaeters, Hebbelinck, Lefevere, Phillipaerts & Clarys 2010).

The vegan diet may include legumes, vegetables, nuts and seeds, essential plant-oils, fruit or whole-grain food products and all of these food groups have been shown to be beneficial to health (Boeing, Bechthold, Bub, Ellinger, Haller, Kroke, Leschik-Bonnet, Muller, Oberritter, Schulze, Stehle & Watzl 2012). The food products consumed in a vegan diet are not necessarily nutritious or beneficial for health. Particularly if the diet comprises of increased levels of fat, table salt or sugar added to vegan meals (Richter *et al* 2016).

In recent years, there has been an increase in processed food products available to suit food preferences of vegans, this has improved the supply of food for those following a vegan diet. In July/August 2013, approximately 90% of the 852 vegans who participated in an online survey in Germany, stated that it had become much easier to follow a vegan in recent years (Kerschke-Risch 2015). Due to the increasing demand of vegan food, a range of replacement and convenience vegan foods are now available in the market, including meat and cheese substitutes. This has been created to respond to vegan consumers and their desire for a wider variety of choices and to create familiar dishes (Hauner 2015). Some of the vegan food products are greatly processed with numerous artificial additives, and the nutritional significance of these

additives raises concerns. However, if these foods are fortified with various micronutrients, it can provide adequate nutrient quality in the vegan diet (Leitzmann 2003). Therefore, a number of tools were created to assist vegetarians and vegans in selecting food groups, the quantities that should be consumed and how to plan their meals in order to sustain a healthy diet (Messina, Melina & Mangels 2003).

2.5.1 Vegetarian food guide pyramid

In 2003, a vegetarian food guide in the form of a pyramid was created to illustrate food groups and serving sizes for all types of vegetarian diets. These guides were also used for those following a vegan diet. The guide consisted of the following food groups: grains, protein foods, vegetable, fruit, legumes, nuts, fats and calcium rich foods (Messina *et al* 2003). Figure 2.2 shows the vegetarian food guide pyramid.

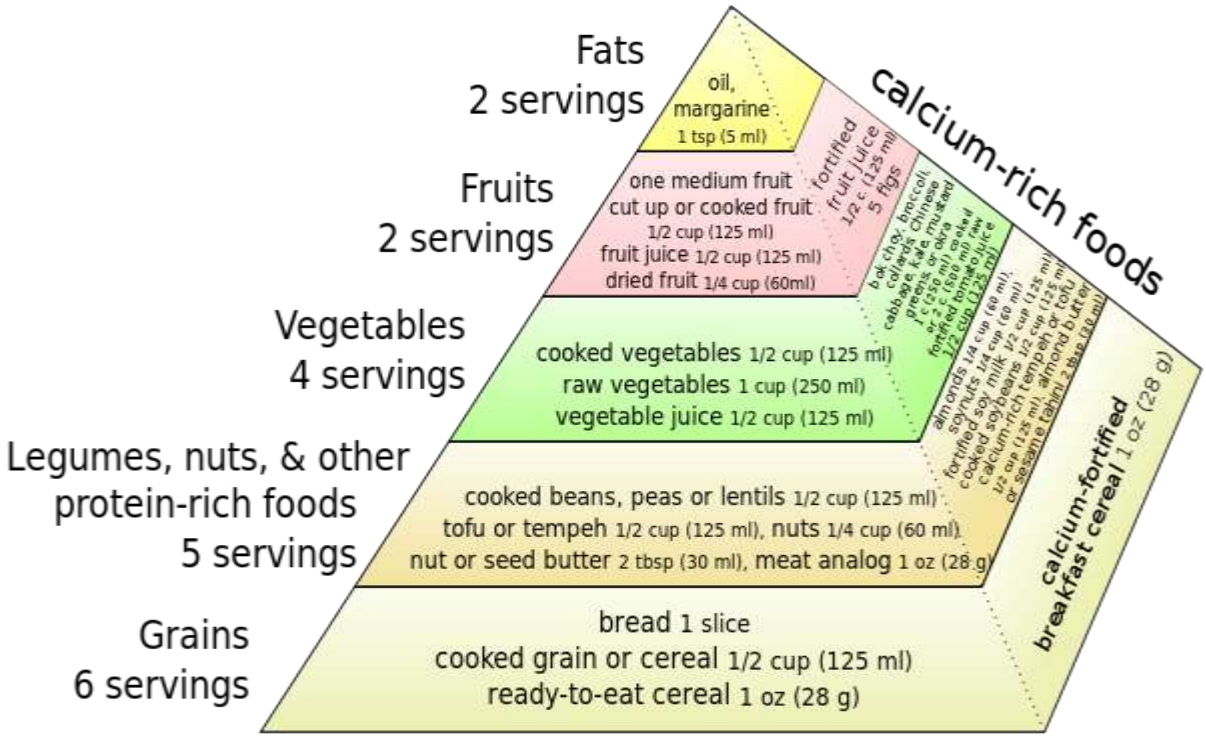

Figure 2.2: Illustration of the vegetarian food guide pyramid (after Messina *et al* 2003)

There are supporting guidelines to assist the individual in planning a meal when using the pyramid. These guidelines are as follows (Messina *et al* 2003):

- Choose a variety of meals.

- The number of serving sizes is minimum daily intakes. Choose more foods from any group to meet energy requirements.
- A single serving from the calcium-rich food group should provide 10% of daily requirement for an adult. Choose eight or more servings from this group per day.
- Canola and olive oil are the best fats that should be used for cooking. Include two servings of daily of fats that contain omega-3 fatty acids.
- It is important to gain adequate vitamin D from sunlight and fortified food sources or supplements.
- Include at least three good sources of vitamin B12 in the diet.
- If sweets and alcohol is included in the diet, consume in moderation.

Vegan diets exclude animal products, therefore specific guidelines are required for the adequate consumption of vitamin B12, which were not included in the pyramid. Plant foods have insufficient vitamin B12 therefore a regular and reliable source should come from foods fortified with vitamin B12, vitamin B12 supplements or both. Some vegetable-protein food products, ready-to-eat cereals, nutritional yeasts and milk alternatives are now fortified with vitamin B12 (Haddad, Sabaté & Whitten 1999b). Although, the pyramid showed the constituents of a healthy diet, it does not emphasise the need for daily physical activity and how to maintain a healthy body weight, and individuals had a difficult time understanding the recommendations (McCullough, Feskanich, Stampfer, Giovannucci, Rimm, Hu, Spiegelman, Hunter, Colditz & Willet 2002). Meal planning was also difficult as the pyramid included too many recommended servings with large portions in each meal. Finally, although the fat group was at the apex of the pyramid indicating that it is a small component of a healthy diet, fat is also a significant component found in other food groups such as nuts, seeds and meat analogues (Kahlon 2006).

2.5.2 The vegan plate

In 2014, a vegan plate guide was developed by the Academy of Nutrition and Dietetics and the Dieticians of Canada. This plate consisted of five food groups namely: grains, nuts and seeds, legumes, vegetables and fruits (Davis & Melina 2014). At the centre of the plate, calcium rich foods were shown. Other essential nutrients were also illustrated such as omega-3, vitamin B12, vitamin D and iodine. Figure 2.3 shows an illustration of the vegan plate and Table 2.2 shows guidelines on planning meals and eating healthy using the vegan plate.

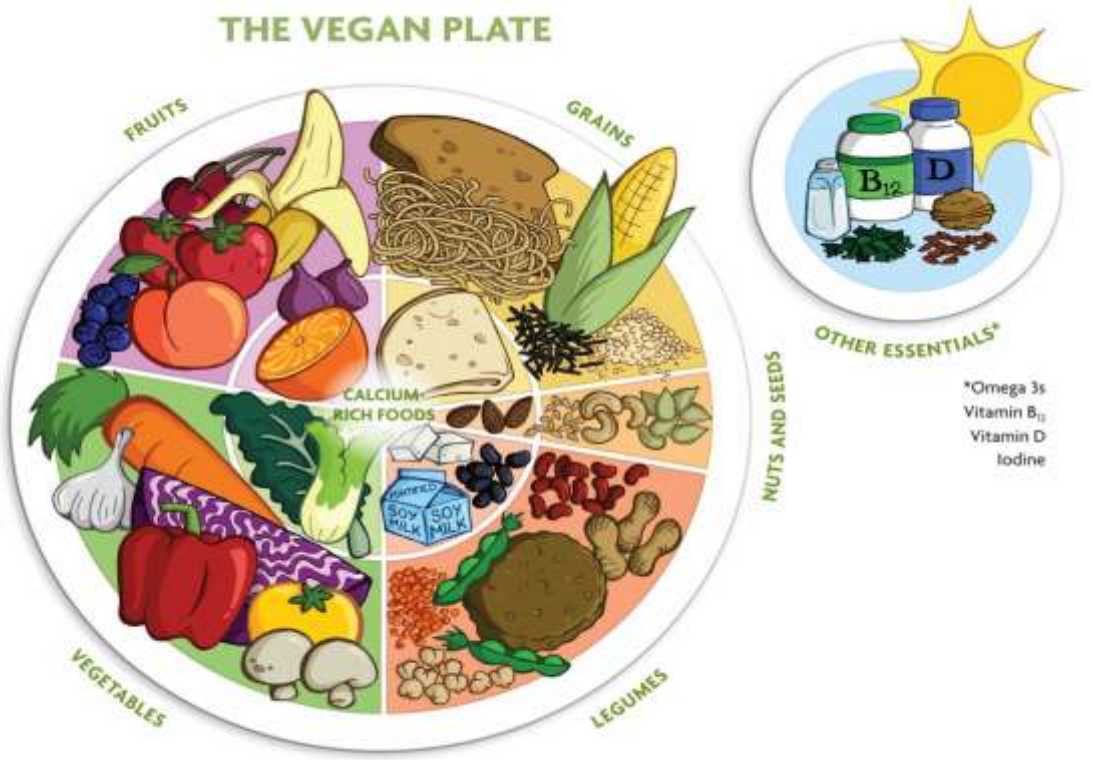

Figure 2.3: Illustration of the vegan plate (Davis & Melina 2014, p434).

Table 2.2: The Vegan Plate Guidelines (Davis & Melina 2014, p435)

Food group and serving sizes per day	Foods in this group with serving size	Calcium rich foods with serving size	Additional notes
Vegetables: 5 or more serving	½ cup (125ml) raw or cooked vegetables 1 cup (250ml) raw leafy vegetables ½ cup (125ml) vegetable juice	1 cup (250ml) cooked bok choy, broccoli, collard greens, kale, mustard greens, napa cabbage or okra 2 cups (500ml) raw bok choy, broccoli, collard greens, kale, mustard greens or napa cabbage ½ cup (125ml) calcium-fortified tomato or vegetable juice	• Include at least 2 daily servings of calcium-rich greens. • Choose from the full rainbow of colourful vegetables: purple, blue, green, yellow, orange, red and white.
Fruit:4 or more servings	½ cup (125ml) fruit or fruit juice ¼ cup (60ml) dried fruit 1 medium fruit	½ cup (125ml) calcium-fortified fruit juice ¼ cup (60ml) dried figs 2 oranges	• Fruit are excellent sources of potassium. • Enjoy the full spectrum of colourful fruits and make them your sweet treats.
Legumes: 3 or more servings	½ cup (125ml) cooked beans, peas, lentils, tofu or tempeh 1 cup (250ml) raw peas or sprouted lentils or peas ¼ cup (60ml) peanuts	1 cup (250ml) black or white beans ½ cup (125ml) fortified soy milk or soy yoghurt ½ cup (125ml) calcium-set tofu (look for calcium in the ingredient list), cooked soy beans or soy nuts	• Legumes are great sources of protein, iron and zinc with an average of 7 to 9 grams of protein per serving. • Include a selection from this group at most meals.
Grains: 3 or more servings	½ cup (125ml) cooked cereal, pasta, quinoa, rice or other grain 1 ounce (28g) bread ½ cup (125ml) raw corn or sprouted quinoa, buckwheat or other grain 1 ounce (28g) cold cereal	1 ounce (28g) calcium-fortified cereal or bread 1 calcium-fortified tortilla	• Select whole grains as often as possible. • Adjust the number of grain servings to suit your energy needs: some need many more servings. • Some fortified cereals and tortillas are particularly high in calcium
Nuts and Seeds: 1 or more servings	¼ cup (60ml) nuts or seeds 2 tablespoons (30ml) nut or seed butter	¼ cup (60ml) almonds 2 tablespoon (30ml) almond butter or sesame tahini	• Seeds and nuts contribute copper, selenium, other minerals, vitamin E and fat. • Choose some that are rich in omega-3.

2.5.3 The VegPlate

The Academy of Nutrition and Dietetics in the USA released its latest position paper on vegetarian diets in December 2016. This paper reinforced that well-planned vegetarian diets should be suitable for all stages of life and be nutritionally adequate and healthful. The diet should provide health benefits in the treatment and prevention of chronic diseases and result in the least environmental damage (Melina, Craig & Levin 2016). A new Mediterranean VegPlate was created according to the Italian dietary reference intakes (DRI). The plate is for adult vegans and vegetarians as well as pregnant and lactating females. The plate is based on six food groups, namely; protein-rich foods, grains, vegetables and fruit, seeds and fats. Table 2.3 shows the serving sizes of foods from the different groups of the VegPlate and their calcium content. A variety of plant foods with importance given to certain critical nutrients are the most crucial recommendation to achieve adequacy of the diet. Diary and eggs are considered optional depending on the diet (Baroni, Goggi & Battino 2018). Figure 2.4 shows the basic structure of the VegPlate model (A), this is for adults and pregnant and lactating females, the small plates (B) added to the big plate which shows pregnant and lactation for the second trimester (P2), third trimester (P3) and lactating (L).

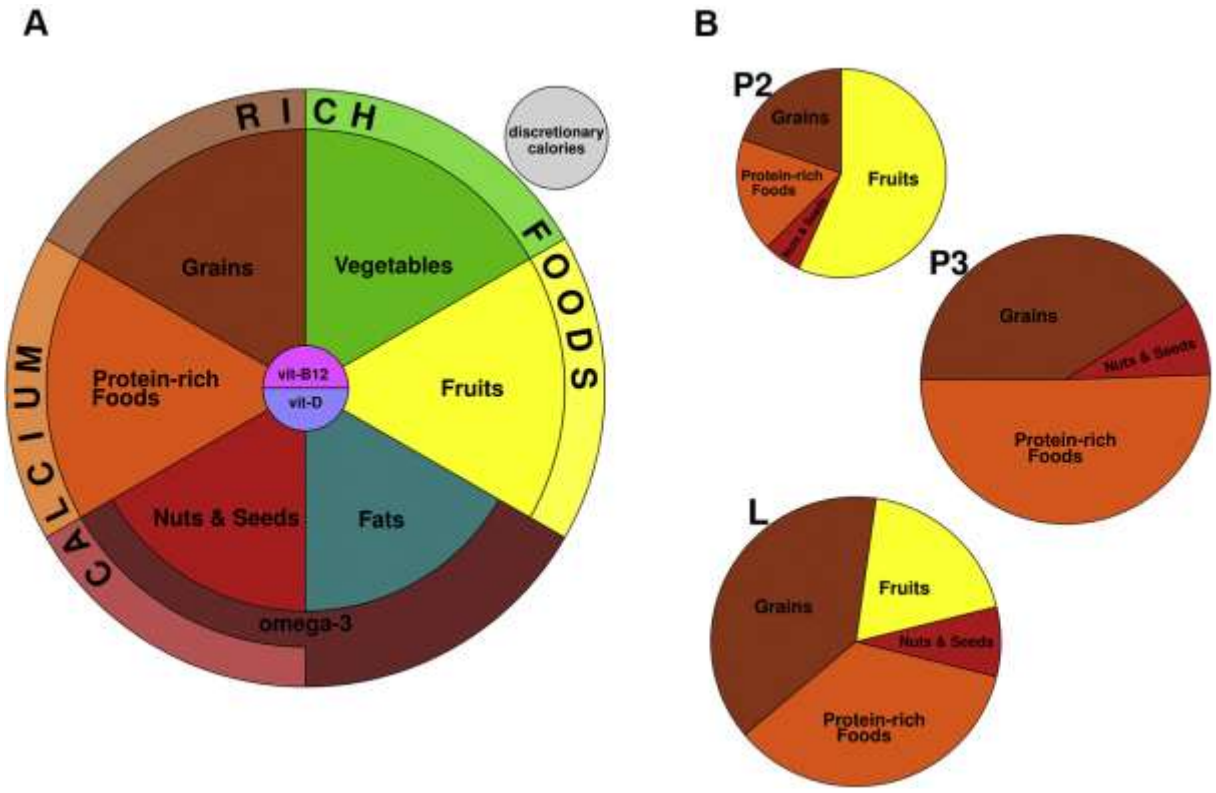

Figure 2.4: Illustration of the VegPlate Model (Baroni *et al* 2018)

Table 2.3: Serving sizes and calcium content of foods from the VegPlate (Baroni *et al* 2018)

Food group	**Foods (Calcium content per serving)**	**Serving size (household measures)**
1. Grains	Bread, crackers (whole flour)	30g (1 regular slice)
	Whole cereal grains	30g, dry (1 ½ Tbsp)
	Pasta, bulgur, couscous	30g, dry (1/3 cup)
	Popcorn	30g, cooked (4 cups)
	Ready-to-eat cereals	30g (3/4 cup)
	Non-dairy milk made from cereals (enriched with calcium, 240 milligrams (mg) **)	200ml (1 cup)
	Potatoes	120g (1 egg-sized potato)
2. Protein-rich foods	Legumes (soy beans 77mg*)	30g, raw (2 Tbsp)
	Tofu (84 mg *), Tempeh (96mg *)	80g, 1/3 cup
	Meat substitutes (with soy or gluten)	30g (3 regular slices)
	Soy (enriched with calcium 240mg**) or cow's milk (240mg **)	200ml (1 cup)
	Soy (enriched with calcium 160mg **) or cow's yoghurt (160mg **)	125g (1 single-serve container of 125g)
	Eggs	60g (one, medium)
	Cheese (165 mg *)	30g (1/3 cup)
3. Vegetables	Cooked or raw vegetables (artichoke 86 mg*, broccoli 72 mg*, cardoon 96*, chicory 150 mg*,endive 93 mg*, rocket 160 mg*, garden cress 131 mg*, green radicchio 115 mg*, taraxacum 187 mg*, turnip greens 97 mg*, watercress 170 mg*)	100g
	Vegetables juice	100 ml (½ cup)
4. Fruits	Raw fruit	150g (one, medium)
	Cooked or sliced fruit	150g
	Dry fruit (figs 84mg *)	30g
	Fruit juice	150ml (3/4 cup)
5. Nuts and seeds	Nuts and seeds (almonds 71mg*, sesame 293 mg*)	30g (3 Tbsp)
	Nuts and seed butter (almonds 71mg*, sesame 293mg *)	30g (3 Tbsp)
6. Fats	Oil, mayonnaise and soft margarine	5g (½ Tbsp)
7. Calcium-rich foods	*One serving of calcium-rich foods **Two servings of calcium-rich foods Tap water, calcium 100mg/L (125mg*) Mineral water, calcium 350mg/L (125mg*)	 1,250 mL 350 mL
8. Omega-3 rich foods (belonging to group 5 and 6)	Flaxseed oil	5g (½ Tbsp)
	Flaxseeds, to be consumed ground	10g (1 Tbsp)
	Chia seeds, to be consumed ground	15g (1 ½ Tbsp)
	Walnuts	30g (3 Tbsp)

The food groups included in the VegPlate model are as follows (Baroni *et al* 2018):

- **Grains:** Wheat, corn, rice, millet, rye, barley, spelt, oat, buckwheat and their derivatives (bread, pasta and rice milk) and potatoes.
- **Protein-rich food:** Beans, chickpeas, lentils, fava beans, peas, soy beans and their derivatives (tofu, tempeh and soymilk). Dairy products and eggs, although included in this group, there foods were not considered for the calculations.
- **Vegetables:** Twenty five of the most common type of vegetables in Italy.
- **Fruit:** Eighteen most common type of fruit in Italy.
- **Nuts and seeds:** Almonds, flax seeds, sesame seeds, sunflower seeds and walnuts.
- **Fats:** Olive and flaxseed oils.
- **Calcium-rich foods group:** Including the foods richest in calcium from all of the previous groups, except for fats**.**
- **Omega- 3 (n-3) fatty acid rich foods group:** Including foods highest in omega-3 fatty acids from the fats and the nuts and seeds groups.

It is important that vegans and vegetarians receive practical information to achieve the best dietary planning to meet nutritional requirements. The VegPlate is an easy tool to plan vegan, vegetarian and lacto-ovo vegetarian diets. The tool provides detailed serving suggestions and specific advice for managing critical nutrients in the diet (Baroni *et al* 2018). The number of servings using the VegPlate for adults and pregnant and lactating females can be seen in Table 2.4.

Table 2.4: Number of servings using the VegPlate model (Baroni *et al* 2018)

Kilocalories (kCal)	**Grains**	**Protein-rich foods**	**Vegetables**	**Fruit**	**Nuts and seeds**	**Fats**	**Calcium-rich foods** (a)	**Omega-3 Fatty Acid foods** (b,c)
VegPlate for adults								
1,200	5	3	6	1	1	1	6	2
1,400	7	3	6	1	1	1	6	2
1,600	8	3	6	1.5	1.5	1	6	2
1,800	9	3	6	2	2	1	6	2
2,000	10	3	6	2.5	2	2	6	2
2,200	11	3	6	3	2.5	2	6	2
2,400	12	3	6	3	3	2	6	2
2,600	13	3	6	3.5	3	3	6	2
2,800	14	3	6	4	3	4	6	2
3,000	15	3	6	4.5	3	5	6	2
3,200	16	3	6	5	3	6	6	2
VegPlate for pregnancy and lactation								
1,800	9	3	6	2	2	2	6	2
2,000	10	3	6	2.5	2	3	6	2
2,200	11	3	6	3	2	4	6	2
2,400	12	3	6	3	2.5	5	6	2
2,600	13	3	6	3.5	2.5	6	6	2
2,800	14	3	6	4	2.5	7	6	2
3,000	15	3	6	4.5	3	8	6	2
3,200	16	3	6	5	3	9	6	2
Additional servings, [d] 2nd trimester of pregnancy (P2)								
260	0.5	0.5	0	1	0.5	0	-	-
Additional servings, [d] 3rd trimester of pregnancy (P4)								
500	1.5	2	0	0	1	0	-	-
Additional servings, [d] Lactation (L)								
500	1.5	1.5	0	0.5	1	0	-	-

a. This total number of servings must be consumed as calcium-rich foods from the other food groups.
b. Of which at least one serving of flaxseed oil.
c. The number of servings of omega-3 enriched foods must be included in the total number of servings of nuts and seeds or fats.
d. To be added to the servings already set for the VegPlate for pregnancy and lactation.

2.6 Nutritional quality of the vegan diet

A current approach to measure the overall quality of diets is the use of indices to measure dietary pattern analysis as an alternative to the more detailed nutrient methodology (Hu 2009). The analysis of dietary patterns is a complimentary process to observe the outcome of a particular diet: food and various nutrients are not eaten separately, and the "single food or nutrient" method will not consider the multifaceted interactions among food and nutrients (Hu 2009). There are a limited number of studies that use indices to measure dietary quality and to compare restricting diets with omnivorous diets. However, none of these studies investigated

a distinct set of vegan respondents and the results of these studies were indefinite (Clarys, Deriemaeker, Huybrechts, Hebbelinck & Mullie 2013; Farmer, Larson, Fulgoni, Rainville & Liepa 2011; Kennedy, Ohls, Ma & Fleming 1995).

A vegan diet must be balanced and well-planned in order for it to be consistent with good health outcomes. A varied vegetarian and vegan diet can lessen the possibility of chronic diseases (White & Frank 1994). However, it is important to take care during the adolescent years as there is an increased demand for nutrients needed by the body. There should be sufficient intakes of total energy, vitamins and minerals. Vegans are recommended to sustain a diet with a range of vegetarian foods and to make certain that there are sufficient intakes of protein, calcium, zinc, iodine, iron, riboflavin, selenium, vitamin D and vitamin B12 by consuming enriched foods or supplements (Elorinne *et al* 2016).

A study by Clarys, Deliens, Huybrechts, Deriemaeker, Vanaelst, De Keyzer, Hebbelinck & Mullie (2014) conducted in Belgium with 1475 respondents consisting of vegans (n = 104), vegetarians (n = 573), semi-vegetarians (n = 498), pesco-vegetarians (n = 145) and omnivores (n = 155), found that when compared to the omnivorous diet, the nutritional intake of vegans is similar to that of earlier research. Vegans had a lower energy intake when compared to other diets. The vegan group was also found to have a reduced dietary protein and cholesterol intake, a reduced total fat, saturated and mono-unsaturated fatty acids (MUFA) intake and low sodium and alcohol intake compared to the omnivorous group ($p < 0.01$). Saturated fat daily intake in vegans was 21 g a day compared to 54 g for omnivores ($p < 0.01$). Vegans had the highest consumption of dietary fibre, iron and poly-unsaturated fatty acids (PUFA). Sugar and carbohydrate intakes were the same across all diets, while relative consumption was highest in vegans and lowest in the omnivorous diet. This shows that higher carbohydrate consumption may lead to improved macronutrient distribution in restrictive diets (Key *et al* 2009). It is known that fruit is an important contribution to sugar and carbohydrate intake in more restrictive diets, as consumption of fruit is typically higher (Craig 2009). Less healthy sources of sugar (for example cookies, cakes, sweets and chocolate) most often contain animal products, which allows a limited availability to vegans (Larsson & Johansson 2002). Interestingly sodium intake in vegans was less than half when compared to the intake by omnivores, while vegans reached only half of the values for required calcium intake (Clarys *et al* 2014).

Currently, it is much easier for vegans to compile a suitable vegan diet compared to many years ago (Craig, Mangels & American Dietetic Association 2009). This is due to the growth and adaptability of the vegan market. In addition, as the variety of fortified foods have increased, new vegetarian and vegan convenience foods as well as nutritional supplements are now readily available. There is also an increased awareness on how to appropriately plan vegan diets (Craig *et al* 2009).

A large cohort study conducted on 199 944 respondents in the United Kingdom by Bradbury, Tong & Key (2017), investigated the dietary consumption of high-protein foods and other major foods among regular meat-eaters, low meat-eaters, poultry-eaters, fish-eaters, vegetarians and vegans. In the study, respondents were classified as meat-eaters if they consumed red meat including beef, lamb and pork more than three times a week and low-meat eaters if they consumed red meat three or less than three times a week. Poultry-eaters reported consuming no red meat or processed meat but did report consuming poultry while fish-eaters did not report consuming red meat, processed meat or poultry and reported consuming at least one oily fish or other fish. In the study, it was found that in the vegan group (n = 248), plant milk provided 2 - 3% of the total energy, while meat substitutes, legumes and nuts provided about 10% of total energy. Therefore, the contribution that plant-based milks and meat substitutes make towards the nutritional quality of the vegan diet will be further discussed in this section. Table 2.5 shows the studies that assessed the nutritional quality of the vegan diet and their findings.

Table 2.5: Studies assessing the nutritional quality of the vegan diet

Authors	Objectives	Respondents	Methodology	Results	Conclusion
Menal-Puey, del Ruste & Marques-Lopes (2018) Spain.	To determine and evaluate the dietary intake of Spanish vegan and vegetarian population.	n = 102 Vegans: n = 40 Vegetarians: n = 62	A semi-quantitative food frequency questionnaire was developed to assess dietary assessment.	Vegan respondents showed higher energy and fibre intakes when compared to vegetarians. Vegans showed considerably higher poly unsaturated fatty acids. Vitamin B12 intake was lower in vegans than vegetarians.	The diet of both vegans and vegetarians were well-balanced with regards to fibre and macronutrients. Vitamin B12 and vitamin D intakes should be increased in both diets.
Allès, Baudry, Méjean, Touvier, Péneau, Hercberg & Kesse-Guyot (2017) France.	To describe the socio-demographic and nutritional characteristics of self-reported, adult vegetarians and vegans, compared to meat-eaters, from the French NutriNet-Santé study.	n = 93 823 Vegans: n = 789 Vegetarians: n = 2370 Meat-eaters: n = 90 664	Web-based self-administered 24-hour dietary recalls via interactive interface.	Vegans had the lowest total energy intake and mean contribution of total proteins, total lipids and saturated fatty acids. Vegans had the highest contribution of polyunsaturated fatty acids, plant proteins and simple and total carbohydrates. The vegan group consumed the highest fibre and lowest dietary intake of vitamin-D and vitamin B-12.	Overall vegetarians and vegans had better macronutrient composition and diet quality. The consumption of meat substitutes and nutrient supplementation should be considered as there are concerns related to zinc, iron and vitamin B12 especially among vegans.

Table 2.5: Studies assessing the nutritional quality of the vegan diet continued

Authors	Objectives	Respondents	Methodology	Results	Conclusion
Elorinne *et al* (2016) Finland.	To compare dietary intake and nutritional status of Finnish long-term vegans and non-vegetarians.	n = 41 Vegans: n = 22 Non-vegetarians: n = 19	Dietary consumption and the use of supplements were estimated using a 3 day dietary record. Nutritional status was evaluated by measuring biomarkers in serum, plasma and urine samples.	The results showed no significant difference in total energy consumption among the two group. However, there were variances in other nutrient and essential nutrient intakes. Vegans consumed significantly less vitamin B12, vitamin D, niacin, saturated fat and cholesterol (all $p<0.001$).	Nutritional education and guidance is important to vegans and vegan diets should be regularly supplemented with essential nutrients. More prominence should be placed on iodine and vitamin D to ensure requirements are met. This will contribute to a more favourable fatty acid and lipid profile in vegans.
Clarys *et al* (2014) Belgium.	To compare the quality and the contributing components of the vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diet	n = 1475 Vegans: n = 104 Vegetarians: n = 573 Semi-vegetarians: n = 498 Pesco-vegetarians: n = 145 Omnivores: n = 155	Cross sectional online survey with 52-item FFQ Healthy Eating Index 2010 (HEI-2010) and Mediterranean Diet Score (MDS) was calculated as indicators for diet quality	Vegans had a lower energy intake compared to other diets. The vegan group had a lower total fat consumption, saturated and mono-saturated fat, dietary cholesterol, dietary proteins, alcohol (all $p<0.01$) Vegan group had the lowest calcium and highest iron, dietary fibre and poly-unsaturated fatty acids.	Both the HEI-2010 and MDS indicated that the vegan diet is the most health diet after estimating the overall diet quality.

Table 2.5: Studies assessing the nutritional quality of the vegan diet continued

Authors	Objectives	Respondents	Methodology	Results	Conclusion
Waldmann *et al* (2003) Germany.	To evaluate the dietary intakes and lifestyle factors of German vegans.	Vegans: n = 154	A pre- and main questionnaire with a two 9-day food frequency questionnaires and blood sampling.	Overall energy intake was in proportion to the total energy intake. Protein consumption was at a low level. Saturated, monounsaturated, and polyunsaturated fatty acids was in line with current recommendations. Iron, vitamin B12 and calcium was not within recommended values.	Vegans in this study had an above average healthy lifestyle and followed a diet which was well-balanced with a high density of nutrients. The intake of calcium, cobalamin and iron needs to be improved and strict vegans should consider supplementation of these vitamins and minerals.
Larsson & Johansson (2002) Sweden.	To compare the dietary intake and nutritional status of young Swedish vegans and omnivores.	n = 60 Vegans: n = 30 Omnivores: n = 30	Diet history interview to measure dietary intakes. Blood samples, doubly labelled water method and 24-hour urine excretion measures were also used.	Energy intake from the diet-history was underestimated when compared to the doubly labelled water and urine excretion. Vegans consumed below average requirements of selenium, riboflavin, vitamin-D, vitamin B12 and calcium. The intake of selenium and calcium remained low even with the addition of dietary supplements.	The dietary patterns of vegans varied substantially and were not in accordance with the average recommendations for some required nutrients.

Table 2.5: Studies assessing the nutritional quality of the vegan diet continued

Authors	Objectives	Respondents	Methodology	Results	Conclusion
Haddad, Berk, Kettering, Hubbard & Peters (1999a) United States.	To evaluate the dietary and nutritional status of individuals consuming a vegan diet by using biochemical, hematologic, and immunologic methods in comparison with a non-vegetarian group.	Total n = 45 Vegans: n = 25 Non-vegetarians: n = 20	Four-day dietary records were completed and fasting, peripheral venous blood samples were taken from both groups.	Vegan females consumed more dietary fibre and less dietary cholesterol. They also consumed significantly lower intakes of protein, total fat, saturated fat and monounsaturated fat both in quantity and percentage of energy intake when compared to non-vegan females. The intakes of vegan males showed similar trends.	Further research is required to explain the associations between diet, body weight, and immune function processes in healthy individuals.

In order to guide health and nutrition professionals with dietary assessment of either groups or individuals, dietary reference intakes (DRIs) are used. The term DRI refers to a set of four reference values which are nutrient-based that represent an approach adopted by the Food and Nutrition Board to provide quantitative estimations of nutrient consumption for the use in assessment and planning of diets for healthy individuals. When sufficient information is accessible, each nutrient has a set of DRIs. A particular nutrient can either have an estimated average requirement (EAR), a recommended dietary allowance (RDA) or an adequate intake (AI). In addition, many nutrients may also have a tolerable upper intake level (UL) (Murphy & Poos 2002). It can be appropriate to compare individual nutrient intake with specific DRIs, however, nutrient intake information alone cannot be used to determine the nutritional status. The assessment of the diet is only one component of the assessment of nutritional status, on condition that the dietary intake is collected accurately, the correct DRI is chosen and the results are appropriately interpreted. However, in order to provide a valid assessment of the nutritional status of an individual, it is preferred that dietary intake information is combined with anthropometric, biochemical and clinical information (Murphy & Poos 2002).

Many South African studies have used DRIs to assess the nutritional status of individuals and prevalence of nutritional deficiencies among groups of individuals including children. For example, Kolahdooz, Spearing & Sharma (2013), conducted a study in a rural community in KwaZulu-Natal, South Africa, consisting of 137 men and women and used AIs to determine the nutritional adequacy of the study population. Daily nutrient intakes and energy values were compared with the appropriate indications for all males and females over the age of 19 years. When age and gender was available, dietary adequacy was calculated and used to determine EARs. Similarly, Schutte, van Rooyen, Huisman, Kruger, Malan & De Ridder (2003), who conducted the Thusa Bana study in South Africa, consisting of 694 Black African children between the ages of 10 to 15 years, used the dietary intakes and compared this against the RDAs for specific nutrients in the study. The RDA cut-offs used for the Thusa Bana study was obtained from the Institute of Medicine, Food and Nutrition Board, Dietary Reference Intakes document from the year 1998. The current RDAs are particularly important in identifying nutritional deficiencies among high-risk groups including vegans and vegetarians. Many international studies have compared the dietary intake of vegans and vegetarians to DRI's (Dyett, Rajaram, Haddad & Sabate´ 2014; Ströhle, Ströhle, Waldmann, Koschizke, Leitzmann & Hahn 2011; Dunn-Emke, Weidner, Pettengill, Marlin, Chi & Ornish 2005).

2.6.1 Nutrient deficiencies in the vegan diet

According to Fields, Ruddy, Wallace, Shah, Millstine & Marks (2016), vegans are at increased risk for many deficiencies such as protein, omega-3 fatty acids, calcium, vitamin D, iron and vitamin B12. Health care professionals need to encourage vegan patients to consume a variety of nutrients sources to meet recommended levels as seen in Figure 2.2.

2.6.1.1 Vitamin B12

Plant foods are comprised of an insufficient quantity of vitamin B12 and vegans have a difficulty reaching the recommended dietary allowance (RDA) of 2.4 micrograms (μg) and maintaining acceptable blood values of vitamin B12 (Fields *et al* 2016). Mandry, Lisowska, Grevowiec & Walkowiak (2012) conducted a five year prospective study of twenty omnivores in Poland, who changed to a strict vegan diet for five years. Half of the respondents consumed natural products while the other half consumed foods fortified with vitamin B12. Vitamin B12 serum levels were taken before and 6, 12, 24 and 60 months after implementing the diet. The results showed a significant decrease ($p < 0.0002$) in serum B12 levels in the whole study group after 60 months of following the diet, however the group consuming natural products showed

lower levels of B12 when compared to the group consuming fortified B12 food products ($p < 0.0001$). Therefore, it can be noted that the transition from an omnivorous to a vegan diet can be associated with an increased risk of vitamin B12 deficiency (Mandry *et al* 2012).

A cross sectional study by Gilsing, Crowe, Lloyd-Wright, Sanders, Appleby, Allen & Key (2010), conducted in the United Kingdom involving 689 men (226 omnivores, 231 vegetarians and 232 vegans), found that 52% of vegans, 7% vegetarians and one omnivore were vitamin B12 deficient. Interestingly, there was no significant association between age and the duration of adherence to a specific diet and serum vitamin B12 levels. It is important to consider the occurrence of vitamin B12 deficiency in vegans and health care professionals should advise vegans to consume supplemental vitamin B12 or foods fortified with vitamin B12. Vitamin B12 levels should be periodically monitored to ensure sufficient intake (Fields *et al* 2016). Foods fortified with vitamin B12 include some breakfast cereals, soy products, plant-based milks and yeast extract which can assist in preventing a deficiency (Gilsing *et al* 2010).

2.6.1.2 Iron

One of the most common nutrient deficiencies globally is iron deficiency anaemia (Waldmann *et al* 2003). Even though the haemoglobin levels in vegans may be unexpectedly higher than the levels seen in omnivores, the levels of ferritin which stores iron, is reduced in vegans (Craig 2009). The vegan diet consists of nutrients to inhibit and enhance the absorption of iron such as phytates and organic acids, respectively, resulting in fluctuating iron levels (Clays *et al* 2014; Waldmann, Koschizke, Leitzmann & Hahn 2004). Iron deficiency prevalence is more common in young woman following a vegan diet (Waldmann *et al* 2004). Fields *et al* (2016), recommends that periodic assessments of iron status is conducted for all vegans especially vegan woman of childbearing age and children. Vegans should be encouraged by health care professionals to consume supplements with food that enhance iron absorption.

2.6.1.3 Calcium and vitamin D

Many studies have shown reduced intakes of calcium and vitamin D in the vegan diet (Waldmann *et al* 2004; Parsons, van Dusseldorp, van der Vliet, van de Werken, Schaafsma & van Staveren 1997). Several studies have demonstrated lower bone mineral density (BMD) in vegans compared to non-vegans (Parsons *et al* 1997). When dietary calcium consumption is reduced, calcium absorption in the gastrointestinal tract increases. Low animal protein consumption reduces the excretion of renal calcium. Therefore, a vegan diet might lessen negative skeletal effects. Increased alkalinity, vitamin K & phytoestrogens in the vegan diet

are believed to improve BMD. Health care professionals recommend that adult vegans have a daily intake of at least 525 mg of calcium and 15 μg of vitamin D (Fields *et al* 2016).

2.6.1.4 Omega-3 fatty acids (EPA and DHA)

The human body is unable to make two essential fatty acids which has to be obtained from the diet namely: linoleic acid (LA) and alpha-linolenic acid (ALA). The main constituent of many vegetable-based oils is linoleic acid; as a result, vegans need to include vegetable fat in their diet in order to avoid a fatty acid deficiency. ALA can be found in many vegan foods such as flax seeds, walnuts, soy, soybean and canola (rapeseed) oil. There are two additional fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Vegans would need to consume large amounts of seaweed, walnuts, flax and chia seeds in order to attain both fatty acids in the diet, therefore they are reliant on the production of EPA and DHA from ALA. Both EPA and DHA are lacking in the vegan diet. The health outcomes of reduced levels of EPA and DHA continues to be a concern, as both play an important role in metabolism. This includes EPA's effect on the aggregation of platelets (via thromboxane) and inflammation (via leukotrienes) and the effect of DHA on visual and overall brain functioning. Health care professionals can advise patients to consume DHA supplements which are plant-based such as those made from algae (Fields *et al* 2016). Table 2.6 shows the summary of nutrients found in common vegan food sources.

Table 2.6: Vegan sources and nutrients (Fields *et al* 2016)

Nutrient	**Vegan Sources**
Vitamin B-12	Fortified soy and rice milk, cereals, meat substitutes, nutritional yeast and supplements.
Calcium	Collard greens, fortified plant milks and juices, blackstrap and molasses.
Vitamin D	Fortified plant milk and ultraviolet B-exposed mushrooms
Iron	Tofu, soy beans, collard greens, lentils and spinach.
Essential amino acids	Legumes, buckwheat, hempseed, chia, soy and quinoa.
Omega- 3 fatty acids (EPA and DHA)	Walnuts, flax seed, chia and algae (EPA and DHA).

2.6.2 Meat substitutes

Food decisions not only impact on one's well-being but the sustainability of ecosystems. At present, systems in place for food and meat production especially in the Western society, places a substantial burden on the environment. Besides the negative environmental impact, there is a rise in pollution of the water, soil and air from the inadequate transformation of feed into meat from animals. For example, one kilogram of meat needs 3-10 kilograms of grain to be consumed by the animal (Tilman, Cassman, Matson, Naylor & Polasky 2002). According to Post (2012), there are three major concerns associated with the production of meat. The first concern is environmental issues regarding the reduction of natural resources, deforestation and pollution. The second concern is the issue of animal welfare, which involves the unethical and cruel treatment of animals during the growing, transporting and slaughtering processes. The third concern is public health problems surrounding livestock production for human consumption.

According to Wolk (2016), scientific evidence has shown that an increased consumption of red meat, particularly processed red meat, may be related to an increased risk of major chronic diseases such as CVD, type 2 diabetes mellitus, cancer and increased risk of mortality. The term 'red meat' includes mutton, lamb, pork, veal and beef. The red colour is formed when myoglobin in the muscle of these meat products is exposed to oxygen and transforms into a reddish oxymyoglobin. Processed meat is meat that undergoes different treatments to extend its shelf-life, improve flavour, quality and colour. Therefore, processed meat usually has a higher content of sodium and nitrates/nitrites when compared to unprocessed meat (Wolk 2016). There are a variety of types of processed meat products and it is difficult to sort them by categories, therefore companies label them according to parameters used in manufacturing such as curing (addition of salt and other additives), smoking, cooking drying and packaging (Santarelli, Pierre & Corpet 2008).

Steinfeld, Gerber, Wassenaar, Food and Agriculture Organization of the United Nations (FAO), Castel, Rosales & de Haan (2006), stated that the consumption of red meat has been a popular topic among non-medical researchers during the last two decades. This is due to the adverse effects that red meat production has on the climate and the environment. Red meat production results in fossil energy use, greenhouse gas emissions and increased water use and changes in water quality due to various livestock operations involving water pollutants (namely animal waste products, pesticides and fertilisers). If the demand for red meat changes, there may be a positive impact on the environment, influencing how much meat is produced. Globally, it has

been estimated that meat consumption may double from year 2000 to year 2050 mostly as a result of an increase in the world population and increased per capita meat consumption (Alexandratos, Bruinsma, Boedeker, Schmidhuber, Broca, Shetty & Ottaviani 2006).

On the other hand, meat in general is considered one of the highest quality protein sources and is widely consumed due to its appetising taste and flavour profiles. The functionality of meat products also contribute to the development and growth of the food industry (Joshi & Kumar 2015). However, vegetarian and vegan foods have a larger space in today's market due to consumers' increasing health and environmental concerns (Craig 2010). Meat alternatives are used in place of animal meat in these diets. These alternative meat products can be referred to as "faux meat", "meat substitutes", "meat alternatives" or "meat analogues". A meat substitute is a product that possesses the same chemical and/or aesthetic characteristics of certain varieties of meat (Kumar, Chatli, Mehta, Singh, Malav & Verma 2017). An important pre-requisite for a customer to accept a meat substitute is if they can recognise the meat substitute as being a product that can be consumed as a replacement for meat. This means that the meat substitute should have a similar form and usage to meat. In group discussions, many consumers specified that the appearance of a meat substitute is important, and one should know how to cook a meal with that particular meat substitute (Elzerman, Hoek, van Boekel & Luning 2011).

Another significant feature that is essential for the acceptance of meat substitutes are the sensory properties including texture, taste and appearance of the products. Many consumers greatly value the texture and taste of meat (Bredahl, Grunert & Fertin 1998; Grunert 1997). The tenderness and juiciness are especially preferred texture characteristics. In order for meat substitutes to be accepted by meat eaters, the substitute does not have to possess the same sensory properties, but the taste and texture should be acceptable (Hoek, Luning, Stafleu & de Graaf 2004). These replacement meat products are in the initial phase of progress and account for just about 1 - 2 % in the overall meat industry (De Bakker & Dagevos 2012). Nevertheless, due to these products being cheaper as protein is originated from vegetable sources, the demand and use of these products will certainly increase as a replacement for expensive animal proteins (Kumar *et al* 2017).

The vegan diet is mostly rich in fruit, vegetables and fibre. Protein sources can be included in the diet with the regular intake of meat substitutes. The main component of material for meat substitutes are vegetable proteins, such as soybean, wheat glutens, peanut, groundnut globulins, yeast and sesame. The important ingredients used to prepare the meat substitutes are

vegetables, nuts, pulses, cereal proteins, mycoproteins and soy protein. However, consumer choices have widened, and this has led to the addition of new ingredients (Kumar *et al* 2017). Table 2.7 shows the nutritional composition of meat substitutes compared to meat products.

Table 2.7: Nutritional composition of meat substitutes and meat products (Bohrer 2019)

Product	Energy value (kcal)	Protein (g)	Fat (g)	Saturated Fat (g)	Cholesterol (g)	Total carbohydrates (g)	Dietary fibre (g)	Na (mg)	Fe (mg)
Meat substitute products									
Beyond burger	221.24	17.70	15.93	5.31	0.00	2.65	1.77	345.13	3.72
Impossible burger	212.39	16.81	12.39	7.08	0.00	7.96	2.65	327.43	3.72
MorningStar farms grillers original burger	203.13	25.00	7.81	0.78	0.00	12.50	6.25	609.38	1.72
Boca all American veggie burger	140.85	18.31	5.63	1.41	7.04	8.45	5.63	492.96	2.39
Gardein meatless meatballs	166.67	15.56	7.78	0.56	0.00	10.00	3.33	355.56	8.33
Tofurky ham roast with glaze	203.70	20.37	5.56	0.46	0.00	18.52	0.93	592.59	1.76
Quorn brand chik'n nuggets	203.39	10.17	8.47	0.42	6.78	24.58	5.93	449.15	0.72
Traditional meat products									
Ground beef (93% lean, 7% fat), uncooked/raw	152.00	20.85	7.00	2.89	63.00	0.00	0.00	66.00	2.33
Ground beef (93% lean ,7% fat), cooked, pan-fried	182.00	25.56	8.01	3.29	84.00	0.00	0.00	72.00	2.82
McDonald's beef patty	266.67	23.33	20.00	8.33	83.33	0.00	0.00	400.00	3.33
Tyson fully cooked home-style beef meatballs	300.00	15.56	16.47	5.88	47.06	5.88	1.18	352.94	2.12
Hormel cure 81 classic boneless ham	105.95	18.45	3.57	1.19	50.95	0.24	0.00	1038.10	0.83
Tyson fully cooked chicken nuggets	300.00	15.56	18.89	4.44	44.44	16.67	0.00	522.22	0.91

2.6.2.1 Ingredients of meat substitutes

2.6.2.1.1 Soy protein

Currently, the majority of meat substitute production is produced with the use of soy beans (Kumar *et al* 2017). Soy beans are also known as "soya beans" mainly in Europe, however, for the purpose of this literature review, the term "soy" will be used. Soy bean is a plant food which contains high biological protein and the only plant protein which contains all the essential amino acids required by the body. It is a complete protein which regulates body processes, repairs tissue and promotes growth (Adigbo & Maddah 2011). Kumar *et al* (2017) stated that soy is known to have functional and nutritional benefits. It is commonly used to provide complete and fractional meat replacements due to its nutrient composition and decreased risk

of CVD. Soy also contains about 9.3% of fibre assisting with the regulation of the digestive tract. It is also composed of various oligosaccharides, saccharose and a small amount of starch, therefore soy is well tolerated by diabetics (Appiah, Boateng, Darko & Boateng 2017). According to Wardlaw & Kessel (2002), soy protein is a beneficial alternative to include in the vegan diet where non-animal sources of protein are essential. Soy beans have a similar biological value when compared to meat. This comparison can be seen in Table 2.8. The beans contain LA and is a good source of calcium. ALA which is an omega-3 fatty acid is also found in soy beans. Soy is also rich in vitamin E, B1, B2 and B6, and minerals such as potassium, magnesium and phosphorous (Appiah *et al* 2017).

Table 2.8: Biological value of protein (Hoffman & Falvo 2004)

Protein type	Biological Value (BV)
Beef	80
Casein	77
Egg	100
Milk	91
Soy protein	74
Wheat gluten	64
Whey protein	104

According to Joshi & Kumar (2015), soy protein concentrates and isolates provide more advantages to manufactures of meat substitutes when compared with minimally and unprocessed soy protein. There is an improvement on colour and flavour of the meat substitute as minimally processed soy protein darkens the product and generally produces a bitter flavour. There has been speculation that majority of manufactures use a combination of non-textured and textured soy protein when producing meat substitutes. However, current literature suggests the use of additional protein sources as well as soy ingredients during the formulation of meat substitutes, to improve nutrition and functional purposes of these products (Joshi & Kumar 2015: Malav, Talukder, Gokulakrishnan & Chand 2015).

2.6.2.1.2 Cereal proteins

Cereal proteins are grouped into many different categories based on the origin of the plant used (for example: rice, oats, wheat, barley) and the extent of processing (for example: the addition of isolates, flour, seeds, flakes) (Malav *et al* 2015). Wheat is the most used type of cereal

protein used in the production of meat substitutes, together with seitan, wheat has been used for several centuries. Seitan, which is also known as "wheat-meat" or "wheat gluten", is a common meat substitute (Malav *et al* 2015). It is also one of the simplest and cost-effective raw materials used in the production of vegetarian burgers, sausages, schnitzels, nuggets and minced meat (Joshi & Kumar 2015). However, oat, barley and rice ingredients are commonly found in the ingredient labels of new meat substitute products. Nutritionally, the carbohydrate content is generally higher in cereal ingredients and protein content is much lower when compared with soy (Bohrer 2019). Interestingly, protein digestibility scores of cereal ingredients are usually lower when compared to other protein sources, due to the low protein digestibility and suboptimal profile of amino acids. Cereal proteins have shown to have lower values of amino acids when compared to other sources of protein. Lysine is one of those amino acids which is limited in cereal proteins (Mota, Santos, Mauro, Samman, Matos, Torres & Castanheira 2016).

Cereal proteins have very useful functional and structural properties and is used by manufacturers of meat substitutes. The structural network of these proteins can be described as visco-elastic, which can assist with successful binding and necessary consistency in meat substitutes. Cereal proteins can further provide the fibrous-like texture that is present in ground meat substitute products (Kumar *et al* 2017; Malav *et al* 2015).

2.6.2.1.3 Legume proteins and mycoproteins

In recent years, legume proteins from pea, mung bean, lentil, chickpea, lupine and other sources, are increasing in popularity among meat substitute manufactures (Bohrer 2019). Nutritionally, legume proteins are typically low in methionine and digestibility is the main challenge (Nosworthy & House 2017). Although, it is assumed that processing improves the digestibility and availability of proteins, the protein digestibility-corrected amino acid scores (PDCAAS) of legume products which are unprocessed is generally in the 0.40 to 0.70, and is not comparable to animal derived proteins or proteins from soy (Huang, Wang, Sivendiran & Bohrer 2018). The functional properties of legume proteins provide optimal complimentary function to other protein ingredients, with distinctive processing characteristics (Kyriakopoulou, Dekkers & van der Goot 2019).

According to Derbyshire & Ayoob (2019), mycoprotein is a fungus type product, first described in the 1960's as an eco-friendly protein substitute. The formulation of mycoprotein involves various techniques of processing and fermentation. Mycoprotein can be compared to animal-derived protein sources with a PDCAAS of 1.00 (Huang *et al* 2018). Functionally, mycoprotein

is usually combined with other ingredients, such as egg albumin, so processing characteristics can be improved (Malav *et al* 2015).

2.6.2.1.4 Fat ingredients

The fat content is usually low in meat substitutes (Kumar *et al* 2017), however, modern meat substitute products contain a considerably higher fat content compared to traditional meat substitute products. In fact, the content of fat in modern meat substitutes is almost equivalent to traditional meat products. Similar to proteins, a variety of fat ingredients is used to formulate meat substitutes. In modern meat substitutes, fat ingredients may include sunflower oil, canola (rapeseed oil), corn oil, coconut oil, sesame oil, cocoa butter and other sources of plant and vegetable oils (Bohrer 2019). As discussed in a review conducted by Kyriakopoulou *et al* (2019), the main role of oils and fats added to meat substitute formulations, is to contribute to release of flavour, tenderness, juiciness and mouthfeel of the product. However, careful consideration should be centred on the effect of these fat during the processing and preparation in order to avoid excessive stickiness and lubrication.

Nutritionally, dietary fats and oil intake in the human diet is highly debated. Generally, dietitians, nutritionists and government organisations (like the American Heart Association) have recommended dietary patterns and guidelines that limit the intake of trans fats and saturated fats and promote unsaturated fat consumption (Appel, Brands, Daniels, Karanja, Elmer, Sacks & American Heart Association 2006). The composition of fatty acids in fats and oils varies between manufacturing methods and sources. It is possible, that various refinement techniques such as isomerization, pressing and fractionation can adjust the fatty acid content of the plant-based fats and oil which are used in modern meat substitutes. Therefore, manufacturers should be aware about the general composition of the fats and oils in modern meat substitutes and the fatty acid breakdown in terms of saturated and unsaturated in these products (Bohrer 2019). The comparison of fat content in meat substitutes and meat products can be seen in Table 2.7.

2.6.2.1.5 Carbohydrate ingredients

Animal meat products do not comprise of carbohydrates, except when carbohydrates are added during the processing of the meat product. This is common in the manufacturing of meat, specifically emulsified processed meat products (Topping 2007). On the other hand, meat substitutes most often contain carbohydrates. These carbohydrates can be obtained from a variety of ingredients and can assist in different purposes during processing. Carbohydrate

ingredients can be characterised as flours or starches which are used to enhance and improve the consistency and texture of the product or gums or binding ingredients, such as acacia gum, methylcellulose, xantan gum and others, that are used to improve the form and stability of products (Kyriakopoulou *et al* 2019; Kumar *et al* 2017; Topping 2007).

The functional purposes of these carbohydrate ingredients is to improve the interaction between water, protein and lipid components of the processed food product in order to form a stable structure. Nutritionally, carbohydrates can be beneficial to health with providing the body with greater amounts of dietary fibre or unfavourable to health by consisting of more refined sugars or starches (Viuda-Martos, Lopez-Marcos, Fernandez-Lopez, Sendra, Lopez-Vargas & Perez-Alvarez 2010; Topping 2007). A combination of sugars, starches and dietary fibre is generally included in the production of meat substitutes and meat products which are processed (Kumar *et al* 2017). Therefore, it is challenging to know if there are actually health benefits of carbohydrate ingredients when added to meat substitutes (Biswas, Kumar, Bhosle, Sahoo & Chatli 2011). It is important that consumers request that food processors provide clear labelling on these food products (Watson 2007).

Presently, most of the meat-substitute food products are based on soy [Textured vegetable protein (TVP), Tempeh and Tofu], mycoprotein (Quorn) and wheat protein (Seitan), and all suit the standard of effective production of protein and are highly beneficial to reducing carbon footprints from food (Hoek *et al* 2004). The success of meat substitutes in the market largely depend on their ability to be included into daily meals and that products are easily recognised and accepted by consumers. Some meat substitutes produced from vegetable origin contain texturing agents and undergo a shearing method to give the product a texture that is fibrous. However, some customers report the texture to be rubbery and elastic resulting in an unpleasant mouthfeel (Kim, Choi, Lee, Lee, Kwon, Oh & Kim 2011).

In the last few years, companies manufacturing meat substitutes had many successful attempts in improving the sensory profiles of their products (Kumar *et al* 2017). There has also been an increase in vegetable proteins being used in meat products as a binding agent, filler or extender, such as skim milk powder, defatted soy flour and refined wheat flour. Meat substitutes continue to be a suitable alternative for vegans, vegetarians, lactose intolerant individuals, those following strict religious rules and health conscious non-vegetarians (Kumar *et al* 2017).

2.6.3 Plant-based milk alternatives

Vegetarian and vegan diets are increasing around the world, with concerns regarding the environment and health as major influencing factors (Messina & Mangels 2001; Van Winckel, Vande Velde, De Bruyne & Van Biervliet 2011). Therefore, over the past few decades, there has been a rise in the demand for alternatives to cow's or bovine milk. These alternatives include mainly soy milk, rice milk, almond milk, coconut milk and cashew milk. A variety of other sources such as oats, hemp, flax, hazelnuts and macadamia, in relatively minor quantities have also been used to produce these milks (Vanga & Raghavan 2018). While the consumption of cow's milk is reducing, the intake of alternative milks is increasing, research on these products is quite limited, with soy milk being an exception (Murugkar 2014). This could be due to other soy products including soy beans being used in different parts of the world for centuries (Vanga & Raghavan 2018).

While there are no detailed definitions and classification of milk alternatives in literature, plant-based or vegetable milk alternatives can be categorised into five groups which can be seen in Table 2.9.

Table 2.9: Type of plant-based and vegetable-based milk alternative (Sethi, Tyagi & Anurag 2016)

Category	Types of milk
Cereal-based	Rice milk, oat milk, corn milk and spelt milk.
Legume-based	Peanut milk, soy milk, cowpea milk and lupen milk.
Nut-based	Almond milk, hazelnut milk, walnut milk, coconut milk and pistachio milk.
Seed-based	Sunflower milk. Hemp milk, flax milk and sesame milk.
Pseudo-cereal based	Teff milk, amaranth milk and quinoa milk.

As research indicates, vegans focus their nutritional decisions around the benefit of the environment and saving the earth's resources; ethical reasons about caring for animals; the use of growth hormones and antibiotics used for producing animals; the danger of animal-borne viruses and the benefits of a plant-based diet on human health (Craig 2009). Vegans are known to be health conscious consumers. A "health conscious" consumer can be described as an

individual who is concerned and aware about their well-being and is strongly driven to maintain their health, prevent illnesses and improve their overall quality of life by following healthy eating behaviours and exercising regularly (Newsom, McFarland, Kaplan, Huguet & Zani 2005).

Plant-based milk alternatives (PBMA) are a popular functional beverage of choice among these groups because of their common health benefits of being low in energy, and free of cholesterol and lactose (Sethi *et al* 2016). Although PBMA are not the exact nutritional equivalent to cow's milk as seen in Table 2.10, these products can be fortified with specific nutrients such as vitamin B12, calcium and vitamin D to become more comparable to cow's milk (Singhal, Baker & Baker 2017). Table 2.10 shows the consumption of 100 g of cow's milk can provide about 64 kilocalories (kCal) of energy, while 4.65 g of carbohydrates provides 29% of energy, 3.66 g of fat providing 46% of energy and 3.28 g of protein yielding 21% of energy. Therefore, in order for PBMA to be used as an alternative source of cow's milk, the selected food should have a similar distribution of energy. The energy distribution is more balanced when compared to rice, almonds and coconuts which are used to produce alternative milks. From the table, it can be calculated that 69% of total energy from almonds and 76% of total energy from coconut come from fats, while 89% of total energy in rice comes from carbohydrates (Vanga & Raghavan 2018).

The total amount of calcium in 100 g of almonds and soy beans is significantly higher when compared to milk (Vanga & Raghavan 2018). However, the total number of calories from 100 g of almonds and soy beans is higher than that of milk, therefore it would be an improper way to compare these values. In order to rectify this information, a novel term was introduced 'weight of nutrient per kCal of energy', which is defined as the density of nutrients for appropriate comparing of the nutrient constituents with regard to the energy yield instead of the mass of food (Newmark 1987). Table 2.10 also shows the total energy found in 240 ml of cow's milk compared to the energy values of PBMA. Cow's milk had a total energy yield of 158 kCal, while the average yield for the same amount of coconut milk, rice milk, soy milk and almond milk was calculated to be 48.75 ± 7.5, 133 ± 13.04, 95 ± 15.16, 36.43 ± 6.9 kCal respectively. The significantly lower energy values that are present in PBMA is one of the main attractions for the increase in demand for the product. This is due to the cow's milk having an increased amount of sugars, which is usually lower in PBMA, rice milk is an exception (Vanga & Raghavan 2018).

In fact, many PBMA are promoted as having either equivalent or greater quantities of vitamin D and calcium contents compared to dairy milk once these products are fortified. However, it is essential to emphasise that the bioavailability of these nutrients varies considerably among products and is not accurately known (Singhal, Baker & Baker 2017).

For example, many of the PBMA are supplemented with calcium. By adding calcium to a product, it does not guarantee that the nutritional composition is equivalent to other products which contain similar quantities of calcium. This is because the bioavailability of calcium differs in each type of PBMA (Heaney, Rafferty, Dowell & Bierman 2005).

Table 2.10: Nutritional composition of cow's milk and various plant milks (Vanga & Raghavan 2018)

Nutrients	EAR	Almond (100g)	Soy bean (100g)	Rice (100g)	Coconut (100g)	Cow milk (100 g)	240 ml
Carbohydrates (g)[a]Sugars	130	21.55 4.35	30.16 7.33	81.68 -	15.23 6.23	4.5 -	11.5 -
Fibre	35	12.5	9.3	2.8	9	0.0	0.0
Fats (g)	35	49.93	19.94	0.55	33.49	3.66	9.05
Saturated		3.8	2.88	0.11	29.67	2.28	5.64
MUFA		31.55	4.40	0.2	1.42	1.06	2.62
PUFA		12.33	11.25	0.2	0.37	0.14	0.35
Cholesterol (mg)[b]		0	0	0	0	14	34.1
Protein (g)	55	21.15	36.49	6.81	3.33	3.28	8.11
Minerals (mg)							
Calcium	1100	269	277	11	14	119	294.2
Iron	6.5	3.71	15.7	1.6	2.43	0.05	0.12
Magnesium	350	270	280	23	32	13	32
Phosphorous	600	481	704	71	113	93	230
Potassium	4700	733	1797	77	356	151	373
Sodium	1500	1	2	7	20	49	121
Zinc	9.4	3.12	4.89	1.2	1.1	0.38	0.94
Vitamins							
Vitamin C (mg)	75	0	6	0	3.3	1.5	3.7
Thiamine (mg)	1	0.20	0.87	0.18	0.07	0.04	0.1
Riboflavin (mg)	1.1	1.14	0.87	0.06	0.02	0.16	0.4
Niacin (mg)	11	3.62	1.62	2.15	0.54	0.08	0.2
Vitamin B6 (mg)	1.2	0.14	0.38	0.11	0.05	0.04	0.1
Folate (µg)[c]	320	44	375	7	26	5	12.36
Vitamin B12 (µg)	2	0	0	0	0	0.36	0.89
Vitamin A (µg)	600	0	1	0	0	33	82
Vitamin E (µg)	12	25.63	0.85	-	0.24	-	-
Vitamin D (µg)	10	0	0	0	0	-	-
Energy (kCal)[d]		579	446	370	354	64	158

a. Gram (g) b. Milligram (mg) c. Microgram (µg) d. Kilocalorie (kCal)

2.6.3.1 Soy milk

The most widely available and consumed PBMA is soy milk. Soy is a unique dietary source which is a good source of fat and protein. The seeds contain about 35 - 45% of protein and 20% of fat and serves as an important protein source especially in vegetarian diets (Friedman

& Brandon 2001). Soy milk is also consumed by populations who have lactose intolerance and milk allergies (Vanga & Raghavan 2018). This plant-based beverage, which was first produced in Asia and continued its journey to supermarket shelves in United States and Europe (Mäkinen, Wanhalinna, Zannini & Arendt 2016). Soy milk is also consumed for its health benefits due to the presence of isoflavones, which is related to anti-cancer properties (Omoni & Aluko 2005). In the Western world, soy products are still leading the market but the development of alternative products from other plant sources such as almond, oat and coconut have reduced its popularity. Many new soy milks and other related plant-based products now have an enhanced sensory quality; however, these products carry a stigma because of previous less accepted products in the market (Wansink, Sonka, Goldsmith, Chiriboga & Eren 2005). Milk made from legumes tend to retain a "beany" and "paint-like" flavour, this is due to the activity of lipoxygenase. The intensity of this flavour depends on the storage and processing environments. Another concern is a "chalky" feeling in the mouth due to the insoluble constituents (Durand, Franks & Hosken 2003). This has caused regular complaints among consumers of soy milk. Furthermore, the presence of non-nutritive factors in various soy products and soy beans was also a concern (Vagadia, Vanga, Singh & Raghavan 2016). The contribution of these factors caused a decline in the consumption of soy milk and almond milk raised in popularity among the masses (Dhakal, Liu, Zhang, Roux, Sathe & Balasubramaniam 2014). Despite the concerns surrounding the consumption, it is still widely purchased and consumed as an alternate source of protein in a variety of diets and cuisines with a number of local and international brands (Vanga & Raghavan 2018).

2.6.3.2 Almond milk

Almond beverages have been commonly consumed for a long period of time because of its taste and flavour profiles. However, in recent years almond milk has also became one of the most popular PBMA in the North America, Australian and European Union beverage market (Dhakal *et al* 2014). The consumption of almonds have many health advantages, which is one of the main factors that increased the demand for beverages made from almonds. Almonds are rich in MUFA, which are considered helpful in managing and losing weight (Vanga & Raghavan 2018). Almonds also provide an important source of a variety of nutrients such as protein, vitamin E, manganese and fibre (Chen, Lapsley & Blumberg 2006).

Almond milk is produced using a colloidal dispersion which is the result after mixing pasted or powdered almonds with water. The solids are filtered, and a milky white liquid is produced.

The content of the solid is determined by the almond to water ratio. Generally, the milky white liquid is homogenised by using high pressure during commercial processing techniques. This is followed by pasteurisation processes to improve the stability of the milk and to increase the shelf life (Bernat, Chafer, Chiralt & Gonzalez-Martinez 2014). Almond milk is generally low in calories. It is important to consider the calcium content before selecting a particular brand of product, as the higher content of calcium is mainly due to the addition of calcium prior to the processing in order to imitate cow's milk calcium content. A good level of antioxidants are found in almonds, which is also seen in almond milk. Vitamin A content contributes about 10-50% of the EAR, while vitamin E contributes 10 - 30% of the EAR (Vanga & Raghavan 2018).

2.6.3.3 Rice milk and coconut milk

Rice milk is a common type of grain milk which is usually prepared by combining milled brown rice with water. Generally, rice is known to be a rich source of carbohydrates in the diet and similarly, rice milk has an increased content of carbohydrates compared to cow's milk as seen in Table 2.10. The processing of rice milk results in sugars being formed due to the breakdown of carbohydrates. The process provides rice milk with its distinctive sweet taste without adding sugars. This is usually done through the use of enzymes (Vanga & Raghavan 2018). Rice milk is a good alternative for patients who are lactose intolerant as the milk is lactose free (Lomer, Parkes & Sanderson 2008). According to Craig (2009), rice milk which is unfortified, more especially homemade milk, has a decreased content of vitamins and minerals such as vitamin B12 and calcium. Therefore, fortified commercial rice milk provides a better source of nutrients.

Coconut milk is a liquid which is extracted from grating the white meat of the coconut. Coconut milk is high in saturated fats and is commonly consumed in various parts of South America and Asia. Coconuts are usually cultivated in tropical climates and the canned products are exported to Europe and North America (Tinchan, Lorjaroenphon, Cadwallader & Chaiseri 2015). Many researchers have also found evidence that coconut milk contains lauric acid which can raise high-density lipoprotein (HDL) cholesterol levels, which assists in decreasing the detrimental low-density lipoprotein (LDL) cholesterol levels in the blood (Ekanayaka, Ekanayaka, Perera & De Silva 2013; Mensink, Zock, Kester & Katan 2003). The health advantages linked to coconut milk consumption have contributed to the increased demand in different countries. Coconut milk is different when compared to the other PBMA, as the overall amount of calories is quite low, and most of the calories are obtained from fats which are saturated as coconut milk

contains no protein and a reduced amount of carbohydrates as seen in Table 2.10 (Vanga & Raghavan 2018).

2.6.3.4 Consumer acceptance of PBMA

Although the popularity and demand for PBMA is increasing, consumers' unwillingness to purchase and consume unfamiliar food that are previously known to be unappealing, may be a contributing factor (Mäkinen *et al* 2016). There are many technological concerns which need to be revised with the purpose of producing a PBMA similar to that of cow's milk in nutrient value, taste, stability, appearance and most especially flavour (Sethi *et al* 2016). McCarthy, Parker, Ameerally, Drake & Drake (2017) in North Carolina, conducted an online survey consisting of consumers of fluid milk (n = 999). These consumers included cow's milk consumers (n = 702), non-dairy milk consumers (n = 172) and consumers of both types of milk (n = 125). According to the study results, consumers were more likely to purchase cow's milk based on the fat content of the product, label claims and packaging size.

Consumers preferred 1 or 2% fat content, a gallon (± 3.78 litres) or half a gallon (± 1.9 litres) packaging and a store-brand milk which is conventionally pasteurised. The sugar content is one of the main attributes for the purchase of PBMA, followed by the plant source of the milk and size of packaging. Almond milk was the most preferred plant source and half a gallon packaging of milk was the most preferred packaging size (McCarthy et *al* 2017). Another distinctive characteristic of consumers is that the purchasing of PBMA contributes to the goal of consuming less or no animal products; beliefs about preventing animal abuse and the perceived reduction of the effect on the environment (McCarthy *et al* 2017).

A large scale study by Palacios, Badran, Drake, Reisner & Moskowitz (2009) compared the acceptance of soy milk and lactose free cow's milk among adult consumers in America (n = 893). It was found that lactose free cow's milk was favoured over soy milk, with no influence on dairy intolerance, gender or ethnicity. A study involving American school children found a similar result (n = 425) (Palacios, Badran, Spence, Drake, Reisner & Moskowitz 2010). A review by Diarra, Nong & Jie (2005), showed that the acceptance of peanut milk depends on the absence of peanut flavour, mouthfeel and colour of the milk and its similarity to cow's milk. By providing additional nutritional information to consumers, it can increase the readiness and willingness to try and purchase new food products, especially health benefits and health information. The main purchasing decision for food is predominantly based on the taste of that

particular food item, the information provided about the product and if it is familiar to the consumer (Magnusson, Arvola, Hursti, Aberg & Sjödén 2001).

2.7 Plant-based diets and veganism in South Africa

South Africa is recognised as a low to middle income developing country, in the midst of a nutrition transition which is characterised by a quadruple burden of communicable diseases, NCDs, perinatal, maternal and injury-associated disorders (Pillay-van Wyk, Msemburi, Laubscher, Dorrington, Groenewald, Glass, Nojilana, Joubert, Matzopoulos, Prinsloo, Nannan, Gwebush, Vos, Somdyala, Sithole, Neethling, Nicol, Rossouw & Bradshaw 2013). The nutrition transition that exists in South Africa, is accompanied by the co-existence of both under- and over nutrition in the population (Wentzel-Viljoen, Lee, Laubscher & Vorster 2018), as both have negative outcomes on health (Maunder & Meaker 2007). Undernutrition is related to thinness, underweight and stunting while over nutrition relates mainly to overweight and obesity among the population (WHO 2018). Undernutrition in South Africa is mainly due to the physical and economic lack of accessibility to food, the knowledge of how to use food that is available and proper access to information on preventative and curative health services. The accessibility to clean water, proper hygiene and sanitation and shelter also contributes to an individual's nutritional status (Benson & Shekar2006).

A South African study by Sartorius, Veerman, Manyema, Chola & Hofman (2015), analysed three national cross sectional surveys to assess the determining factors of obesity and attributes associated with the population in South Africa over five years (2008 - 2012), found that the prevalence of obesity increased considerably from 23.5% in 2008 to 27.2% in 2012 ($p < 0.001$) and was more prevalent among females (37.9% in 2012) when compared to males (13.3% in 2012). Many studies have indicated the advantage of using plant-based diets for promoting the loss of weight and preventing overweight and obesity (Turner-McGrievy *et al* 2017; Dewell & Ornish 2007; Barnard *et al* 2005). However, there is a limited number of studies conducted in South Africa regarding the role of PBDs to combat obesity. In South Africa, the nutrition transition is multifaceted and is reinforced by the dietary changes in urban areas and challenges associated with undernutrition, which lead to massive rural to urban migration and rapid urbanisation (Harpham 2009).

This shift causes major public health threats which impacts on the poorer communities in South Africa which are the most food insecure (Sverdlik 2011). Food insecurity is defined as "the lack of physical, social and economic access to sufficient, safe and nutritious food that meets

the dietary needs and food preferences of an active and healthy lifestyle" (Food and Agriculture Organization 2009). Generally, the population in South Africa consumes a diet with limited variation (United Nations 2010) and therefore the population is nutritionally vulnerable (Drimie, Faber, Vearey & Nunez 2013), mainly due to food insecurity and the consumption of staple plant foods (Labadarios, Steyn, Maunder, Macintyre, Gericke, Swart, Huskisson, Dannhauser, Vorster, Nesamvuni & Nel 2005).

The most frequently consumed staple foods include bread, maize, sugar and tea and these food items are not good sources of micronutrients (Steyn, Nel, Nantel, Kennedy & Labadarios 2006). The South African Department of Health introduced a compulsory fortification of nutrients in staple foods including bread flour and maize meal in the year 2003, with the aim of addressing micronutrient deficiencies (South African Department of Health 2013), which came into effect in 2004 (Wentzel-Viljoen *et al* 2018). On the other hand, vegans choose to follow a vegan diet, primarily consisting of food of plant-based origins; in order to exclude all animal products from their diet mainly due to the ethical concern for animals (Gray, Sellon & Freeman 2004) and not because they are from a low economic status. Therefore, individuals who decide to follow a vegan diet are more popular in developed economic countries (Newport 2012).

Vegan products can be seen as a "luxury" to some and the purchasing of these products is synonymous to having wealth and attaining products of high quality. These products are expensive mainly due to their limited availability, and veganism is accompanied by the desire to belong to a specific group that highlights individuality (Palka & Newerli-Guz 2018). Taking this into consideration, veganism may only apply to those of middle to high socio-economic status who can afford such a lifestyle. Lower-economic communities in South Africa spend most of their money on food and it becomes difficult to afford other necessities such as prepaid electricity, school fees and medication (Statistics South Africa 2012).

Individuals in South Africa belong to diverse ethnic cultures and thus a single culture does not exist, but rather a multitude of ethnic values (Abratt & Penman 2002). Currently, there are four main population or ethnic groups in South Africa; namely Black African [Nguni (Zulu, Xhosa, Ndebele and Swai), Sotho-Tswanam Tsong and Venda], Coloured [people of mixed lineage (Africans, whites, former African slaves and indigenous Khoisan)], Indian/Asian and White [(Afrikaners (German, Dutch and French Huguenot descendants), English-speakers (British descendants) and other European descendants of immigrants] (Statistics South Africa 2016). The total population in 2016 was 55.6 million, where 44.9 million were Black African, 4.9

million Coloured, 1.4 million Indian or Asian and 4.5 million were White (Statistics South Africa 2016).

Therefore, it is necessary to take into consideration that diverse ethnic groups have their own traditions and customs, and factors such as age, religion and income play an essential part in the consumption of meat. The consumption of meat forms a fundamental part of South African cuisine, and for most South Africans when meat is not included in a meal it is not considered a meal at all (Erasmus & Hoffman 2017). Among the majority of the population (which is Black African), cultural practices are associated with the consumption of meat products. Meat consumption plays a pivotal role at many gatherings such as initiation ceremonies, certain holidays and visits by significant guests (Kifleyesus 2007).

The sharing of meat in these traditional gatherings is closely related to a lifestyle as one is associated with having wealth and a strong belief in religion (Seleshe, Jo & Lee 2014). These social values and norms contribute to unhealthy eating habits. For example, Black African men preferred to consume meat on a daily basis; the meat served should also be "fatty" as it is a sign of generosity and "lean" meat is associated with stinginess. The Black African population are faced with other difficulties as being overweight is seen as desirable and is a sign of affluence. Individuals who migrated to the city are often envied and complimented when they visit rural communities. In addition, there is still a strong belief that "thinness" is related to having HIV/AIDS and therefore, the majority of the population, especially women found it difficult to maintain a normal body weight (Puoane & Tsolekile 2008).

A study by Peltzer (2004), conducted in South Africa, investigated the understanding of nutrition knowledge among a sample of urban Black African (n = 90) and urban White (n = 90) South Africans. This study found that both Black African and White respondents had practical knowledge on nutrient recommendations and the source of nutrients in food, but a reduced amount of knowledge on the relationship between diet and disease. Whites had more general knowledge on nutrition than Black Africans, while Black African females had a significantly lower knowledge on nutrition than White females. This study is similar to other international studies, whereby more females and Whites were more likely to follow restrictive diets or be practicing vegans (Cruwys, Norwood, Chachay, Ntontis & Sheffield 2020; Radnitz *et al* 2015; Clarys *et al* 2014; Blanco & Enrione 2012).

Due to the massive burden of diet-related diseases, South Africa developed and released its first set of Food Based Dietary Guidelines (FBDG) in the year 2001. The FBDGs consist of ten

simple messages to assist all South Africans over five years of age and from diverse ethnic backgrounds in both urban and rural communities to follow healthy diets and lifestyles. The guidelines emphasised the consumption of food that is available locally and aimed to address public health concerns which are nutrition-related (Gibney & Vorster 2001).

However, when the cost of a typical South African diet was compared to a healthy diet, the healthier diet costed around 69% more than the traditional diet, depending greatly on the food choices. Healthy diets have low energy density and are nutrient dense. A study by Temple & Steyn (2011) found that the cost of these diets were determined by comparing commonly consumed foods in a typical diet such as a hamburger (high fat), full-cream milk, cornflakes, brick margarine, white rice and brown bread to a healthier diet which included a lean hamburger, low-fat milk, bran flakes, margarine rich in polyunsaturated fats, brown rice and white bread. The prices were then recorded from eight different supermarkets. It was estimated that for a family of five this extra cost would amount to R 36.00 per day more than a typical diet. Therefore, for most South Africans, a healthy diet is unaffordable. In a developing country like South Africa, individuals should be provided with education on the advantages of a healthy diet and how to make the diet affordable with appropriate food choices. The government should also implement strategies to manipulate food prices in the country (Temple & Steyn 2011). Therefore considering the multicultural diversity among the South African population, it was expected that a vegan diet would be followed by a food secure population who practised a restrictive diet out of choice and not necessity.

2.8 Conclusion

In the past few years, there has been a significant increase in the number of people who are following a vegan diet. This may indicate that a share of the population are approaching a notable transition motivated by creating awareness about the harm and abuse towards animals, the accumulated data on the health advantages of following a vegan diet and the rise in availability of dairy and meat plant-based alternatives (Radnitz *et al* 2015). From the literature, it can also be seen that becoming a vegan and following a vegan diet involves a process that is continuous. This process is sometimes inhibiting and stimulating by both negative and positive motives and perceived concerns (Larsson *et al* 2003). Vegans are motivated for different reasons; however, it is essential to note that individual's dietary motivations have a tendency to modify over time (Ruby 2012). The diet also largely depends on the motive behind following the diet. Those individuals following a vegan diet for health reasons had the tendency to choose

foods that are more nutritious and make healthier food related decisions, whereas ethically motivated individuals consumed more supplements and high fat foods (Radnitz *et al* 2015).

According to Waldmann *et al* (2003), overall vegans consumed a diet that is well-balanced with a high amount of nutrients and followed a beyond average healthy lifestyle. Although the consumption of vitamin B12, iodine and calcium should be improved in the diet. As literature suggests, strict vegans should add supplements of minerals and vitamins to their plant-based diet to meet nutritional requirements. Radnitz *et al* (2015) states that in future, vegan consumers will soon influence omnivore consumers to change dietary patterns.

Both the food industry and agricultural segment should increase the consumer concerns that surround animal welfare (Grunert & Aachmann 2016). The stigma that is attached to following a vegan diet should be reduced by public awareness about the benefits to health and the environment. Family and friends should support vegans so that the diet could become a normative pattern of eating (Markowski & Roxburgh 2019).

Over the years, there has been much focus on the vegetarian diet, although currently there is an evident shift to a stricter vegetarian diet. The vegan diet is a topic that has not been researched in South Africa to date. Veganism and the vegan diet is becoming a growing trend in South Africa as more individuals are choosing to adopt the lifestyle for a variety of reasons. Therefore, data from this research will be beneficial, as it has determined the demographic characteristics of vegans in South Africa and whether the diet is more likely to be followed by a particular gender, race, education level and socio-economic group. Many international studies have focused on numerous factors that influence an individual to follow a vegan diet. As previous literature presents, the main motivation is the prevention of animal abuse, however, sustaining the environment and better health outcomes are also contributing factors that influence individuals to transition into the diet.

According to the literature presented, it was important that this study objectives were based on the findings of international research. It was important to investigate the demographics and factors influencing South African vegans and whether these factors were different or similar to international studies.

The literature has shown that it is important to further investigate the challenges that vegans face in South Africa, including the social stigma attached to avoiding animal food and products, the availability of vegan food products, vegan meals in restaurants and financial implications

associated with the transition. The different ways that these challenges were overcome were also investigated as it will assist other vegans who might face similar challenges in the future.

Based on the literature surrounding the nutritional composition of vegan diets, it was important to investigate the nutritional quality of the vegan diet followed by South Africans, the variety of different food groups and types of processed food consumed by vegans in South Africa. It was anticipated that this would show how South African vegans plan and follow the diet in comparison with international vegans.

The next chapter will address the methodology used in order to accomplish the objectives of the study.

CHAPTER 3: METHODOLOGY

This chapter will outline the methodology of the study. The following sections will be covered: the study design, type of study, study population and sample section. The chapter will further elaborate on the development of the survey questionnaire and data quality control tools used to ensure reliability and validity of the questionnaire. The pilot study, statistical analysis and ethical considerations of the study will also be discussed.

3.1 Study design

A cross-sectional study design using quantitative research was chosen for this study to determine the motives and challenges facing South Africa vegans and the nutritional quality of their diet. This was conducted using an online questionnaire.

3.2 Study setting

An online questionnaire was published on the South African Vegan Society (SAVS) group on their Facebook page with the following link: https://www.surveymonkey.com/r/3N52ZRP and was open to all vegans living in South Africa. The SAVS group was chosen as the best vegan group to use as it had the most number of members compared to other researched vegan groups.. SAVS is known as the primary vegan outreach organisation in South Africa. At the point of data collection, in August 2019, this page consisted of a total of 9 819 members from all provinces in South Africa. The SAVS Facebook group was also the best method of targeting South African vegans as the majority of individuals of all age groups use the internet and join popular social media sites such as Facebook. This group is open to the public providing updated information on vegan diet trends and the latest veganism practices in South Africa (South African Vegan Society 2015).

3.3 Type of study

3.3.1 Cross sectional study

A cross-sectional study design has a purpose of discovering the occurrence of the result of concern seen in a population or subpopulation at any point in time (Levin 2006). These studies are usually conducted by using survey formats. These studies have the advantage of being quick and inexpensive. Another advantage is that a reduced number of resources are required to conduct the study and there is no follow up of respondents (Mann 2003). A non-random convenience sampling method was used for this study.

3.3.2 The use of an online questionnaire

Surveys in the form of questionnaires are mainly used to evaluate the behaviour, knowledge and attitudes of respondents in a study (Rubenfeld 2004). Structured multiple-choice questions are used to assess *knowledge* in usual types of surveys. Surveys that assess *attitudes* generally do not have correct answers and are formulated to prompt the respondents' feelings about a particular topic (Rubenfeld 2004). On the other hand, surveys that measure *behaviour* are commonly self-reported surveys which have limitations. Respondents may be hesitant to confess to certain behaviours and often forget other behaviours they normally practice (Groves 2005). Researchers expect that the results of their survey will show attitudes, behaviour and true knowledge from the surveyed respondents (Rubenfeld 2004). Therefore, the main purpose of a survey is to collect unbiased, consistent and reliable data (McColl, Jacoby, Thomas, Soutter, Bamford, Steen, Thomas, Harvey, Garratt & Bond 2001).

There are two important forms used for the collection of data: self-administered questionnaires and standardised interviews. However, variations can exist within each of these forms. For example, standardised interviews can be done over the telephone or through a face-to-face interview in person. Self-administered questionnaires can be used in an individual or a group setting. Email and internet self-administered questionnaires are becoming increasingly popular (De Leeuw, Hox & Dillman 2008, pp313 - 314). Table 3.1 shows the advantages and disadvantages of self-administered questionnaires and structured interviews.

Table 3.1: Advantages and disadvantages of self-administered questionnaires and structured interviews (Brace 2008, pp26 - 34; Meadows 2003; Bourque & Fielder 2003, pp2, pp9 - 19)

Type of data collection tool	Definition	Advantages	Disadvantages
Self-administered questionnaires	Questionnaires used to collect data from respondents who complete the tool by themselves.	• Reduced cost when compared to other methods. • Wider geographical coverage. • Coverage to a larger sample population. • Easier to implement compared to other methods.	• Poor response rates due to barriers of language and literacy. • Lack of control of respondents who complete the questionnaire. • Some questionnaires are completed poorly.
Structured interviews	Each subject under study is asked a sequence of questions according to an arranged interview schedule.	• Any queries about questions can be discussed. • Questions can be corrected if misunderstood. • Respondents are motivated to provide longer answers to open-ended questions. • More complex questions can be asked.	• The cost involved with finding a representative sample of the survey under study. • The communication between the interviewer and participant can influence the accuracy of the data and introduce bias.

After careful consideration regarding the advantages and disadvantages of the two types of questionnaires listed in Table 3.1, a self-administered online questionnaire was chosen for this study. According to Brace (2008), a self-administered questionnaire can either be on paper or online. Paper-based questionnaires have the advantage of allowing the respondent time for completion, where they are able to answer open-ended questions fully with minimal time pressure. A major disadvantage is that paper-based questionnaires allow the respondent to read through the questions before answering them in the required sequence according to the stated instructions. By constructing questions using a specific sequence, there is a logical flow to the survey. Respondents should start with the easier questions before progressing on to the more complex questions. However, this can lead to questionnaires being incomplete or completed incorrectly, causing the researcher to be uncertain regarding its validity. The researcher may have spent time carefully entering data only to discover the questionnaire is incomplete (Jones, Murphy, Edwards & James 2008).

According to Jones *et al* (2008), web-based or online questionnaires have more advantages than those that are presented in hard copy and have unique attributes that decrease the disadvantages of online questionnaires. For example, the researcher has a number of methods to provide personal contact with the respondent. This can be done by using movie clips and images providing instructions. The researcher can also provide their email address by use of hyperlinks, should the respondent require additional information about the questionnaire. Online questionnaires should be designed to be eye-catching and appealing (Denscombe 2003) and the entry of data can be monitored at any point by "real time error checking and correction" (Solomon 2001) so that respondents are guided during the process. This is done to ensure that questionnaires are completed correctly before submission. Survey fatigue, also known as respondent fatigue, is a common concern when collecting data for surveys. There are many factors that influence survey fatigue such as the topic of the survey, length of the survey, complexity of questions and type questions especially open-ended questions. Survey fatigue often increases the possibility of attaining data which is incomplete and respondents tend to terminate study participation in the middle of the survey (O'Reilly-Shah 2017).

There are three main disadvantages of online questionnaires. The first disadvantage is that adapting a questionnaire to be delivered via the internet involves expertise and skill from researchers when compared to a paper-based questionnaire. The second disadvantage is that response rates are generally lower in email and internet questionnaires when compared to postal questionnaires (Solomon 2001; Couper 2000; Couper, Blair & Triplett 1999). Similarly, a

study by Sinclair, O'Toole, Malawaraarachchi & Leder (2012), found that online response rates were considerably lower than other modes. The third disadvantage is associated with sampling. A questionnaire delivered via the internet automatically disregards those respondents who lack computer literacy skills or access to a computer (Jones *et al* 2008). Therefore, attaining a representative sample from a population, may completely or partly exclude specific groups, such as the elderly (Denscombe 2003).

In order to overcome these challenges, the researcher constructed the questionnaire and included mostly closed-ended questions which were fairly easy to answer and analyse. Questions were constructed to provide as much information as possible and were designed to address the four objectives of the study. The sequence of questions in the questionnaire were according to the objectives, this was done to make it easier for grouping and data analysis. The questionnaire consisted of 32 questions including the food frequency questionnaire (FFQ) and 24-hour recall. The advantages of a 24-hour recall include an elevated response rate, multiple recalls can estimate the usual intake of individuals, the administration of recalls do not require much time or cost, there is high precision if the recall is administrated in the same study subjects (2-3 times) and it is considered a valid instrument for the assessment of energy and nutrients. The disadvantages or limitations of a 24-hour includes the extensive dependence on the recent memory of the study subjects, the capability of the interviewer for describing ingredients, food preparation and dishes and the administration of recalls require well-trained interviewers. There is often difficulty in precisely estimating food consumption and in general 24-hour recalls tend to underestimate intake. One single 24-hour recall does not estimate usual intake and the planning of 2 or more 24-hour recalls complicates field work (Castell, Serra-Majem & Ribas-Barba 2015).

The advantages of FFQs include that is relatively easy and inexpensive to administer, the questionnaire is able to target a specific nutrient or all food and nutrient groups, it is effective at ranking individuals within a group and results of a FFQ can be scanned and entered into a software program. The disadvantages and limitations include that the respondents require a certain degree of literacy, a FFQ relies on long-term recall ability, the tool is generally not as effective at determining absolute intake of nutrients and it may not include foods that are unique to the culture or important for the health condition of interest (Ralph, Ah, Scheett, Hoverson & Anderson 2011).

The questionnaire was easy to follow and read as large front was used (≥ 12 - point), making it visible to all age groups (Rubenfeld 2004). A pilot test was conducted online to make certain the questionnaire was acceptable to the population and to recognise issues with formatting, language and length (Monroe & Adams 2012) as well as questions requiring skip logic functions, when subsequent questions are not applicable to respondents (Manski & Molinari 2008).

Burns, Duffett, Kho, Meade, Adhikari, Sinuff & Cook (2008), stated that constructing a well-defined questionnaire requires a clear objective. The development stage of the questionnaire involves careful attention given to both the layout and design. This is important as the appearance of the questionnaire can influence a participant's decision to respond or not (Meadows 2003).

When designing web-based questionnaires the following guidelines should be considered:

- Questionnaires should be presented on a "single-scrolling page" or multiple linked pages and this should be supplemented with links and electronic instructions to assist the participant with effective completion (Burns *et al* 2008).

- Questions should be well organised and numbered correctly and options to respond should be presented on different lines (Burns *et al* 2008).

- Questions should be categorised according to the content (McColl *et al* 2001) and questions should possibly be ordered from easy to challenging (Meadows 2003).

3.3.2.1 The use of social media to administer an online questionnaire

The online questionnaire link was posted on Facebook a popular social network site where many individuals spend most of their time (Hei-man 2008). In general, social media is where people are allowed to exchange opinions and concepts, have content discussions on pages and have online contacts. Social media is unlike other media platforms, whereby everybody is able to comment and contribute to the available content. The content may be in the format of a text, photograph, audio or video and other visual formats that assist individuals to connect with one another and to combine communities (Drahošováa & Balco 2017).

The term "social media" is superior to "social network" and includes numerous media to create social interaction in the form of online communication such as blogs, videos and photo sharing sites (Drahošováa & Balco 2017). A social network falls under social media and it is a term

used to describe the interaction between people by creating personal profiles with the aim of becoming a "community" of friends. Examples of social networks include MySpace, LinkedIn and Facebook. The advantages of using social media is that there is constant communication and exchange of information, one is able to communicate at leisure, services are provided and there are educational advantages by sharing of resourceful information. The major disadvantages include the lack of confidentiality felt by users and information overload on particular platforms (Drahošováa & Balco 2017).

According to Nayak & Narayan (2019), online surveys have various advantages and are useful in collecting data, questionnaire preparation, storage of data, visualisation of data and collaborating of work. Online surveys can also be conducted at a reduced cost and in a short period of time. The researcher is able to begin the survey, pause at any time and restart the survey whenever he or she chooses to. Some of the disadvantages or challenges related to online surveys are related to sampling, response rates, non-respondent characteristics, confidentiality maintenance and ethical issues.

Currently, software packages have been developed to assist with conducting online surveys which makes online survey research faster and easier (Wright 2005). Thousands of organisations and groups have shifted online, many of which are constantly conducting promotions through the use of advertisements, list of emails and popular search engines. These online organisations not only provide information to users, but also offer researchers the opportunity to access a range of individuals who are associated with these organisations or groups (Wright 2005).

One of the main advantages of online survey research is the ability of the internet to provide accessibility to individuals and groups who would be difficult or sometimes impossible to contact when using other channels (Garton, Haythornthwaite, & Wellman, 1999). According to Wright (2000), the benefit of using virtual community sites for research, is that these sites are a platform that provides assistance to the researcher to reach out to individuals who share particular beliefs, attitudes, values and interests with regards to an activity, concern or particular issue in society. In contrast to other forms of traditional methods of survey research, it can be further complicated to reach a larger population of a comparable nature.

Llieva, Baron & Healey (2002), mentioned that online surveys save time and allows researchers to work on other tasks while collecting data. Once an invite is sent to respondents to take part in the survey which is either posted on the website of a particular community, emailed to

individuals or circulated through an internet-based survey research service, researchers can continue the data collection process while completing other tasks (Andrews, Nonnecke & Preece 2003). Online survey responses are usually sent immediately to the researcher via a database file or email. Therefore, while waiting to collect the required number of responses, the researcher can carry out primary analysis on the composed data (Llieva *et al* 2002).

The final advantage is that researchers can reduce costs by transitioning from a paper-based format to a format which is electronic (Llieva *et al* 2002; Couper 2000; Yun & Trumbo 2000). According to Llieva *et al* (2002), the need for paper and other costs incurred such as printing, posting and entry of data are eliminated when online surveys are used. Also, conducting interviews online, in the format of "chat "or by emails, results in saving of costs. Costs for the use of telephones, travel and equipment can be excluded. Moreover, since online responses are documented automatically, transcription costs can be eliminated. The latest online survey development software and service costs can differ from a small amount to large sums of money depending on the services selected and specific types of features required; however, when compared to traditional paper-based surveys, it is relatively inexpensive (Wright 2005).

The main disadvantage of online surveys that researchers encounter, is issues with sampling (Andrews *et al* 2003). For example, there is a limited amount of information known about people who are part of online communities, apart from some basic demographic characteristics and could possibly be uncertain (Dillman 2000). Some web survey services offer accessibility to populations. These population groups are generated from email lists of those who previously participated in online surveys Therefore, there is no guarantee that self-reported data from respondents of prior surveys provided correct characteristic and demographic details (Wright 2005).

Another disadvantage is generating samples from online organisations and virtual communities. However, some of these groups provide email lists of those who are part of the membership and this can assist researchers to develop a sampling frame. Although, all members of online organisations and virtual groups may not agree to list their email addresses, and many may forbid administrators to allow researchers access to their email addresses. Therefore, is it important to comply with the Protection of Personal Information (PoPI) Act especially while on social media platforms and be aware of cyber security (Botha, Eloff & Swart 2015). This also makes it challenging for researchers to accurately estimate the size of the online population. If the researcher obtains an email list, it can be possible to email the survey invite and web link

for participation in the online survey to each member on the list. This could ideally provide the researcher with a sampling frame. However, issues such as multiple responses from respondents, multiple email address for each respondent and inactive or invalid email address could make online random sampling a problematic process (Andrews *et al* 2003; Couper 2000).

It should be noted that some people in these virtual communities are "regulars" who contribute regularly to the discussions, while other people contribute intermittently. Moreover, people who read and acknowledge posts and do not send messages otherwise known colloquially as "lurkers", may complete an online survey despite the fact that they are invisible to others in the community. The occurrence of "lurkers" in these communities are greatly variable (Preece, Nonnecke, & Andrews, 2004). Studies have shown that some communities online have a greater percentage of lurkers, between 45% and 99%, while others have just a few (Preece *et al* 2004). This is because "lurkers" do not make themselves known on these online groups, researchers may find it challenging to acquire a precise sampling size or correct estimation of the sample population (Wright 2005).

The researchers may have a solution to this by proposing that respondents contact them for a distinct number or code and indicate this on the online questionnaire before completion. However, this extra detail might reduce the number of responses. An alternate solution is that some advanced online survey programs provide tracking of responses. In order to complete the surveys, email addresses of the respondents must be submitted. Once the survey is completed, the online survey program stores the respondents email address and permits anyone who uses the same email address to access that particular survey. This feature can assist with reducing multiple responses, however, there is a risk that someone can possibly complete an additional survey using an alternate email address (Konstan, Rosser, Ross, Stanton, & Edwards 2005).

The final disadvantage is issues with access. Many researchers access prospective respondents by posting survey invitations on chatrooms and on discussion and community groups. However, some members of these groups many find this to be disrespectful or unpleasant (Hudson & Bruckman 2004) or consider these posts to be a form of "spam" (Andrews *et al* 2003). The representative of that community may remove the post, or incensed community members may send emails to the researcher. However, many individuals from web communities are willing to accept invitations to participate in studies by researchers, particularly if these members are interested in how other people perceive their community (Reid 1996). Often it is challenging to access some online communities, and obtaining permission

takes time. Therefore, it is important to clarify the purpose, benefits, aims and objectives of the study and this may assist the researcher to be allowed to use that community (Andrews *et al* 2003). Wright (2000) suggests that researchers form a good relationship with community respondents and provide information about the study and the results to the community. This can be done by compiling a study report, posting it on an online page or posting a link on the community online page.

3.3.2.2 The use of an online survey software package

Currently, there are many online survey software packages to choose from as well as other web survey services that are obtainable to researchers who are prepared to incur the costs (Wright 2005). For the purpose of this study the SurveyMonkey software package was used. The features of SurveyMonkey were standard and the user was able to create an unlimited number of surveys. According to Symonds (2011), when compared to other software programs, SurveyMonkey does not require the installation of other programs. The program provides permission to researchers to export, save and correlate data in different formats, this assists with reducing human error as subsequent statistical analysis can be facilitated (McPeake, Bateson & O'Neill 2014). The program can also randomly organise questions and hide irrelevant follow-up questions. The program also improves the quality of data by including alarms, checks and notifies respondents when incomplete answers are entered (Van Gelder, Bretveld & Roeleveld 2010). SurveyMonkey generates an automatic response when a participant leaves a survey question empty and has an optional box to avoid questions that are unanswered. Surveys posted online are returned more quickly that those sent via post, as there are more respondents each day. This also allows for instantaneous administration, whereby many respondents are able to answer the survey simultaneously (Van Gelder et *al* 2010).

The program offers illustrations, which indicate the number of completed surveys per month. If the researcher needs to find out when a particular respondent had completed the survey, this information can be accessed via the "Individual Answers" section. SurveyMonkey archives the date and day as well as the start and finishing time and the total time the survey questions were completed by the respondent (Symonds 2011). The program has a wide assortment of default formats of question types, which assist in creating both understandable and simple survey designs. SurveyMonkey creates an individual web link to directly access and answer the survey. The dominant sources of distribution of surveys is through social networks and email (McPeake *et al* 2014). Researchers can use data management systems to send invitations and

email reminders automatically to all study respondents. Regular reminders may be a solution if there are low response rates (Aerny-Perreten, Domínguez-Berjón, Esteban-Vasallo, García-Riolobos 2015; McPeake *et al* 2014).

Overall, SurveyMonkey provides many benefits to a study. Using the program provides easy access and distribution of surveys, so that individuals could complete the surveys at home without an instructor (McPeake, *et al* 2014). The quicker response rates and feedback allows for an increased number of replies within a shorter space of time and the automatic compiling of data reduces the amount of coding and entry errors (McPeake *et al* 2014; Symonds 2011; Van Gelder *et al* 2010). The fact that the survey is online, respondents have a sense of anonymity so that they could respond truthfully in the survey (Ekman & Litton 2007). Despite some limitations, online surveys are a good substitute to other data collection methods (Varela, Ruiz, Andres, Roy, Fuste & Saldana 2016).

3.3.2.2 The types of questions used in the questionnaire

This study made use of multiple choice questions (MCQs) as well as questions using a Likert scale. A Likert scale is comprised of a sequence of four or more items that are joined into a single score during the data analysing process (Boone & Boone 2012). This scale provides quantitative information on an individual's personality or character (Boone & Boone 2012). MCQs are known to be a reliable source of evaluation. These questions are quick to complete and can address any topic (McCoubrie 2004). A well-formulated MCQ will be able to assist respondents with applying knowledge rather than recalling facts that are isolated (Case & Swanson 2001).

3.3.2.3 Method of data collection

This study involved individuals who follow a vegan diet in South Africa and using an online questionnaire was selected an effective tool to cover the wide geographical area. The questionnaire was published on the SAVS social media sites as it provided a country wide coverage for vegans to respond. Using telephonic interviews or sending questionnaires via email would have not been feasible due to the busy schedules of the respondents as well as locating the vegan community within each province. Nowadays, most individuals have access to the internet via cell phones and computer technology and this provides an influential platform for communication and research (Keshav, Chawathe, Chen, Zhang & Wolman 2007).

3.4 Study population and sample selection

3.4.1 Study population

The SAVS is a volunteer organisation that focuses on outreach to the public, resource distribution, product endorsement as well as the provision of guidance and support for those who decide to follow a vegan lifestyle (South African Vegan Society 2015). The SAVS Facebook national group had approximately 9 819 members currently from all the provinces in South Africa (August 2019) (South African Vegan Society Facebook Page 2019). A non-random convenience sampling method was used in this study.

3.4.2 Sample selection

The online self-administered questionnaire was published in August 2019 on the SAVS Facebook page available for all South African vegans to complete.

3.5 Questionnaire development

To date, no study has been conducted in South Africa on the motives and challenges that face South African vegans and the nutritional quality of their diet. Therefore, the online questionnaire was developed from other similar studies conducted internationally (Janssen *et al* 2016; Kerschke-Risch 2015; Radnitz *et al* 2015; Dyett *et al* 2013; Rothgerber 2013; Greenebaum 2012; Timko *et al* 2012; Izmirli & Phillips 2011; Waldmann *et al* 2003; Larsson *et al* 2003).

The questionnaire consisted of four sections with MCQ and Likert scale type questions, followed by 24-hour recall and a food frequency questionnaire (FFQ) to measure dietary intake analysis. Household food measurement photographs were developed to assist respondents in answering the 24-hour recall. Section A of the questionnaire covered the demographic characteristics of the respondents. Section B of the questionnaire addressed the motives for following a vegan diet. Section C of the questionnaire covered the challenges faced by individuals following a vegan diet. Section D of the questionnaire investigated the nutritional quality of the vegan diet. Closed-ended questions were also used which were less time consuming and easier to complete by the participant. A copy of the questionnaire can be found in Appendix A, p199 and household food measurements provided to the respondents when completing Section D can be found in Appendix B, p217.

3.5.1 Section A of the questionnaire

The first section of the questionnaire assesses the demographic characteristics of vegans as well as the duration they have been following the diet. Demographic characteristics usually follow a similar format. This section consisted of 18 questions presented in different formats. The nationality, province of residence and age of respondents were followed by education, total monthly income and the frequency and duration of physical activity levels. In this section of the question, respondents were also asked to report on the use of vitamin or mineral supplements, smoking and alcohol consumption. These questions would have shown similar characteristics of vegans in South Africa. The duration of following a vegan diet formed part of demographic characteristics as seen in other studies. Table 3.2 shows similar studies that included demographic characteristics as section A of their questionnaire.

Table 3.2: Studies used to formulate demographic characteristics of the questionnaire

Authors	Title	Purpose	Methodology	Respondents
Heiss, Coffino & Hormes (2017) United States.	Eating and health behaviours in vegans compared to omnivores: Dispelling common myths.	To compare dietary vegans to omnivores in terms of eating attitudes and behaviours.	Self-administered online questionnaire	Vegans (n = 358) Omnivores (n = 220)
Janssen *et al* (2016) Germany.	Motives of consumers following a vegan diet and their attitudes towards animal agriculture.	To determine whether all consumers following a vegan diet oppose animal agriculture in general or if some of these consumers accept certain forms of animal agriculture.	Face-to-face interviews	Vegans (n = 329)
Radnitz et al (2015) United States.	Investigation of lifestyle choices of individuals following a vegan diet for health and ethical reasons.	To determine the extent to which the reason for following a vegan diet was associated with health behaviours.	Online questionnaire	Vegans (n = 246)

3.5.2 Section B of the questionnaire

This section of the questionnaire addressed the motives for following a vegan diet and what influenced the respondents when transitioning to this diet. There are currently no published studies done in South Africa that have addressed this topic. Section B of the questionnaire consisted of three questions which included two Likert scale type questions and one closed-ended question. The first Likert scale question directly addressed the motives of following a vegan diet, whereby the respondent had to use a Likert scale to answer 16 different statements. The second question was to find out if the respondent's motivation had changed since the beginning of their diet. The final question addressed what assisted the respondents during their transition into the vegan diet, whereby the respondents had to use a Likert scale to answer 13 different statements. However, the studies in Table 3.3 were used to formulate questions for this section of the questionnaire as they addressed similar objectives to the present study.

Table 3.3: Studies used to assess the motives for following a vegan diet

Authors	Title	Purpose	Methodology	Main motive
Janssen *et al* (2016) Germany.	Motives of consumers following a vegan diet and their attitudes towards animal agriculture.	To identify different segments of consumers according to their motivation for following a vegan diet.	Face-to-face interviews	Ethical reasons
Kerschke-Risch (2015) Germany.	Vegan diet: motives, approach and duration.	To determine the motives, approach and duration of a vegan diet.	Web-based questionnaire	Environmental reasons
Radnitz et al (2015) United Sates.	Investigation of lifestyle choices of individuals following a vegan diet for health and ethical reasons.	To determine the extent to which the reason for following a vegan diet was associated with health behaviours.	Online questionnaire	Ethical reasons
Dyett et al (2013) United states.	Vegan lifestyle behaviours. An exploration of congruence with health-related beliefs and assessed health indices.	To investigate health belief as a major motive for diet and lifestyle behaviours and determine the congruence with selected health and nutrition outcomes.	Written self-administered questionnaire	Health- related reasons

Table 3.3: Studies used to assess the motives for following a vegan diet continued

Authors	Title	Purpose	Methodology	Main motive
Rothgerber (2013) United States.	A meaty matter. Pet diet and the vegetarian's dilemma.	To examine pet ownership and current pet diet of non-meat eaters.	Online questionnaire	Ethical reasons
Greenebaum (2012) United States.	Veganism, identity and the quest for authenticity.	To examine how vegans negotiate the difficulties of living in an animal-based consumer-driven society.	Face-to-face interviews	Ethical reasons
Timko et al (2012) United States.	Will the real vegetarian please stand up? An investigation of dietary restraint and eating disorder symptoms in vegetarians versus non-vegetarians.	To determine whether or not differences existed between vegans, vegetarians, semi-vegetarians and omnivores.	Web-based questionnaire	Ethical reasons
Izmirli & Phillips (2011) Turkey and Australia.	The relationship between student consumption of animal products and attitudes to animals in Europe and Asia.	To determine the relationship between the consumption of animal products and attitudes towards animals among university students in Eurasia.	Web survey	Health-related reasons
Waldmann et al (2003) Germany.	Dietary intakes and lifestyle factors of a vegan population in Germany: results from the German Vegan Study.	To evaluate the dietary intakes and lifestyle factors of German vegans.	Paper-based questionnaire	Health-related reasons
Larsson et al (2003) Sweden.	Veganism as status passage: The process of becoming a vegan among youths in Sweden.	The process of becoming a vegan among adolescents.	Group interview	Ethical reasons

3.5.3 Section C of the questionnaire

This section of the study looked at the challenges that vegans experienced during their transition into following the vegan diet. The questions also addressed what assisted respondents in overcoming these challenges. This section of the questionnaire consisted of seven questions. The format of these questions included three Likert scale type questions and four multiple

choice questions. The questions in the first part of this section addressed the feelings and emotions experienced by the respondents during their transition into a vegan diet. This was followed by determining if the respondents faced any financial challenges and where most of their vegan food products were purchased from. The section ended with a Likert scale question addressing the challenges faced during their transition, how these challenges were overcome and their agreement or disagreement to three common statements about a vegan diet. Table 3.4 shows the studies used to formulate questions for this section of the questionnaire.

Table 3.4: Studies used to assess the challenges associated with following a vegan diet

Authors	Title	Purpose	Methodology	Respondents
Emre (2016) Germany.	No Milk Today? Challenges of Maintaining a Vegan Diet in Germany.	To identify the variables influencing the maintenance of a vegan diet in Germany.	Online questionnaire	Vegans (n = 2847)
Hirschler (2011) United States.	"What Pushed Me over the Edge Was a Deer Hunter": Being Vegan in North America.	To examine the interpersonal and intrapersonal impact of the diet and associated practises.	Semi-structured interviews	Vegans (n = 32)
McDonald (2000) Europe.	"Once you know something, you can't not know it": An empirical look at becoming vegan.	To investigate how vegans learn to adopt a vegan lifestyle.	Unstructured interviews	Vegans (n = 12)

3.5.4 Section D of the questionnaire

This section of the questionnaire assessed that nutritional quality of the vegan diet. This section included a 24-hour recall for one day of the week and a quantitative FFQ which included a variety of different food groups consumed by South African vegans. Both measures were used for dietary intake analysis. The study by Dyett *et al* (2014) was especially important in assisting the development of the FFQ specifically for vegan respondents. This section of the questionnaire consisted of four questions. The first question was a Likert scale type question consisting of five statements about the nutritional quality of the vegan diet, this was followed by a question on the frequency of visiting restaurants to consume vegan meals.

The 24-hour recall and FFQ were designed in order to gather as much nutritional information as possible from the respondents. For the 24-hour recall, respondents were asked to indicate all food, beverages and condiments they have consumed in the last 24 hours and to also include the time and place of consumption, preparation method and portion size of that particular meal. An example of a 24-hour recall was provided to assist respondents with completing the recall. The FFQ consisted of 291 vegan food items. The respondents were asked to indicate by selecting how much of the item they used per meal or snack and how often they consumed meals or snacks containing this particular food item. The respondents were given three quantity options to choose from and five frequency options. For both the 24-hour recall and FFQ, clear instructions were indicated above each question, providing assistance to the respondents. The researcher's personal details were also included at the beginning of the questionnaire for the respondents to use should they encounter any difficulty during the questionnaire or required additional information. Similar studies that used this format can be seen in Table 3.5.

Table 3.5: Studies used to assess 24-hour recalls and food frequency questionnaires

Authors	Title	Purpose	Methodology	Respondents
Dyett *et al* (2014) United States.	Evaluation of a Validated Food Frequency Questionnaire for Self-Defined Vegans in the United States.	To develop and validate a de novo food frequency questionnaire for self-defined vegans in the United States.	Three 24-hour recalls (Two weekday and one weekend day) Food frequency questionnaire	Vegans living in the United States (n = 100)
Elorinne *et al* (2016) Finland.	Food and Nutrient Intake and Nutritional Status of Finnish Vegans and Non-Vegetarians.	To investigate the nutritional status of vegans, who may be at risk of nutritional deficiencies.	Three-day diet records	Finnish vegans (n = 22)
Kristensen, Madsen, Hansen, Allin, Hoppe, Fagt, Lausten, Gøbel, Vestergaard, Hansen & Pedersen (2015) Denmark.	Intake of macro- and micronutrients in Danish vegans.	To determine and evaluate the dietary and supplementary intake of vegans.	Four-day weighed food record	Danish vegans (n = 70)

Table 3.5: Studies used to assess 24-hour recalls and food frequency questionnaires continued

Authors	Title	Purpose	Methodology	Respondents
Clarys *et al* (2014) Belgium.	Comparison of Nutritional Quality of the Vegan, Vegetarian, Semi-Vegetarian, Pesco-Vegetarian and Omnivorous Diet.	To compare the quality and the contributing components of vegan, vegetarian, semi-vegetarian, pesco-vegetarian and omnivorous diets.	Food frequency questionnaire Healthy Eating Index 2010 (HEI-2010) Mediterranean Diet Score (MDS)	Vegans living in Belgium (n = 104)
Waldmann *et al* (2004) Germany.	Dietary Iron Intake and Iron Status of German Female Vegans: Results of the German Vegan Study.	To determine the iron status in German vegan women using dietary intake data, information on menstrual cycle, and biochemical parameters.	Two 9-day food frequency questionnaires	German vegan women (n = 75)
Waldmann *et al* (2003) Germany.	Dietary intakes and lifestyle factors of a vegan population in Germany: results from the German Vegan Study.	To evaluate the dietary intakes and lifestyle factors of German vegans.	Two 9-day food frequency questionnaires	German vegans (n = 154)
Larsson & Johansson (2002) Germany.	Dietary intake and nutritional status of young vegans and omnivores in Sweden.	To assess the dietary intake and nutritional status of a group of Swedish vegans aged 16–20 years living in Umeå, Sweden.	Diet history	Swedish vegans (n = 30)
Thorogood, Roe, McPherson & Mann (1990) United Kingdom.	Dietary intake and plasma lipid levels: lessons from a study of the diet of health conscious groups.	To re-examine the contentious relation between diet and plasma lipids within a population.	Four-day diet record	British vegans (n = 52)

3.6 Pilot study

The pilot study consisted of five individuals following a strict vegan diet and who were part of the SAVS Facebook group online. The researcher sent personal emails to each of the respondents of the pilot study, detailing the purpose of the pilot study and the attached Survey Monkey link to the questionnaire.

Each participant was advised to reply to the email with both positive and negative feedback on the content and questions, as well as comment on the length and flow of the questionnaire. Once feedback from the pilot study was received, the following alterations were made:

- Section A: If respondents selected "No" to being a South African citizen living in South Africa, the questionnaire would proceed to the next question. A disqualification page with a message was then added so that only South African citizens participate in this study.

- Skip logic or skip sequencing was added to questions that respondents were not required to answer. According to Manski & Molinari (2008), skip sequencing is a common survey practice where the answer to an opening question determines whether subsequent questions should be answered by the respondent. The main objective is to remove questions that are inapplicable to the respondent and this will decrease both interviewing costs and respondent burden. However, adding skip sequencing can also cause data quality concerns.

- "Requires an answer" was inserted for those questions that required an answer from respondents. This was done to prevent respondents from not answering the questions completely.

- The 24-hour recall question could not be answered due to formatting issues. This was changed into easy to fill text boxes.

- The FFQ was very long and consisted of fourteen pages. The options were then reduced and instructions were added below the question so that respondents knew what was required from them when answering. This was done by consulting with the professional statistician on different formats to reduce the number of household quantities and frequency options and only the most commonly consumed items were included. It was

decided that food items be categorised according to food groups in order to make it easier for respondents to understand and answer. The final FFQ consisted of nine pages.

After the changes were completed, the responses were cleared from the website and a new link was formed with the final questionnaire.

3.7 Data capturing and analyses

Once the online questionnaire was validated by a professional statistician, the director of the SAVS group was contacted and the link was emailed to be posted on the relevant Facebook pages. The director consented to posting the link on the main SAVS page as well as smaller sub-groups which were created to cover specific provinces in South Africa. The link was posted on the following groups:

1. South African Vegan Society Facebook main page (Pinned post and announcement).
2. Vegan Society South Africa National Facebook page (Pinned post).
3. South African Vegan Society – Gauteng Facebook page.
4. South African Vegan Society – KwaZulu-Natal Facebook page.
5. South African Vegan Society – Western Cape Facebook page.
6. South African Vegan Society – East London Facebook page.

Data from the final responses were tabulated by the Survey Monkey programme, saved and downloaded and sent to the statistician for further analyses. The incomplete surveys were excluded and only the completed surveys were used for the data analyses. Incomplete surveys were those surveys which the respondents did not complete and pressed the exit button at any section of the questionnaire. The MRC Food Finder programme was used to analyse the 24-hour recall. This programme was used for the analysis and conversion of food items to nutrients. The analysis can be done for individuals or groups of individuals. The programme requests the user to choose the type of food consumed from a list of foods or beverages and the quantity of food or beverage consumed in household measures or portion sizes in order to create a nutrient analysis. The nutrient analysis can be calculated for a single meal or meals consumed for an entire day. Standard recipes can be broken down into the food items and these items can be entered into the programme in a raw or cooked form. The data was entered on two separate occasions into the programme, to ensure that no errors were made.

In order to analyse the data, the Statistical Package for the Social Sciences (SPSS), version 23 database was used. The following tests were used in the analysis:

- Descriptive statistics which included means and standard deviations, where used when applicable. This type of test uses graphs and tables to provide data. This test was used for Likert scale type responses. There were a total of six Likert scale type questions with six response options. Six response options were provided, so that respondents were able to quantify more on how much they agree or disagree about a particular statement. The Likert scale type questions were asked for those questions directly addressing the objectives of the study.

- Chi-square goodness-of-fit-test: A univariate test, used on a categorical variable to test if any of the response options were selected significantly more or less frequently than other options. It is assumed that all responses were selected equally under the null hypothesis. This test was used mainly for questions from Section A of the questionnaire.

- Chi-square test of independence: Used on cross-tabulations to see whether a significant relationship existed among two variables presented in the cross-tabulation. A Fisher's exact test was used if conditions were not met. Cross-tabulations usually test the relationship among variables of gender, level of education and following a strict vegan diet.

- Binomial test: Tests whether a significant proportion of respondents selected one of two possible responses. This can be extended when data with more than two response options was split into two distinct groups. For example, those type of questions that had "yes" or "no" responses.

- One sample t-test: Tests whether a mean score is significantly different from a scalar value. This test was used to find significant agreement of factors, particularly in Section B of the questionnaire

- Bartlett's Test of Sphericity and Kaiser-Meyer-Olkin Measure of Sampling Adequacy was used to indicate the suitability of the data for structure detection. This test was used in Section B regarding the factors that assisted the respondents' transition into veganism.

Table 3.6 shows the objectives of the study, each variable which required analyses and the statistical tests that were applied to each of the objectives. The confidence interval was 95% and the measured statistical significance was $p < 0.0005$.

Table 3.6: Data analysis of objectives

Objective	Variables required for the analysis	Statistical tests applied
To determine the demographic characteristics of vegans.	• Gender • Age • Race group • Level of education • Income bracket (working or unemployed) • Duration for following the vegan diet	• Descriptive statistics • Fishers exact • Chi-square tests • Chi-square goodness-of-fit test • Binomial test
To determine the factors that influenced an individual to become a vegan.	• Factors include: o Ethical, health, environmental, and other. • The factors influencing the decision: o Magazines, social media, dietitians, friends and family • Who assisted the transition into veganism?	• Descriptive statistics • One-sample t-test • Bartlett's Test of Sphericity • Kaiser-Meyer-Olkin Measure of Sampling Adequacy
To determine the challenges associated with becoming a vegan and how these challenges were overcome.	• Social challenges (fitting in with family and friends, work colleagues). • Financial challenges (affording vegan products vs meat products). • Psychological challenges (replacing meat and fear about being isolated). • Who provided the most support in the decision to become a vegan: family/ friends/ dietitian/ media/ vegan support groups?	• Descriptive statistics • One-sample t-test • Chi-square goodness-of-fit test
To determine the nutritional quality of dietary intake compared to recommendations (EARs) and to identify the variety of food groups and types of processed food consumed in the vegan diet.	• 24-hour recall (1 day) • Food frequency questionnaire with main food groups. • Types of vegan processed food added to the diet (vegan milk, vegan meat products, vegan butter).	• Descriptive statistics

3.8 Data quality control

3.8.1 Validity and reliability

According to Joppe (2000), validity and reliability are relevant concepts in research. Reliability is the degree to which results are constant at all times and provides a detailed interpretation of the study population. The research instrument may be considered reliable if the study results can be repeated when a similar methodology is used. Validity is used to determine if the research actually measures what it was proposed to measure or the accuracy of the research results (Joppe 2000). The FFQ was constructed in line with a validated FFQ from a similar study (Dyett *et al* 2014), before being validated by a professional South African statistician for the present study. The respondents were instructed to provide a valid email address before commencing with the questionnaire. These email addresses were saved to identify the respondents and ensure that no respondent filled out the question more than once.

The respondents were provided with clear and concise instructions before answering each question. The online service package, SurveyMonkey, used for the questionnaire was available online 24-hours a day for the period of data collection. The questionnaire link was first posted on the 14th of August 2019 and remained on the online group until the 14th of October 2019, approximately 8.5 weeks (60 days). The link was posted twice more after the initial posting on the 2nd of September 2019 (after 3 weeks online) and 26th of September (after 6 weeks online). In the first month of August 2019, 162 vegans responded to the questionnaire. This number reduced in September 2019, where 66 vegans responded to the questionnaire and 5 vegans responded in October 2019. The last response was received on the 10th of October 2019. Despite the reposting of the questionnaire, twice after the initial posting date, respondents continued to decrease substantially. The researcher and statistician decided to close the online questionnaire at the 60 day mark (14th of October 2019), due to the lack of further responses.

3.8.2 Content validity

Content validity is a measurement tool that provides an assessment of whether information is comprehensive and effectively reflects the perceptions for the population under study. Moreover, content validity ensures that response options; instructions and formatting are applicable, by providing evidence to allow acceptability and understanding of the measure (Brod, Tesler & Christensen 2009). Content validity was ensured by using previous and current literature to formulate questions for the questionnaire. The questions were guided by studies conducted in other countries around the world and foodstuffs were modified according to local availability in South Africa. This was done by researching vegan food products in

supermarkets and online stores. The questions were formulated based on addressing the study objectives.

The researcher obtained face validity from a statistician and content validity from a vegan expert. A professional South African statistician edited and revised the questionnaire numerous times to identify any bias and repetition. Both the 24-hour recall and FFQ were reduced in length to make it less time consuming for respondents to complete. More answer options were added to the Likert scale type questions to improve analysis. The director of the SAVS group who is a South African expert in veganism also reviewed the questionnaire by ensuring the questions did not cause misconceptions among the vegan respondents. The word "veganism "was replaced by "following a vegan diet" throughout the questionnaire as this study focused on the vegan diet and not the vegan lifestyle. The pilot study was then conducted to test the online questionnaire.

3.8.3 Reliability

Questions that were required to be answered had an asterisk next to the questionnaire and respondents could not proceed to the next page until all required questions were answered. According to Chang & Vowles (2013), once responses are obtained online by clicking to the next question, they are recorded instantly. Therefore, the questionnaire must be designed so that respondents do not input invalid responses. In this way input and processing errors could be averted and results were more reliable.

3.9 Reduction of bias

Bias was reduced during the design of the questionnaire by developing questions that were neutral, multiple questions were asked to sufficiently cover each topic, the order of the questions were addressed so that one question did not influence the next question and instructions were clear and unbiased (Kitchenham & Pfleeger 2002).

3.10 Ethical consideration

Ethical approval was received from the Biomedical Research Ethics Committee (BREC). The gatekeepers' permission letter was attained from the director of SAVS, to allow the questionnaire to be published on the group's Facebook pages (Appendix C, p234). The reference number for the approval was BE712/18 (Appendix D, p235).

Respondents were notified that any personal information provided would not be disclosed to the public and was to be used only for the study (Appendix E, p236). This was done to ensure

confidentiality. Respondents were able to withdraw from participation at any given time by pressing the exit button on the questionnaire. The letter of informed consent appeared at the beginning of the questionnaire when the respondents clicked on the link posted online. Once the respondents clicked "okay" after reading the informed consent where they able to proceed to answering the questionnaire. The data set was anonymised after data were extracted from the researcher's personal SurveyMonkey account and the questionnaire and account was deleted. Therefore, data cannot be associated with any of the respondents.

3.11 Summary

This chapter addressed the methodology used to determine the motives and challenges facing South African vegans and the nutritional quality of their diet. The design of the questionnaire and supporting literature were outlined. The results of the data analysis will be presented in the next chapter.

CHAPTER 4: RESULTS

This chapter presents the results of the study in accordance to the objectives. For each objective, a number of statistical tests were used and data analysis was conducted. The chapter is sectioned into the response rate and results obtained from the demographic characteristics of the respondents, the motives for following a vegan diet and challenges that respondents found whilst following a vegan diet and how these challenges were overcome. The chapter concludes with the nutritional quality of the respondent's diet by presenting results from the 24-hour recall and food frequency questionnaire (FFQ).

4.1 The response rate and demographic characteristics of the respondents

A total of 222 responses were collected, however in the final analysis only 205 of these responses were included. Five respondents had submitted two questionnaires each and only one completed questionnaire was retained. Three respondents only entered their email address and did not answer anything further, while nine respondents provided only demographic characteristics and did not complete anything further than section A. These questionnaires were also excluded from the study.

The sample population consisted of 9 819 members, however the study sample consisted of 205 respondents, of which 17.6% (n = 36) were male and 82.4% (n = 169) were female. The study was comprised of predominately of White respondents (82.4%, n = 169), followed by Indian/Asian respondents (9.3%, n = 19), Coloured respondents (3.4%, n = 7), Black African respondents (2.4%, n = 5) and the remainder of the respondents were from other race groups (2.4%, n = 5).

Most respondents resided in Gauteng province (43.9%, n = 90), followed by Western Cape (29.3%, n = 60), KwaZulu-Natal (19.0%, n = 39), Eastern Cape (5.4%, n = 11) and North West province (1.5%, n = 3). The two provinces with the least number of respondents were Mpumalanga (0.5%, n = 1) and Free State (0.5%, n = 1). No respondents in the study resided in Limpopo and the Northern Cape.

Table 4.1 shows the marital status and age category among the respondents in the study, followed by the level of education and current monthly income. Most respondents were single (53.2%, n = 109) or married (37.6%, n = 77). Most of the respondents belonged to the 18-29 year category (29.3%, n = 60) followed by the 40-49 year category (22.0%, n = 45). Two respondents belonged to the <18 years category and while it is not known exactly how old they

were, the Facebook age account age restriction is 13 years and older and it was assumed that no parental consent was required for the respondent to participate. In South Africa, currently there is no age specified in law for research (Strode, Slack & Essack 2010), however adolescents can provide individual consent for low-risk research (National Health Research Ethics Council 2004). Parental consent is required depending on the type of research, for example, research involving clinical trials require parental consent and agreement from the child (South African Department of Health 2006). The highest level of education was a diploma/degree (37.1%, n = 76), followed by a post-graduate degree (30.2%, n = 62). The total current monthly income in this sample population was between the R25 601 – R51 200 category (23.4%, n = 48), followed by the R12 801 – R25 600 category (20.5%, n = 42) per month.

Table 4.1: Marital status, age category, level of education and monthly income of the sample population (n = 205)

		n	%
Marital status	Single	109	53.2
	Married	77	37.6
	Divorced/separated	15	7.3
	Widowed	4	2.0
Age	<18	2	1.0
	18 – 29	60	29.3
	30 – 39	44	21.5
	40 – 49	45	22.0
	50 – 59	36	17.6
	60+	18	8.8
Level of education	Some schooling	1	0.5
	Matric	45	22.0
	Certificate	20	9.8
	Diploma/Degree	76	37.1
	Post graduate degree	62	30.2
	Other*	1	0.5
Monthly income	No income	32	15.6
	Up to R400	2	1.0
	R 801 – R 1 600	5	2.4
	R1 601 – R 3 200	7	3.4
	R 3 201 – R 6 400	10	4.9
	R 6 401 – R 12 800	32	15.6
	R 12 801 – R 25 600	42	20.5
	R 25 601 – R 51 200	48	23.4
	R 51 201 – R 102 400	16	7.8
	R 102 401 – R204 800	3	1.5
	R204 801 or more	18	3.9

*Training programmes

A binomial test revealed that a significant number of respondents 81.5% (n = 167) ($p < 0.0005$) responded 'yes' to following a strict vegan diet and 18.5% (n = 38) responded 'no'.

A Fisher's exact test found a significant relationship between gender and education amongst those who followed a strict vegan diet, (Fisher's exact 163.954, p = 0.002). A significant number of male respondents with either some schooling, a post graduate degree/diploma or 'other' qualification followed a vegan diet.

Table 4.2 shows the results of the length of time that the respondents had been following a vegan diet. A chi-square goodness-of-fit test showed a significant number of the respondents had been following a vegan diet from one to less than 5 years (χ^2 (7) = 143.449, $p < 0.0005$).

Table 4.2: Respondent length of following the vegan diet (n = 205)

Time period	n	%
<6 months	24	11.7
6 months - <1 year	19	9.3
1 - <3 years	79	38.5
3 - <5 years	29	14.1
5 - <7 years	16	7.8
7 - <9 years	10	4.9
9 - 10 years	5	2.4
>10 years	23	11.2

Lifestyle factors including smoking, consumption of alcoholic beverages, supplementation use and physical activity was tested among the population. Most of the respondents did not smoke 83.9% (n = 172) while 16.1% (n = 33) did. Alcoholic beverages were consumed by 60.0% (n = 123) of the population and 40.0% (n = 82) did not consume these beverages. A chi-square goodness-of-fit test showed a significant number of the respondents consumed alcoholic beverages 'less than once a week' (56%, n = 27.3), followed by 'once a week' (13.2%, n = 27) (χ^2 (6) =117.902, $p<0.0005$). With regards to supplementation use, 72.7% (n = 149) consumed supplements, whilst (27.3%, n = 56) did not consume supplements.

A binomial test indicated a significant number of respondents (84.9%, n = 174) participated in physical activity ($p=<0.0005$) whilst 15.1% (n = 31) did not. Table 4.3 shows reports on the duration and type of physical activity.

Table 4.3: Reported analyses of physical activity (n = 174)

	Low Intensity: Casual walking or bike riding, yoga, stretching , walking up the stairs		Moderate Intensity: Weight training, jogging, cycling, swimming, brisk walking, aerobics		High intensity: Circuit training, vigorous forms of weight training, running, cardio workouts	
Frequency of physical activity	**n**	**%**	**n**	**%**	**n**	**%**
Never	4	2.0	26	12.7	78	38.0
Once a week	12	5.9	37	18.0	27	13.2
Twice a week	20	9.8	26	12.7	27	13.2
Three times a week	32	15.6	37	18.0	20	9.8
Four times a week	24	11.7	23	11.2	11	5.4
Five times a week	15	7.3	7	3.4	7	3.4
Six times a week	5	2.4	8	3.9	4	2.0
Every day	48	23.4	10	4.9	0	0
More than once a day	14	6.8	0	0	0	0

Descriptive statistics were conducted and a significant number of the population who exercised, participated in low intensity physical activity ‘everyday’ (n = 48), ‘three times a week” (n = 32) or ‘four times a week’ (n = 24) ($p < 0.0005$) Moderate intensity physical activity was done by a significant number of the population at most ‘4 times a week’ ($p < 0.0005$). In this study, moderate physical activity was mostly done ‘once a week’ (n = 37), ‘three times a week’ (n = 37), ‘twice a week” (n = 26), and ‘four times a week’ (n = 23). High intensity physical activity is done at most ‘twice a week’ (n = 27), followed by ‘once a week’ (n = 27). Most of the population (n = 78), never participated in high intensity physical activity. A chi-square goodness-of-fit test found that a significant number of respondents participated in physical activity which was ‘low intensity’ (χ^2 (8) =79.966, $p < 0.0005$), followed by ‘moderate intensity’ ($\chi 2$ (7) =48.161, $p < 0.0005$) and then ‘high intensity’ ($\chi 2$ (6) =152.989, $p < 0.0005$). The duration of participating in physical activity on average in a day is presented in Table 4.4.

Table 4.4: Duration of participating in physical activity on average in a day (n = 174)

Duration	n	%
<30 minutes	28	13.7
30 minutes - <1 hour	85*	41.5
1 - <2 hours	49*	23.9
2 - <3 hours	9	4.4
At least 3 hours	3	1.5

*Indicates a significant number according to the chi-square goodness of fit test.

A chi-square goodness-of-fit test showed that a significant number of the respondents ($\chi 2$ (4) =127.724, $p < 0.0005$) participated in physical activity on average between 30 minutes to < 1 hour (n = 85), followed by between 1 hour and < 2 hours (n = 49) in a day.

4.2 The motives for following a vegan diet

One sample t-tests were conducted to test the motives of following a vegan diet among the sample population. The results of these tests are presented in Table 4.5.

Table 4.5: Reported analyses of motives for following a vegan diet (n = 205)

	Strongly disagree		Disagree		Slightly disagree		Slightly Agree		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Ethical concern for animals (preventing cruelty, animal rights and welfare).	3	1.5	3	1.5	1	0.5	6	2.9	20	9.8	172	83.9
2. To improve health.	6	2.9	16	7.8	7	3.4	36	17.6	55	26.8	85	41.5
3. Protecting the environment.	1	0.5	3	1.5	5	2.4	15	7.3	59	28.8	122	59.5
4. Family tradition and/or friends following the diet.	115	56.1	47	22.9	13	6.3	12	5.9	14	6.8	4	2.0
5. Influence of social media.	72	35.1	50	24.4	13	6.3	35	17.1	22	10.7	13	6.3
6. Personal well-being.	10	4.9	9	4.4	3	1.5	32	15.6	64	31.2	87	42.4
7. To reduce the carbon footprint/impact on the environment.	3	1.5	6	2.9	5	2.4	33	16.1	56	27.3	102	49.8
8. The effect of animal product consumption on climate change.	1	0.5	6	2.9	6	2.9	25	12.2	58	28.3	109	53.2
9. Religious beliefs (Jains, Buddhists).	116	56.6	42	20.5	5	2.4	15	7.3	14	6.8	13	6.3
10. To prevent diseases and illnesses.	20	9.8	21	10.2	4	2.0	46	22.4	52	25.4	62	30.2

Table 4.5: Reported analyses of motives for following a vegan diet (n = 205) continued

	Strongly disagree		Disagree		Slightly disagree		Slightly Agree		Agree		Strongly agree	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
11. Taste aversion to meat.	39	19.0	41	20.0	19	9.3	47	22.9	39	19.0	20	9.8
12. Social justice (world hunger could be reduced by feeding nutritious grains to the underprivileged instead of to farm animals).	12	5.9	8	3.9	14	6.8	34	16.6	53	25.9	84	41.0
13. Protect endangered species.	7	3.4	9	4.4	8	3.9	30	14.6	59	28.8	92	44.9
14. Less water usage.	5	2.4	9	4.4	2	1.0	40	19.5	55	26.8	94	45.9
15. Prevent pollution.	5	2.4	10	4.9	10	4.9	32	15.6	61	29.8	87	42.4
16. Protect factory and farm workers from unsafe conditions.	24	11.7	25	12.2	25	12.2	50	24.4	40	19.5	41	20.0

Table 4.6 shows the mean motivating factors of respondents who follow a vegan diet. There was a significant agreement using one-sample t-tests, that motivating factors included: ethical concern for animals ($M = 5.7$, $t(204) = 35.838$, $p < 0.0005$); followed by protecting the environment, ($M = 5.41$, $t(204) = 30.350$, $p < 0.0005$); and the effect of animal product consumption on climate change ($M = 5.24$, $t(204) = 24.276$, $p < 0.0005$). There was neither a significant agreement nor significant disagreement for motivating factors such as family tradition and/or friends following the diet ($M = 1.90$, $t(204) = -17.123$, $p < 0.0005$); religious beliefs, ($M = 2.06$, $t(204) = -12.956$, $p < 0.0005$); and influence of social media ($M = 2.63$, $t(204) = -7.594$, $p < 0.0005$).

Table 4.6: The mean motivating factors for following a vegan diet (n = 204)

	Mean	SD	p Value	t	Df
1. Ethical concerns for animals (preventing cruelty, animal rights and welfare).	5.70	0.878	0.000*	35.838	204
2. To improve health.	4.82	1.369	0.000*	13.800	204
3. Protecting the environment.	5.41	0.901	0.000*	30.350	204
4. Family tradition and/or friends following the diet.	1.90	1.336	0.000*	-17.123	204
5. Influence of social media.	2.63	1.642	0.000*	-7.594	204
6. Personal-wellbeing.	4.91	1.348	0.000*	15.005	204

Table 4.6: The mean motivating factors for following a vegan diet (n = 204) continued

	Mean	SD	p Value	t	Df
7. To reduce the carbon footprint/impact on the environment.	5.14	1.113	0.000*	21.108	204
8. The effect of animal product consumption on climate change.	5.24	1.029	0.000*	24.276	204
9. Religious beliefs (Jains, Buddhists).	2.06	1.588	0.000*	-12.956	204
10. To prevent diseases and illnesses.	4.34	1.633	0.000*	7.377	204
11. Taste aversions to meat.	3.32	1.655	0.125	-1.540	204
12. Social justice (world hunger could be reduced by feeding nutritious grains to the underprivileged instead of to farm animals).	4.76	1.445	0.000*	12.448	204
13. Protection of endangered species.	4.96	1.303	0.000*	15.994	204
14. Saving of water.	5.01	1.219	0.000*	17.795	204
15. Preventing pollution.	4.93	1.268	0.000*	16.114	204
16. Protecting factory and farm workers from unsafe conditions.	3.88	1.630	0.001*	3.321	204

* Represents a significant agreement according to one sample t-tests

A Kaiser Meyer Olkin measure of sampling adequacy test (KMO) and a Bartlett's test for sphericity was conducted on the data. The KMO test of 0.842 indicated that data was adequate for successful and reliable extraction. The Bartlett's test ($p < 0.05$) indicated that correlations between items were not too low. Three factors were extracted which account for 67.17% of the variance in the data. The factors can be interpreted as environment, health and social factors. A one-sample t-test showed that there was a significant agreement with environmental motivating factors ($M = 5.1124$, $t(204) = 23.947$, $p < 0.0005$) and health motivating factors ($M = 4.6911$, $t\ 9204) = 13.049$, $p < 0.0005$). There was neither a significant agreement nor significant disagreement with social motivating factors ($M = 2.6183$, $t(204) = -12.523$, $p < 0.0005$). Table 4.7 shows the mean of grouped motivating factors.

Table 4.7: The mean of grouped motivating factors (n = 204)

	Mean	SD	p Value*	t	Df
Environmental factors	5.1154	0.96547	0.000	23.957	204
Health factors	4.6911	1.30691	0.000	13.049	204
Social factors	2.6183	1.00810	0.000	-12.523	204

*All factors grouped together where significant.

A binomial test revealed that a significant number of respondents (71%, n = 146) (p = <0.0005) indicated that their motivation had not changed since they began following the diet. The one-sample t-test was used to determine what factors assisted a respondent during the transition to following a vegan diet. Table 4.8 shows there was a significant agreement among respondents that reading ingredient lists on products assisted them the most in following a vegan diet (M = 4.77, t (204) = 12.034, p < 0.0005); followed by experimenting with vegan recipes (M = 4.75, t (204) = 12.278, p < 0.0005) and becoming vegetarian first prior to becoming a vegan (M = 4.32, t (204) = 6.252, p < 0.0005). There was neither a significant agreement nor significant disagreement that visiting a dietitian assisted a respondent during their transition into the diet (M = 1.91, t (204) = -17.547, p < 0.0005); this was followed by following a 30 day vegan challenge (M = 2.58, t (204) = -7.589, p < 0.0005) and family and/or friends assisting respondents in following the diet (M = 2.73, t (204) = -6.350, p < 0.0005).

A KMO and Bartlett's test was conducted on the data. The KMO test of 0.809 data was adequate for successful and reliable extraction. The Bartlett's test (p < 0.05) indicated that correlations between items are not too low.

Table 4.8: The mean factors for transition into following a vegan diet (n = 204)

	Mean	SD	p Value	t	Df
1. Social media and/or the internet	4.17	1.702	0.000*	5.642	204
2. Family and/or friends	2.73	1.732	0.000*	-6.350	204
3. Vegan groups	3.75	1.646	0.033	2.143	204
4. Vegan cook books/magazines /newspaper	3.45	1.643	0.656	-0.446	204
5. Vegan shops	3.38	1.639	0.279	-1.087	204
6. Health stores	3.34	1.559	0.135	-1.501	204
7. Becoming vegetarian first – prior to becoming a vegan	4.32	1.871	0.000*	6.252	204

Table 4.8: The mean factors for transition into following a vegan diet (n = 204) continued

	Mean	SD	p Value	t	Df
8. Experimenting with replacing dairy and meat products with plant-based alternatives	4.10	1.759	0.000*	4.905	204
9. Reading ingredient lists on products	4.77	1.506	0.000*	12.034	204
10. Experimenting with vegan recipes	4.75	1.459	0.000*	12.278	204
11. Visiting a vegan restaurant	3.93	1.788	0.001*	3.419	204
12. Following a 30 day vegan challenge	2.58	1.735	0.000*	-7.589	204
13. Visiting a Dietitian	1.91	1.296	0.000*	-17.547	204

* Represents a significant agreement according to one sample t-tests

Three factors were extracted from the data. These factors include: vegan places and/or books, experimenting with vegan food and social associations that may have assisted the respondents to following a vegan diet. One-sample t-test showed that there was a significant agreement that experimenting with food ($M = 4.5398$, $t(204) = 11.061$, $p < 0.0005$) and social support ($M = 3.9585$, $t(204) = 4.347$, $p < 0.0005$) assisted with the transition into a vegan diet according to the respondents. There was neither a significant agreement nor significant disagreement that vegan places and books assisted with the transition ($M = 3.5220$, $t(204) = 0.228$, $p < 0.820$). Table 4.9 shows the mean of groups for transitioning factors.

Table 4.9: The mean of grouped transitioning factors (n = 204)

	Mean	SD	p Value	t	Df
Vegan places/ books	3.5220	1.37872	0.820	0.228	204
Experimenting with food	4.5398	1.34600	0.000*	11.061	204
Social factors	3.9585	1.51042	0.000*	4.347	204

* Represents grouped factors that are significant

4.3 The challenges associated with following a vegan diet

A one sample t-test found that it was significantly easy (35.1%, n = 72) to transition into the diet ($p < 0.0005$). A t-value of 3.5 was used in this test. Table 4.10 shows the other statement selected to best describe the respondents' transition into following a vegan diet.

Table 4.10: The statement chosen to best describe the transition into following a vegan diet (n = 197)

Statement used to describe the transition	n	%
"Very easy"	36	17.6
"Easy"	53	25.9
"Moderately easy"	72	35.1
"Moderately difficult"	26	12.7
"Difficult"	9	4.4
"Very difficult"	1	0.5

A chi-square goodness-of-fit test showed a significant number of respondents felt excitement and enthusiasm (29.3%, n = 60) as the emotion that best described the beginning of their transition, followed by determined (22%, n = 45) and optimistic (20%, n = 41) ($\chi 2$ (9) = 206.299, $p < 0.0005$). Table 4.11 shows the emotions that respondents' experienced at the beginning of their transition into the diet.

Table 4.11: The emotions experienced at the beginning of following a vegan diet (n = 197)

Emotions	n	%
Excitement and enthusiasm	60	29.3*
Determined	45	22.0*
Optimistic	41	20.0*
Contentment	19	9.3
Confident	13	6.3
Confusion	9	4.4
Anxious	3	1.5
Resentful	3	1.5
Depressed	3	1.5
Fear	1	0.5

* Represents grouped factors that are significant

A binomial t-test found that a significant number of respondents 74.6% (n = 153) ($p < 0.0005$) responded "no" to financial challenges whilst 21.5% (n = 44) ($p < 0.0005$) responded "yes" to financial challenges experienced following a vegan diet. Therefore, following a vegan diet was not a financial challenge among majority of the respondents.

Respondents were asked to indicate where most of their vegan food items were purchased. A chi-square goodness-of-fit test showed that a significant number of respondents purchased their food from the supermarket 86.3% (n = 177), followed by a health food store 7.8% (n = 16) and online 2.0% (n = 4) ($\chi 2$ (2) = 284.234, $p < 0.0005$).

One sample t-tests were to determine what was most challenging during the time of transitioning to a vegan diet according to the respondents. The results of these tests are presented in Table 4.11.

Table 4.12: Reported analyses of challenges faced during the transition into the vegan diet (n = 197)

	Strongly disagree		**Disagree**		**Slightly disagree**		**Slightly Agree**		**Agree**		**Strongly agree**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
1. Communicating the decision to family and friends.	19	9.3	26	12.7	11	5.4	46	22.4	55	26.8	40	19.5
2 .Associating yourself with meat-eaters in a social setting	15	7.3	22	10.7	20	9.8	43	21.0	58	28.3	39	19.0
3 .Gathering information on veganism	46	22.4	61	29.8	25	12.2	29	14.1	18	8.8	18	8.8
4. Avoiding meat and meat products	67	32.7	46	22.4	13	6.3	17	8.3	22	10.7	32	15.6
5. Planning a suitable vegan diet	30	14.6	33	16.1	25	12.2	41	20.0	42	20.5	26	12.7
6. Finding vegan supermarkets	9	4.4	33	16.1	26	12.7	34	16.6	42	20.5	53	25.9
7. Finding vegan meal options in restaurants	9	4.4	11	5.4	9	4.4	29	14.1	56	27.3	83	40.5

Table 4.13 shows the mean challenging factors to following a vegan diet according to the respondents. There was a significant agreement among the respondents that finding vegan meal options in restaurants ($M = 4.83$, $t(196) = 13.336$, $p < 0.0005$), was the main challenge to following the vegan diet, followed by finding vegan supermarkets ($M = 4.15$, $t(196) = 5.753$, $p < 0.0005$). There was neither a significant agreement nor significant disagreement that gathering information on veganism ($M = 2.83$, $t(196) = -5.898$, $p < 0.0005$) as this was the least challenge faced among the respondents, followed by avoiding meat and meat products ($M = 2.88$, $t(196) = -4.567$, $p < 0.0005$).

Table 4.13: The mean challenges faced while following a vegan diet (n = 197)

	Mean	SD	p Value	t	Df
1. Communicating the decision to friends and family.	4.08	1.597	0.000*	5.064	196
2. Associating yourself with meat-eaters in a social setting.	4.14	1.521	0.000*	5.880	196
3. Gathering information on veganism.	2.83	1.601	0.000*	-5.898	196
4. Avoiding meat and meat products.	2.88	1.896	0.000*	-4.567	196
5. Planning a suitable vegan diet.	3.56	1.651	0.620	0.496	196
6. Finding vegan shops.	4.15	1.579	0.000*	5.753	196
7. Finding vegan meal options in restaurants.	4.83	1.402	0.000*	13.336	196

* Represents a significant agreement according to one sample t-tests

The respondents were asked how they overcame the challenges that they faced at the beginning of their transition into the vegan diet. A one sample t-test (t-value of 3.5) was used and the mean factors of overcoming the challenges can be seen in Table 4.14. There was a significant agreement among respondents that research on the internet ($M = 5.16$, $t(196) = 20.592$, $p < 0.0005$), followed by joining a vegan group on social media or attending meetings ($M = 4.43$, $t(196) = 9.036$, $p < 0.0005$), assisted them in overcoming challenges that they faced during the transition into following a vegan diet. There was neither a significant agreement nor significant disagreement about visiting a dietitian ($M = 2.04$, $t(196) = -15.728$, $p < 0.0005$) as seen in Table 4.15.

Table 4.14: Reported analyses of how challenges were overcome following a vegan diet (n = 197)

	Strongly disagree		Disagree		Slightly disagree		Slightly Agree		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Research on the Internet.	5	2.4	4	2.0	5	2.4	23	11.2	64	31.2	96	46.8
2. Talking to/ educating friends and family about veganism.	18	8.8	25	12.2	21	10.2	47	22.9	59	28.8	27	13.2
3. Visiting a Dietitian.	86	42.0	69	33.7	12	5.9	15	7.3	9	4.4	6	2.9
4. Reading vegan books and other literature.	20	9.8	15	7.3	15	7.3	49	23.9	48	23.4	50	24.4
5. Joining a vegan group on social media or attending meetings.	11	5.4	14	6.8	18	8.8	45	22.0	54	26.3	55	26.8

Table 4.15: The mean factors that assisted in overcoming challenges following a vegan diet (n = 197)

	Mean	SD	p Value	t	Df
1. Research on the Internet.	5.16	1.130	0.000*	20.592	196
2. Talking to/ educating friends and family about veganism.	3.94	1.514	0.000*	4.071	196
3. Visiting a Dietitian.	2.04	1.307	0.000*	-15.728	196
4. Reading vegan books and other literature.	4.22	1.587	0.000*	6.353	196
5. Joining a vegan group on social media or attending meetings.	4.43	1.447	0.000*	9.036	196

* Represents a significant agreement according to one sample t-tests

Respondents were asked about their agreement to statements about what further challenges they faced following a vegan diet. Table 4.16 shows the t-tests results regarding the agreement and disagreement towards these statements. According to one-sample t-tests (t-value of 3.5) there was a strong agreement among respondents that vegan recipes are easily accessible ($M = 5.47$, $t(196) = 33.018$, $p < 0.0005$). There was neither a significant agreement nor significant disagreement that it cost more to follow a vegan diet than a diet which included animal products ($M = 2.48$, $t(196) = -9.024$, $p < 0.0005$). These results can be seen in Table 4.17.

Table 4.16: Reported analyses of statements regarding following a vegan diet (n = 197)

	Strongly disagree		Disagree		Slightly disagree		Slightly Agree		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%	n	%
1. Vegan recipes are easily accessible.	4	2.0	4	2.0	8	3.9	61	29.8	120	58.5	197	96.1
2. There is an adequate range of vegan products at your nearest supermarket or retail store.	26	12.7	24	11.7	21	10.2	47	22.9	54	26.3	25	12.2
3. It costs more to follow a vegan diet than a diet which includes animal products	73	35.6	49	23.9	24	11.7	22	10.7	16	7.8	13	6.3

Table 4.17: The mean statements regarding following a vegan diet (n = 197)

	Mean	SD	p Value	t	Df
1. Vegan recipes are easily accessible.	5.47	0.836	0.000*	33.018	196
2. There is an adequate range of vegan products at your nearest supermarket or retail store.	3.78	1.590	0.014	2.487	196
3. It costs more to follow a vegan diet than a diet which includes animal products.	2.48	1.583	0.000*	-9.024	196

* Represents a significant agreement according to one sample t-tests

4.4 The nutritional quality of a vegan diet

T-tests were conducted to determine the nutritional quality of a vegan diet. The respondents were asked about their agreement and disagreement with statements about the nutritional quality of the vegan diet that they follow. Table 4.18 shows the results of these tests.

Table 4.18: Reported analyses of statements about nutritional quality of a vegan diet (n = 197)

	Strongly disagree		Disagree		Slightly disagree		Slightly Agree		Agree		Strongly agree	
	n	%	n	%	n	%	n	%	n	%	n	%
1. A vegan diet is nutritionally complete and adequate for a healthy lifestyle.	0	0	2	1.0	7	3.4	9	4.4	44	21.5	135	65.9
2. Meat alternatives are healthier than meat products.	6	2.9	9	4.4	15	7.3	53	25.9	52	25.4	62	30.2
3. Milk alternatives provide adequate calcium for the body.	7	3.4	15	7.3	20	9.8	38	18.5	66	32.2	51	24.9
4. Vegan food is bland and requires many added ingredients in order to be appetizing.	114	55.6	43	21.0	12	5.9	15	7.3	10	4.9	3	1.5
5. Vegan food does not provide a feeling of satiety.	130	63.4	45	22.0	3	1.5	12	5.9	4	2.0	3	1.5

One-sample t-tests showed (t-value of 3.5) a significant agreement among the respondents that a vegan diet was nutritionally complete and adequate for a healthy lifestyle ($M = 5.54$, $t(196) = 34.731$, $p < 0.0005$). There was a strong disagreement among the respondents that vegan food does not provide a feeling of satiety ($M = 1.60$, $t(196) = -24.455$, $p < 0.0005$). The results of these tests can be seen in Table 4.19.

Table 4.19: The mean statements about nutritional quality of a vegan diet (n = 197)

	Mean	SD	p Value	t	Df
1. A vegan diet is nutritionally complete and adequate for a healthy lifestyle.	5.54	0.824	0.000*	34.731	196
2. Meat alternatives are healthier than meat products.	4.631	1.289	0.000*	12.353	196
3. Milk alternatives provide adequate calcium for the body.	4.49	1.365	0.000*	10.204	196
4. Vegan food is bland and requires many added ingredients in order to be appetizing.	1.85	1.277	0.000*	-18.166	196
5. Vegan food does not provide a feeling of satiety.	1.60	1.091	0.000*	-24.455	196

* Represents a significant agreement according to one sample t-tests

A chi-square goodness-of-fit test was used to find out how often the respondents visit a restaurant and order a vegan meal. The analysis showed that most of the respondents visited a restaurant once a month (37.6%, n = 77), followed by less than once a month (27.8%, n = 57), several times a month (26.3%, n = 54) and several times a week (4.4%, n = 9) ($\chi 2$ (3) =50.208, $p < 0.0005$).

4.4.1 The food and beverage consumption of the respondents from the FFQ

The food frequency questionnaire was completed by (n = 113) respondents in the study. The frequency of food items and beverages consumed by the respondents can be seen in Table 4.20. The number of respondents who more frequently and least frequently consumed a particular food item or beverage was grouped and listed below. Table 4.21 shows the amount of foods consumed by the respondents.

Starches:

According to the analysis, the respondents most frequently used bread loaf was whole-wheat bread, consumed weekly (1 - 2 slices) (18.0%, n = 37) and the least consumed was French bread (<1 slice) (43.4%, n = 89) which was consumed never or rarely by most of the respondents. In the bread – other category, white bread rolls were most frequently consumed weekly (½ – 1 small item) (19.0%, n = 39) and cornbread least frequently consumed (<½ small item) (52.7%, n = 108) among the respondents. Pasta plain and eggless, was reported to be most commonly consumed weekly (½ – 1 cup) (21.0%, n = 43), while the pasta never or rarely consumed was organic black noodles (<½ cup) (52.7%, n = 108).

Grains and Cereals:

White or brown basmati rice was the most commonly consumed grain consumed once a month by the respondents (½ - 1 cup) (20.0%, n = 41). The least consumed grain was barley flakes (<½ cup) (53.7%, n = 110). Muesli was the most frequently consumed cereal among the respondents (<½ cup) (8.3%, n = 17), while Special K cereal was least consumed (<½ cup) (52.7%, n = 108).

Meat and milk substitutes:

Soya products were most commonly consumed by the respondents, at least once a week (½ – cup) (28.8%, n = 59) while, tofu silken/soft was least frequently consumed (<½ cup) (29.3%, n = 60). The most frequently consumed milk substitute, consumed at least once a day by the respondents was soy milk (½ – 1 cup) (21.0%, n = 43). Flax milk (53.7%, n = 110) and quinoa milk (53.7%, n = 110) was least consumed (<½ cup). Vegan cheese was consumed at least once a month (1 - 2 slices) (22.0%, n = 45) by the respondents whereas an egg replacer was never or rarely consumed (<1 tsp) (42.0%, n = 86).

Mixed food:

Vegan pizza was consumed at least once a month by the respondents (>3 slices) (32.7%, n = 67) while vegan lasagne was consumed less frequently (<1 - 3 slices) (36.1%, n = 74).

Vegetables:

The most frequently consumed leafy vegetable was cooked spinach consumed at least once a week by the respondents (>1 cup) (24.9%, n = 51) and the least frequently consumed was mustard greens (<½ cup) (45.4%, n = 93). With regards to non-leafy vegetables, cooked broccoli was most frequently consumed at least once a week (½ – 1 cup) (36.1%, n = 74), while cassava was least consumed by the respondents (<½ cup) (52.2%, n = 107). The vegetable condiment most frequently consumed were tomato sauces, pasta and salsa at least once a week (<½ cup) (24.9%, n = 51) and tomato juice was least frequently consumed (<½ cup) (48.8%, n = 100).

Peas and Beans:

Among this food group, chickpeas was the most frequently consumed, at least once a week by the respondents (½ - 1 cup) (32.2%, n = 66) while navy/haricot beans was the least consumed (<½ cup) (48.8%, n = 100).

Baked beans (<½ cup) (17.6%, n = 36) were the most frequently consumed bean product at least once a month by the respondents. Refried beans were least consumed (<½ cup) (46.8%, n = 96).

Fruit:

The most frequently consumed fruit were bananas (½ - 1 medium item/ cup) (22.4%. n = 46) at least once a day, while persimmons were the least consumed fruit (<½ medium item/cup) (49.3%, n = 101) among the respondents. Dried raisins (<½ cup) (14.1%, n = 29) were the frequently consumed dried fruit at least once a month, as well as dried pomegranates (<½ cup) (52.2%, n = 107). Freshly prepared orange juice was the most frequently consumed fruit juice, which was consumed at least once a month (<1 cup) (12.7, n = 26), while the least frequently consumed beverage was coconut water (<1 cup) (43.9%, n = 90).

Fats:

The most frequently consumed fat was olive oil which is used by respondents at least once a day (1 - 2 tsp) (20.5%, n = 42) and soybean oil was the least frequently used (<½ cup) (51.7%, n = 106). Peanut butter was the most frequently used nut butter among the respondents (>2 tsp) (19.0%, n = 39), consumed at least once a week. Hazelnut butter was least frequently consumed (<1 tsp) (51.7%, n = 106). Almonds were the most frequently consumed nuts and were consumed at least once a month by the respondents (<½ cup) (12.7%, n = 26). The most frequently consumed fat spread was dairy free margarine, which was consumed at least once a week (1 - 2 tsp) (15.6%, n = 32), while organic coconut butter was least consumed (<1 tsp) (47.3%, n = 97). Hummus was the most frequently consumed dressing, at least once a week (>2 tsp) (22.4%, n = 46) and peri – peri vegan mayonnaise was the least consumed dressing (<1 tsp) (46.3%, n = 95).

Snacks:

Potato chips were the most frequently consumed snack among the respondents at least once a month (1 packet, 125g) (19.0%, n = 39), while coconut chips were least consumed (<1 packet (<125g) (51.2%, n = 105). The most frequently consumed biscuit were wheat-free biscuits (1 - 2 items) (11.7%, n = 24) and least consumed was biscotti (<1 item) (52.2%, n = 107). In the group of chocolate bars and sweets, organic dark chocolate bars were more frequently consumed by the respondents (<1 item) (17.1%, n = 35) at least once a month. Peanut clusters were never or rarely consumed (<1 item) (48.3%, n = 99).

Desserts:

The most frequently consumed dessert among the respondents was non-dairy yoghurt (<½ cup) (10.7%, n = 22), while the least frequently consumed dessert was soy ice cream (<½ cup) (45.9%, n = 94). Egg-less cake was most frequently consumed at least once a month by the respondents (1 - 2 slices) (17.1%, n = 35), while fruit pie was least frequently consumed (<1 slice) (51.2%, n = 105).

Spreads and sweeteners:

Different flavours of jam were the most frequently consumed spreads, used at least once a month by the respondents (1 - 2 tsp) (13.2%, n = 27), while organic chocolate spread was least frequently consumed (<1 tsp) (49.3%, n = 101). Brown sugar was the most frequently consumed sweetener used at least once a day by the respondents (1 - 2 tsp) (17.1%, n = 35), and coconut syrup was the least frequently consumed sweetener (<1 tsp) (52.7%, n = 108).

Beverages:

Decaffeinated or regular coffee were the most commonly consumed beverage among the respondents, consumed at least once a day (1 - 2 cup) (29.3%, n = 60), and fruit flavoured juice was least frequently consumed by the respondents (<1 cup) (45.9%, n = 94). In the list of other beverages, sugar-sweetened soft drinks were most frequently consumed (<1 cup) (11.2%, n = 23), consumed at least once a month. Non-alcoholic wine was least frequently consumed among the respondents (<1 cup) (48.8%, n = 100).

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113)

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Milk substitutes								
Almond milk	43	21.0	26	12.7	20	9.8	24	11.7
Cashew milk	103	50.2	6	2.9	1	0.5	0	0
Coconut milk	44	21.5	44	21.5	19	9.3	2	1.0
Flax milk	110	53.7	0	0	0	0	0	0
Hemp milk	109	53.2	0	0	1	0.5	1	0.5
Homemade soy milk	107	52.2	1	0.5	2	1.0	0	0
Macadamia milk	108	52.7	1	0.5	0	0	1	0.5
Oat milk	98	47.8	8	3.9	2	1.0	3	1.5
Quinoa	110	53.7	0	0	0	0	0	0
Rice milk	94	45.9	8	3.9	6	2.9	3	1.5
Soy milk	39	19.0	13	6.3	16	7.8	43	21.0
Bread Loaves								
Brown bread	50	24.4	18	8.8	28	13.7	7	3.4
French bread	89	43.4	13	6.3	3	1.5	1	0.5
Rye bread	58	28.3	30	14.6	16	7.8	3	1.5
Sour dough bread	65	31.7	24	11.7	15	7.3	2	1.0
White bread	60	29.3	21	10.2	17	8.3	9	4.4
Whole-wheat bread	35	17.1	23	11.2	37	18.0	14	6.8
Bread Other								
Cornbread	108	52.7	2	1.0	0	0	0	0
English muffin	98	47.8	8	3.9	3	1.5	0	0
Muffin – bran/oat	87	42.4	17	8.3	7	3.4	0	0
Pita	65	31.7	43	21.0	1	0.5	0	0
Rolls – brown	87	42.4	19	9.3	2	1.0	1	0.5
Rolls – white	56	27.3	39	19.0	15	7.3	1	0.5
Rolls – whole-wheat / seeded	68	33.2	33	16.1	6	2.9	3	1.5
Tortilla	75	36.6	27	13.2	8	3.9	0	0
Waffles	101	49.3	9	4.4	0	0	1	0.5
Pasta								
Brown rice noodles	102	49.8	6	2.9	2	1.0	0	0
Buckwheat pasta	100	48.8	7	3.4	1	0.5	0	0
Chick pea pasta	97	47.3	9	4.4	2	1.0	1	0.5
Corn and quinoa pasta	107	52.2	1	0.5	1	0.5	1	0.5
Green pea pasta	106	51.7	4	2.0	0	0	1	0.5
Maize and rice pasta	100	48.8	8	3.9	3	1.5	0	0
Organic black noodles	108	52.7	1	0.5	0	0	0	0
Organic brown rice pasta	99	48.3	8	3.9	2	1.0	0	0
Organic lasagna sheets	99	48.3	9	4.4	2	1.0	0	0
Organic spelt pasta	108	52.7	2	1.0	0	0	0	0
Pasta – plain , egg	103	50.2	4	2.0	1	0.5	0	0
Pasta – plain , eggless	28	13.7	42	20.5	43	21.0	0	0
Pure rice pasta	97	47.3	10	4.9	3	1.5	0	0
Red lentil pasta	99	48.3	6	2.9	3	1.5	1	0.5
Rice and corn pasta	105	51.2	2	1.0	2	1.0	0	0
Wholegrain pasta	75	36.6	17	8.3	18	8.8	0	0
Grains								
Amaranth	107	52.2	1	0.5	1	0.5	0	0
Barley flakes	110	53.7	0	0	0	0	0	0
Brown rice koji	109	53.2	1	0.5	0	0	0	0
Buckwheat	94	45.9	11	5.4	3	1.5	2	1.0
Bulgar wheat	81	39.5	22	10.7	6	2.9	1	0.5
Cornmeal	108	52.7	1	0.5	0	0	0	0
Couscous	50	24.4	39	19.0	19	9.3	1	0.5

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Flax meal	90	43.9	5	2.4	10	4.9	4	2.0
Maize meal	91	44.4	11	5.4	8	3.9	0	0
Millet	102	49.8	6	2.9	1	0.5	0	0
Oat bran	98	47.8	8	3.9	4	2.0	1	0.5
Oatmeal	81	39.5	11	5.4	10	4.9	6	2.9
Organic black rice	106	51.7	3	1.5	1	0.5	0	0
Organic wild rice	89	43.4	16	7.8	5	2.4	1	0.5
Organic wheat kennels	108	52.7	1	0.5	0	0	0	0
Pearled barley	86	42.0	18	8.8	4	2.0	1	0.5
Polenta	95	46.3	12	5.9	2	1.0	0	0
Puffed rice	103	50.2	3	1.5	3	1.5	0	0
Rice – brown	41	20.0	31	15.1	36	17.6	1	0.5
Rice – white	53	25.9	30	14.6	26	12.7	0	0
Rolled oats	39	19.0	31	15.1	23	11.2	17	8.3
Sorghum	106	51.7	3	1.5	1	0.5	0	0
Sushi rice	72	35.1	27	13.2	7	3.4	0	0
Teff grain	108	52.7	2	1.0	0	0	0	0
White / brown Basmati rice	44	21.5	41	20.0	22	10.7	2	1.0
White / red / black quinoa	65	31.7	30	14.6	11	5.4	2	1.0
Cereals								
All Bran flakes	94	45.9	9	4.4	3	1.5	3	1.5
Cheerios	107	52.2	3	1.5	0	0	0	0
Cornflakes	99	48.3	4	2.0	7	3.4	0	0
Muesli	77	37.6	11	5.4	17	8.3	5	2.4
Oat bran flakes	99	48.3	6	2.9	3	1.5	1	0.5
Rice Krispies, Milo cereal	105	51.2	5	2.4	1	0.5	0	0
Special K	108	52.7	1	0.5	1	0.5	0	0
Weet-bix	85	41.5	8	3.9	10	4.9	7	3.4
Vegan Meats								
Gluten (Seitan)	59	28.8	35	17.1	15	7.3	3	1.5
Textured vegetable protein (from dry)	65	31.7	21	10.2	20	9.8	4	2.0
Soya products	12	5.9	31	15.1	59	28.8	9	4.4
Tofu – firm	41	20.0	47	22.9	19	9.3	2	1.0
Tofu – silken / soft	60	29.3	35	17.1	10	4.9	3	1.5
Egg / Cheese substitutes								
Egg replacer	86	42.0	17	8.3	5	2.4	1	0.5
Vegan cheese	36	17.6	45	22.0	25	12.2	6	2.9
Mixed Food								
Vegan lasagna	74	36.1	33	16.1	3	1.5	1	0.5
Vegan pizza	33	16.1	67	32.7	11	5.4	0	0
Peas and Beans								
Adzuki beans	98	47.8	6	2.9	3	1.5	1	0.5
Black beans	29	14.1	39	19.0	37	18.0	3	1.5
Black-eye beans	67	32.7	30	14.6	9	4.4	1	1.5
Brown lentils	15	7.3	47	22.9	43	21.0	6	2.9
Butter beans	32	15.6	37	18.0	39	19.0	1	0.5
Cannellini beans	63	30.7	29	14.1	16	7.8	0	0
Chick peas	6	2.9	30	14.6	66	32.2	9	4.4
Green soybean	98	47.8	7	3.4	2	1.0	0	0
Kidney beans	32	15.6	32	15.6	42	20.5	3	1.5

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Lima beans	98	47.8	8	3.9	2	1.0	0	0
Mature soybean	99	48.3	6	2.9	2	1.0	1	0.5
Mung beans	76	37.1	22	10.7	9	4.4	2	1.0
Navy/haricot beans	100	48.8	7	3.4	1	0.5	0	0
Pinto beans	90	43.9	11	5.4	7	3.4	0	0
Red split lentils	44	21.5	33	16.1	29	14.1	3	1.0
Split green peas	66	32.2	27	13.2	16	7.8	0	0
Sugar beans	54	26.3	25	12.2	27	13.2	1	0.5
White beans	61	29.8	29	14.1	19	9.3	0	0
Bean products:								
Baked beans	51	24.9	36	17.6	24	11.7	0	0
Refried beans	96	46.8	7	3.4	2	1.0	1	0.5
Nuts								
Almonds	26	12.7	42	20.5	32	15.6	12	5.9
Brazil nuts	78	38.0	17	8.3	11	5.4	1	0.5
Cashew nuts	25	12.2	50	24.4	28	13.7	7	3.4
Coconut	69	33.7	24	11.7	17	8.3	1	0.5
Peanuts	44	21.5	27	13.2	30	14.6	7	3.4
Pecan nuts	74	36.1	21	10.2	12	5.9	3	1.5
Pistachio nuts	88	42.9	13	6.3	5	2.4	1	0.5
Soy nuts	104	50.7	2	1.0	1	0.5	0	0
Walnuts	58	28.3	32	15.6	14	6.8	7	3.4
Seeds/Nut Butters:								
Almond nut butter	87	42.4	12	5.9	6	2.9	3	1.5
Cashew butter	99	48.3	5	2.4	4	2.0	0	0
Coconut butter	100	48.8	2	1.0	4	2.0	2	1.0
Flax seeds	43	21.0	26	12.7	19	9.3	21	10.2
Hazelnut butter	106	51.7	2	1.0	0	0	0	0
Macadamia nut butter	100	48.8	6	2.9	2	1.0	0	0
Peanut butter	22	10.7	23	11.2	39	19.0	26	12.7
Pumpkin seeds	46	22.4	35	17.1	19	9.3	11	5.4
Roasted sunflower/ pumpkin seed butter	105	51.2	2	1.0	1	0.5	0	0
Sesame seeds	49	23.9	38	18.5	17	8.3	6	2.9
Sesame Tahini	59	28.8	29	14.1	21	10.2	2	1.0
Sunflower seeds	47	22.9	33	16.1	19	9.3	10	4.9
Fats/Oils:								
Almond oil	107	52.2	1	0.5	0	0	0	0
Canola oil	61	29.8	13	6.3	25	12.2	8	3.9
Coconut oil	39	19.0	25	12.2	31	15.1	15	7.3
Flax seed oil	98	47.8	7	3.4	2	1.0	0	0
Ghee (clarified butter)	103	50.2	3	1.5	0	0	1	0.5
Grapeseed oil	100	48.8	2	1.0	6	2.9	0	0
Hemp seed oil	104	50.7	1	0.5	1	0.5	2	1.0
Macadamia oil	103	50.2	3	1.5	0	0	1	0.5
Olive oil	21	10.2	18	8.8	31	15.1	42	20.5
Pine nut oil	106	51.7	2	1.0	0	0	0	0
Sesame oil	84	41.0	20	9.8	5	2.4	0	0
Soybean oil	106	51.7	0	0	0	0	0	0
Sunflower oil	61	29.8	14	6.8	27	13.2	7	3.4
Butter and Margarine:								
Dairy-free margarine	38	18.5	13	6.3	32	15.6	29	14.1
Organic Coconut butter	97	47.3	2	1.0	7	3.4	1	0.5
Salad dressings:								
French dressing	94	45.9	8	3.9	5	2.4	2	1.0
Hummus	23	11.2	36	17.6	46	22.4	7	3.4

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Italian dressing	90	43.9	10	4.9	10	4.9	0	0
Peri- peri vegan mayonnaise	95	46.3	9	4.4	5	2.4	0	0
1000 island style vegan mayonnaise	85	41.5	12	5.9	10	4.9	1	0.5
Leafy vegetables:								
Bok choy	72	35.1	22	10.7	11	5.4	3	1.5
Cabbage – green	41	20.0	40	19.5	22	10.7	4	2.0
Cabbage – red	48	23.4	38	18.5	14	6.8	5	2.4
Chinese/ Lapa cabbage	95	46.3	7	3.4	4	2.0	1	0.5
Collard greens	76	37.1	13	6.3	12	5.9	5	2.4
Green leaf lettuce	34	16.6	24	11.7	41	20.0	10	4.9
Iceberg lettuce	55	26.8	17	8.3	31	15.1	6	2.9
Kale	56	27.3	25	12.2	20	9.8	7	3.4
Mustard greens	93	45.4	11	5.4	3	1.5	0	0
Romaine lettuce	56	27.3	20	9.8	23	11.2	7	3.4
Spinach – cooked	20	9.8	36	17.6	51	24.9	2	1.0
Spinach- raw	38	18.5	23	11.2	38	18.5	9	4.4
Swiss chard	73	35.6	16	7.8	19	9.3	1	0.5
Non-Leafy Vegetables:								
Artichoke	87	42.4	18	8.8	4	2.0	0	0
Asparagus	76	37.1	26	12.7	8	3.9	0	0
Beetroot	31	15.1	43	21.0	29	14.1	5	2.4
Broccoli – raw	60	29.3	19	9.3	27	13.2	2	1.0
Broccoli – cooked	6	2.9	28	13.7	74	36.1	4	2.0
Butternut	19	9.3	38	18.5	52	25.4	1	0.5
Carrots – cooked	11	5.4	28	13.7	60	29.3	9	4.4
Carrots – raw	25	12.2	28	13.7	44	21.5	11	5.4
Cassava	107	52.2	1	0.5	1	0.5	0	0
Cauliflower – raw	73	35.6	27	13.2	9	4.4	1	0.5
Cauliflower- cooked	15	7.3	37	18.0	58	28.3	1	0.5
Corn on the cob	44	21.5	44	21.5	22	10.7	0	0
Gem squash	56	27.3	36	17.6	18	8.8	0	0
Green beans	29	14.1	34	16.6	47	22.9	0	0
Green peas	26	12.7	34	16.6	48	23.4	2	1.0
Mushrooms	14	6.8	22	10.7	59	28.8	15	7.3
Okra	99	48.3	8	3.9	2	1.0	0	0
Olives – black/ green	39	19.0	39	19.0	28	13.7	4	2.0
Potato – white/red	18	8.8	22	10.7	62	30.2	8	3.9
Pumpkin	57	27.8	30	14.6	20	9.8	1	0.5
Sweetcorn	36	17.6	36	17.6	36	17.6	0	0
Sweet potato	21	10.2	34	16.6	51	24.9	2	1.0
Zucchini / Baby marrow	16	7.8	47	22.9	44	21.5	3	1.5
Other vegetable condiments:								
Carrot juice	92	44.9	14	6.8	2	1.0	2	1.0
Packet vegetable soups or broths	75	36.6	23	11.2	11	5.4	2	1.0
Tomato juice	100	48.8	6	2.9	3	1.5	1	0.5
Tomato sauces, paste & salsa	25	12.2	27	13.2	51	24.9	6	2.9
Fresh/ Frozen Fruit								
Apple	17	8.3	27	13.2	42	20.5	24	11.7
Avocado	7	3.4	22	10.7	63	30.7	19	9.3
Banana	16	7.8	14	6.8	33	16.1	46	22.4
Blueberries	43	21.0	36	17.6	19	9.3	9	4.4
Cantaloupe	89	43.4	16	7.8	3	1.5	0	0
Cherries	86	42.0	14	6.8	5	2.4	2	1.0
Dragon fruit	101	49.3	4	2.0	5	2.4	0	0

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Figs	90	43.9	14	9.8	4	2.0	0	0
Grapes	39	19.0	47	22.9	17	8.3	6	2.9
Jack fruit	97	47.3	11	5.4	1	0.5	0	0
Litchis	86	42.0	15	7.3	5	2.4	1	0.5
Mango	48	23.4	44	21.5	17	8.3	0	0
Nectarine	54	26.3	32	15.6	20	9.8	1	0.5
Orange	27	13.2	31	15.1	37	18.0	12	5.9
Papaya	56	27.3	31	15.1	18	8.8	3	1.5
Peaches	67	32.7	32	15.6	9	4.4	0	0
Pear	68	33.2	24	11.7	13	6.3	4	2.0
Persimmons	101	49.3	4	2.0	4	2.0	0	0
Pineapple	39	19.0	48	23.4	20	9.8	2	1.0
Plums	75	36.6	21	10.2	12	5.9	0	0
Strawberries	34	16.6	43	21.0	25	12.2	6	2.9
Watermelon	63	30.7	37	18.0	8	3.9	1	0.5
Dried & Canned Fruit:								
Apple sauce	99	48.3	10	4.9	0	0	0	0
Dried apricots	81	39.5	23	11.2	4	2.0	1	0.5
Dried berries	88	42.9	12	5.9	7	3.4	2	1.0
Dried figs	96	46.8	9	4.4	3	1.5	1	0.5
Dried mangoes	74	36.1	25	12.2	7	3.4	3	1.5
Dried mixed fruit	81	39.5	23	11.2	3	1.5	3	1.5
Dried peaches	88	42.9	19	9.3	2	1.0	0	0
Dried pomegranates	107	52.2	2	1.0	0	0	0	0
Dried prunes	92	44.9	10	4.9	4	2.0	3	1.5
Dried raisins	45	22.0	29	14.1	27	13.2	9	4.4
Peaches –canned	100	48.8	9	4.4	0	0	0	0
Pineapple- canned	96	46.8	12	5.9	0	0	0	0
Fruit juices:								
Apple juice	90	43.9	11	5.4	8	3.9	0	0
Coconut water	90	43.9	15	7.3	3	1.5	0	0
Grape juice	90	43.9	10	4.9	7	3.4	0	0
Mixed fruit juice	88	42.9	9	4.4	10	4.9	0	0
Orange juice	72	35.1	22	10.7	12	5.9	1	0.5
Orange juice – freshly prepared	65	31.7	26	12.7	15	7	1	0.5
Jams/Marmalade/ Sweetened spreads								
Jam e.g. strawberry, apricot, raspberry and plum, mixed fruit, mixed berry	57	27.8	27	13.2	18	8.8	7	3.4
Marmalade e.g. citrus fruits, olive, berries, ginger, fig, mixed Fruit	90	43.9	11	5.4	7	3.4	0	0
Organic chocolate spreads	101	49.3	7	3.4	1	0.5	0	0
Papaya chutney	103	50.2	3	1.5	2	1.0	1	0.5
Beverages:								
Coffee – decaffeinated/regular	26	12.7	8	3.9	14	6.8	60	29.3
Coffee substitutes	96	46.8	1	0.5	3	1.5	7	3.4
Five roses tea	67	32.7	6	2.9	17	8.3	19	9.3
Flavored tea	80	39.0	14	6.8	8	3.9	5	2.4
Fruit cordials	91	44.4	9	4.4	5	2.4	2	1.0
Fruit flavored juice	94	45.9	6	2.9	7	3.4	1	0.5
Green tea	56	27.3	19	9.3	13	6.3	18	8.8
Herbal tea	43	21.0	13	6.3	32	15.6	19	9.3

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Rooibos tea	31	15.1	15	7.3	25	12.2	38	18.5
Other beverages:								
Artificially sweetened diet soft drinks	90	43.9	9	4.4	4	2.0	6	2.9
Beer	73	35.6	24	11.7	8	3.9	3	1.5
Kombucha	81	39.5	12	5.9	8	3.9	7	3.4
Liquor/Rum	90	43.9	13	6.3	4	2.0	1	0.5
Sugar- sweetened soft drinks	69	33.7	23	11.2	11	5.4	6	2.9
Sweetened - Iced tea	95	46.3	13	6.3	1	0.5	0	0
Wine- Non-alcoholic	100	48.8	4	2.0	3	1.5	1	0.5
Wine- Red	69	33.7	25	12.2	10	4.9	3	1.5
Wine – White	79	38.5	19	9.3	8	3.9	2	1.0
Snacks:								
Chips – potato	35	17.1	39	19.0	32	15.6	2	1.0
Coconut chips	105	51.2	4	2.0	0	0	0	0
Fruit crisps	103	50.2	4	2.0	1	0.5	0	0
Oyster mushroom biltong	102	49.8	6	2.9	0	0	0	0
Packet chips – tortilla/corn	49	23.9	38	18.5	20	9.8	1	0.5
Pretzel (hard)	88	42.9	15	7.3	6	2.9	0	0
Rice / oat cakes	68	33.2	23	11.2	13	6.3	5	2.4
Salted peanuts	62	30.2	33	16.1	13	6.3	1	0.5
Vegan Droëwors	102	49.8	5	2.4	1	0.5	0	0
Vegetable crisps	68	33.2	34	16.6	7	3.4	0	0
Biscuits:								
Biscuits (wheat free) e.g. choc chip, vanilla	71	34.6	24	11.7	13	6.3	1	0.5
Biscotti	107	52.2	1	0.5	1	0.5	0	0
Buttermilk/ bran rusks	92	44.9	8	3.9	8	3.9	1	0.5
Grain-free crackers	97	47.3	8	3.9	4	2.0	0	0
Muesli rusks	81	39.5	15	7.3	9	4.4	4	2.0
Bars and candy:								
Granola bar	84	41.0	17	8.3	7	3.4	0	0
Organic dark chocolate bar	57	27.8	35	17.1	15	7.3	2	1.0
Organic fruit gums	98	47.8	8	3.9	2	1.0	1	0.5
Organic white/ brown chocolate bars	97	47.3	8	3.9	4	2.0	0	0
Peanut clusters	99	48.3	7	3.4	3	1.5	0	0
Trail mix bar	94	45.9	12	5.9	3	1.5	0	0
Desserts:								
Coconut cream	77	37.6	22	10.7	10	4.9	0	0
Non-dairy cream	97	47.3	7	3.4	4	2.0	0	0
Non-dairy custard	100	48.8	7	3.4	1	0.5	0	0
Non-dairy yoghurt	72	35.1	22	10.7	10	4.9	4	2.0
Soy ice cream	94	45.9	11	5.4	2	1.0	0	0
Pies/ Puddings:								
Egg-less cake	69	33.7	35	17.1	6	2.9	0	0
Fruit pie	105	51.2	4	2.0	0	0	0	0
Vegan cheesecake	99	48.3	10	4.9	0	0	0	0
Sweeteners:								
Agave	93	45.4	12	5.9	3	1.5	0	0
Coconut sugar	99	48.3	5	2.4	4	2.0	0	0
Coconut syrup	108	52.7	0	0	0	0	0	0
Jaggery powder	105	51.2	1	0.5	2	1.0	0	0

Table 4.20: The frequency and consumption of food items from the FFQ (n = 113) continued

	Frequency of food items consumed							
	Never/rarely		At least once a month		At least once a week		At least once a day	
	n	%	n	%	n	%	n	%
Molasses	96	46.8	7	3.4	2	1.0	3	1.5
Non- nutritive sweeteners e.g. Xylitol, Sucralose, Saccharin, Aspartame, Acelfame K	84	41.0	5	2.4	9	4.4	10	4.9
Organic date syrup	99	48.3	7	3.4	2	1.0	1	0.5
Organic rice syrup	108	52.7	1	0.5	0	0	0	0
Raw bee honey	89	43.4	8	3.9	6	2.9	6	2.9
Real maple syrup	86	42.0	13	6.3	9	4.4	0	0
Stevia	99	48.3	2	1.0	4	2.0	5	2.4
Sugar, brown	55	26.8	9	4.4	10	4.9	35	17.1
Sugar, white	85	41.5	5	2.4	9	4.4	11	5.4

Table 4.21: The amount of food items consumed from the FFQ (n = 113)

	Frequency of food items consumed					
	n	%	n	%	n	%
Milk substitutes	<½ cup		½ - 1 cup		>1 cup	
Almond milk	34	16.6	28	13.7	13	6.3
Cashew milk	25	12.2	0	0	4	2.0
Coconut milk	28	13.7	16	7.8	17	8.3
Flax milk	26	12.7	0	0	1	0.5
Hemp milk	26	12.7	0	0	1	0.5
Homemade soy milk	27	13.2	0	0	2	1.0
Macadamia milk	25	12.2	0	0	2	1.0
Oat milk	30	14.6	1	0.5	3	1.5
Quinoa	27	13.2	0	0	1	0.5
Rice milk	25	12.2	4	2.0	8	3.9
Soy milk	23	11.2	28	13.7	21	10.2
Bread Loaves	<1 slice		1-2 slices		>2 slices	
Brown bread	7	3.4	33	16.1	12	5.9
French bread	18	8.8	8	3.9	7	3.4
Rye bread	13	6.3	29	14.1	13	6.3
Sour dough bread	14	6.8	21	10.2	11	5.4
White bread	17	8.3	28	13.7	11	5.4
Whole-wheat bread	13	6.3	39	19.0	20	9.8
Bread Other	<½ small item		½ - 1 small item		>1 small item	
Cornbread	24	11.7	0	0	1	0.5
English muffin	22	10.7	7	3.4	4	2.0
Muffin – bran/oat	19	9.3	12	5.9	7	3.4
Pita	15	7.3	24	11.7	13	6.3
Rolls – brown	14	6.8	14	6.8	5	2.4
Rolls – white	11	5.4	30	14.6	18	8.8
Rolls – whole-wheat / seeded	18	8.8	16	7.8	17	8.3
Tortilla	20	9.8	13	6.3	13	6.3
Waffles	23	11.2	5	2.4	1	0.5
Pasta	<½ cup		½ - 1 cup		>1 cup	
Brown rice noodles	19	9.3	2	1.0	6	2.9
Buckwheat pasta	19	9.3	1	0.5	4	2.0
Chick pea pasta	17	8.3	7	3.4	6	2.9
Corn and quinoa pasta	17	8.3	0	0	4	2.0
Green pea pasta	17	8.3	1	0.5	3	1.5
Maize and rice pasta	20	9.8	3	1.5	6	2.9

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Organic black noodles	17	8.3	4	2.0	21	10.2
Organic brown rice pasta	19	9.3	5	2.4	6	2.9
Organic lasagna sheets	18	8.8	4	2.0	8	3.9
Organic spelt pasta	18	8.8	2	1.0	2	1.0
Pasta – plain , egg	17	8.3	2	1.0	4	2.0
Pasta – plain , eggless	10	4.9	28	13.7	38	18.5
Pure rice pasta	19	9.3	3	1.5	7	3.4
Red lentil pasta	20	9.8	4	2.0	6	2.9
Rice and corn pasta	16	7.8	2	1.0	4	2.0
Wholegrain pasta	16	7.8	11	5.4	18	8.8
Grains	<½ cup		½ - 1 cup		>1 cup	
Amaranth	21	10.2	0	0	1	0.5
Barley flakes	19	9.8	0	0	0	0
Brown rice koji	20	9.8	0	0	0	0
Buckwheat	26	12.7	7	3.4	2	1.0
Bulgar wheat	21	10.2	17	8.3	7	3.4
Cornmeal	18	8.8	0	0	0	0
Couscous	21	10.2	27	13.2	9	4.4
Flax meal	32	15.6	1	0.5	0	0
Maize meal	21	10.2	8	3.9	5	2.4
Millet	22	10.7	3	1.5	2	1.0
Oat bran	21	10.2	7	3.4	0	0
Oatmeal	18	8.8	18	8.8	2	1.0
Organic black rice	21	10.2	0	0	4	2.0
Organic wild rice	22	10.7	9	4.4	6	2.9
Organic wheat kennels	20	9.8	1	0.5	1	0.5
Pearled barley	20	9.8	9	4.4	7	3.4
Polenta	24	11.7	5	2.4	3	1.5
Puffed rice	23	11.2	2	1.0	1	0.5
Rice – brown	17	8.3	33	16.1	20	9.8
Rice – white	13	6.3	27	13.2	17	8.3
Rolled oats	26	12.7	38	18.5	10	4.9
Sorghum	20	9.8	0	0	2	1.0
Sushi rice	23	11.2	14	6.8	10	4.9
Teff grain	22	10.7	1	0.5	0	0
White / brown Basmati rice	22	10.7	30	14.6	16	7.8
White / red / black quinoa	20	9.8	23	11.2	4	2.0
Cereals	<½ cup		½ - 1 cup		>1 cup	
Oat bran flakes	17	8.3	11	5.4	0	0
All Bran flakes	19	9.3	9	4.4	4	2.0
Cheerios	19	9.3	3	1.5	0	0
Cornflakes	17	8.3	7	3.4	4	2.0
Muesli	26	12.7	13	6.3	3	1.5
Rice Krispies, Milo cereal	19	9.3	4	2.0	1	0.5
Special K	20	9.8	3	1.5	0	0
Weet-bix	19	9.3	11	5.4	7	3.4
Vegan Meats	<½ cup		½ - 1 cup		>1 cup	
Gluten (Seitan)	18	8.8	24	11.7	9	4.4
Soya products	15	7.3	45	22.0	23	11.2

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Textured vegetable protein (from dry)	15	7.3	17	8.3	12	5.9
Tofu – firm	20	9.8	31	15.1	10	4.9
Tofu – silken / soft	24	11.7	18	8.8	6	2.9
Egg / Cheese substitutes	<1 slice		1-2 slices		>2 slices	
Egg replacer	20	9.8	9	4.4	5	2.4
Vegan cheese	17	8.3	33	16.1	17	8.3
Mixed Food	<1 slice, <1 tsp		1-2 slices, 1-2 tsp		>2 slices, >2 tsp	
Vegan lasagna	20	9.8	9	4.4	5	2.4
Vegan pizza	17	8.3	33	16.1	17	8.3
Peas and Beans	<½ cup		½ - 1 cup		>1 cup	
Adzuki beans	22	10.7	4	2.0	3	1.5
Black beans	29	14.1	36	17.6	9	4.4
Black-eye beans	29	14.1	15	7.3	7	3.4
Brown lentils	22	10.7	38	18.7	23	11.2
Butter beans	28	13.7	33	16.1	12	5.9
Cannellini beans	27	13.2	14	6.8	9	4.4
Chickpeas	16	7.8	49	23.9	25	12.2
Green soybean	20	9.8	2	1.0	4	2.0
Kidney beans	31	15.1	29	14.1	12	5.9
Lima beans	22	10.7	4	2.0	3	1.5
Mature soybean	20	9.8	3	1.5	6	2.9
Mung beans	21	10.2	17	8.3	6	2.9
Navy/haricot beans	20	9.8	1	0.5	3	1.5
Pinto beans	20	9.8	9	4.4	2	1.0
Red split lentils	20	9.8	30	14.6	12	5.9
Split green peas	26	12.7	18	8.8	6	2.9
Sugar beans	25	12.2	20	9.8	10	4.9
White beans	23	11.2	20	9.8	8	3.9
Bean products:	<½ cup		½ - 1 cup		>1 cup	
Baked beans	27	13.2	25	12.2	7	3.4
Refried beans	22	10.7	3	1.5	3	1.5
Nuts						
Almonds	59	28.8	17	8.3	0	0
Brazil nuts	38	18.5	3	1.5	1	0.5
Cashew nuts	58	28.3	15	7.3	2	1.0
Coconut	38	18.5	8	3.9	1	0.5
Peanuts	39	19.0	16	7.8	4	2.0
Pecan nuts	38	18.5	5	2.4	0	0
Pistachio nuts	27	13.2	9	4.4	0	0
Soy nuts	21	10.2	3	1.5	0	0
Walnuts	49	23.9	6	2.9	0	0
Seeds/Nut Butters:	<1 tsp		1-2 tsp		>2 tsp	
Almond nut butter	18	8.8	8	3.9	9	4.4
Cashew butter	16	7.8	6	2.9	5	2.4
Coconut butter	18	8.8	3	1.5	5	2.4
Flax seeds	19	9.3	28	13.7	17	8.3
Hazelnut butter	21	10.2	2	1.0	2	1.0
Macadamia nut butter	20	9.8	3	1.5	5	2.4
Peanut butter	5	2.4	37	18.0	40	19.5
Pumpkin seeds	19	9.3	23	11.2	20	9.8
Roasted sunflower/ pumpkin seed butter	20	9.8	1	0.5	4	2.0
Sesame seeds	26	12.7	20	9.8	15	7.3

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Sesame Tahini	23	11.2	16	7.8	18	8.8
Sunflower seeds	15	7.3	23	11.2	23	11.2
Fats/Oils:	<1 tsp		1-2 tsp		>2 tsp	
Almond oil	20	9.8	0	0	1	0.5
Canola oil	19	9.3	21	10.2	13	6.3
Coconut oil	21	10.2	33	16.1	14	6.8
Flax seed oil	19	9.3	4	2.0	3	1.5
Ghee (clarified butter)	19	9.3	0	0	3	1.5
Grapeseed oil	19	9.3	4	2.0	2	1.0
Hemp seed oil	18	8.8	2	1.0	3	1.5
Macadamia oil	20	9.8	1	0.5	1	0.5
Olive oil	21	10.2	38	18.5	23	11.2
Pine nut oil	21	10.2	0	0	1	0.5
Sesame oil	23	11.2	9	4.4	5	2.4
Soybean oil	18	8.8	1	0.5	1	0.5
Sunflower oil	19	9.3	19	9.3	16	7.8
Butter and Margarine:	<1 tsp		1-2 tsp		>2 tsp	
Dairy-free margarine	19	9.3	35	17.1	14	6.8
Organic Coconut butter	19	9.3	6	2.9	2	1.0
Salad dressings:	<1 tsp		1-2 tsp		>2 tsp	
1000 island style vegan mayonnaise	15	7.3	9	4.4	8	3.9
French dressing	21	10.2	2	1.0	3	1.5
Hummus	6	2.9	21	10.2	52	25.4
Italian dressing	17	8.3	6	2.9	7	3.4
Peri- peri vegan mayonnaise	17	8.3	3	1.5	5	2.4
Leafy vegetables:	<½ cup		½ - 1 cup		>1 cup	
Bok choy	21	10.2	11	5.4	16	7.8
Cabbage – green	20	9.8	29	14.1	20	9.8
Cabbage – red	24	11.7	24	11.7	14	6.8
Chinese/ Lapa cabbage	21	10.2	3	1.5	6	2.9
Collard greens	20	9.8	7	3.4	15	7.3
Green leaf lettuce	17	8.3	26	12.7	30	14.6
Iceberg lettuce	19	9.3	18	8.8	21	10.2
Kale	17	8.3	17	8.3	24	11.7
Mustard greens	22	10.7	6	2.9	6	2.9
Romaine lettuce	16	7.8	18	8.8	17	8.3
Spinach – cooked	10	4.9	29	14.1	41	20.0
Spinach- raw	19	9.3	23	11.2	30	14.6
Swiss chard	14	6.8	10	4.9	23	11.2
Non-Leafy Vegetables:	<½ cup		½ - 1 cup		>1 cup	
Artichoke	25	12.2	8	3.9	5	2.4
Asparagus	25	12.2	16	7.8	5	2.4
Beetroot	32	15.6	33	16.1	13	6.3
Broccoli – cooked	10	4.9	46	22.4	38	18.5
Broccoli – raw	24	11.7	22	10.7	12	5.9
Butternut	22	10.7	36	17.6	28	13.7
Carrots – cooked	23	11.2	40	19.5	22	10.7
Carrots – raw	32	15.6	30	14.6	17	8.3
Cassava	21	10.2	0	0	1	0.5
Cauliflower- cooked	15	7.3	34	16.6	39	19.0
Cauliflower – raw	29	14.1	13	6.3	6	2.9
Corn on the cob	16	7.8	35	17.1	12	5.9
Gem squash	20	9.8	29	14.1	10	4.9
Green beans	20	9.8	35	17.1	24	11.7

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Green peas	18	8.8	39	19.0	18	8.8
Mushrooms	10	4.9	46	22.4	28	13.7
Olives – black/ green	47	22.9	18	8.8	4	2.0
Okra	20	9.8	6	2.9	2	1.0
Potato – white/red	10	4.9	41	20.0	32	15.6
Pumpkin	22	10.7	19	9.3	14	6.8
Sweetcorn	25	12.2	33	16.1	11	5.4
Sweet potato	20	9.8	36	17.6	23	11.2
Zucchini / Baby marrow	22	10.7	42	20.5	21	10.2
Other vegetable condiments:	<½ cup		½ - 1 cup		>1 cup	
Carrot juice	17	8.3	5	2.4	6	2.9
Packet vegetable soups or broths	18	8.8	14	6.8	9	4.4
Tomato juice	19	9.3	1	0.5	6	2.9
Tomato sauces, paste & salsa	36	17.6	30	14.6	8	3.9
Fresh/ Frozen Fruit	<½ med item/cup		½ - 1 med item/cup		>1 med item'/cup	
Apple	17	8.3	38	18.5	27	13.2
Avocado	22	10.7	35	17.1	31	15.1
Banana	11	5.4	41	20.0	30	14.6
Blueberries	27	13.2	22	10.7	13	6.3
Cantaloupe	20	9.8	9	4.4	4	2.0
Cherries	21	10.2	8	3.9	7	3.4
Dragon fruit	21	10.2	3	1.5	4	2.0
Figs	17	8.3	7	3.4	8	3.9
Grapes	21	10.2	21	10.2	25	12.2
Jack fruit	18	8.8	8	3.9	5	2.4
Litchis	21	10.2	7	3.4	7	3.4
Mango	21	10.2	19	9.3	19	9.3
Nectarine	16	7.8	16	7.8	21	10.2
Orange	12	5.9	27	13.2	32	15.6
Papaya	20	9.8	15	7.3	23	11.2
Pear	19	9.3	17	8.3	13	6.3
Peaches	20	9.8	14	6.8	14	6.8
Persimmons	20	9.8	3	1.5	5	2.4
Pineapple	21	10.2	24	11.7	20	9.8
Plums	23	11.2	10	4.9	8	3.9
Strawberries	22	10.7	27	13.2	18	8.8
Watermelon	19	9.3	18	8.8	13	6.3
Dried & Canned Fruit:	<½ cup		½ - 1 cup		>1 cup	
Apple sauce	22	10.7	4	2.0	0	0
Dried apricots	33	16.1	4	2.0	1	0.5
Dried berries	24	11.7	6	2.9	3	1.5
Dried figs	26	12.7	1	0.5	0	0
Dried mangoes	28	13.7	13	6.3	5	2.4
Dried mixed fruit	28	13.7	8	3.9	3	1.5
Dried peaches	28	13.7	6	2.9	1	0.5
Dried pomegranates	19	9.3	0	0	0	0
Dried prunes	27	13.2	3	1.5	1	0.5
Dried raisins	47	22.9	13	6.3	4	2.0
Peaches –canned	20	9.8	3	1.5	2	1.0
Pineapple- canned	24	11.7	2	1.0	3	1.5
Fruit juices:	<1 cup		1-2 cup		>2 cups	
Apple juice	16	7.8	11	5.4	7	3.4
Coconut water	18	8.8	13	6.3	2	1.0

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Grape juice	15	7.3	8	3.9	6	2.9
Mixed fruit juice	14	6.8	10	4.9	5	2.4
Orange juice	12	5.9	20	9.8	6	2.9
Orange juice – freshly prepared	20	9.8	17	8.3	13	6.3
Jams/Marmalade/ Sweetened spreads	<1 tsp		1-2 tsp		>2 tsp	
Jam e.g. strawberry, apricot, raspberry and plum, mixed fruit, mixed berry	13	6.3	29	14.1	14	6.8
Marmalade e.g. citrus fruits, olive, berries, ginger, fig, mixed Fruit	18	8.8	8	3.9	4	2.0
Organic chocolate spreads	17	8.3	3	1.5	1	0.5
Papaya chutney	17	8.3	4	2.0	2	1.0
Beverages:	<1 cup		1-2 cup		>2 cups	
Coffee – decaffeinated/regular	12	5.9	43	21.0	30	14.6
Coffee substitutes	18	8.8	5	2.4	3	1.5
Flavored tea	17	8.3	13	6.3	4	2.0
Five roses tea	15	7.3	17	8.3	17	8.3
Fruit cordials	17	8.3	8	3.9	3	1.5
Fruit flavored juice	16	7.8	9	4.4	1	0.5
Green tea	16	7.8	24	11.7	9	4.4
Herbal tea	16	7.8	29	14.1	16	7.8
Rooibos tea	17	8.3	38	18.5	17	8.3
Other beverages :	<1 cup		1-2 cup		>2 cups	
Artificially sweetened diet soft drinks	18	8.8	11	5.4	2	1.0
Beer	21	10.2	14	6.8	9	4.4
Kombucha	22	10.7	9	4.4	5	2.4
Liquor/Rum	23	11.2	6	2.9	3	1.5
Sweetened - Iced tea	26	12.7	7	3.4	0	0
Sugar- sweetened soft drinks	25	12.2	19	9.3	2	1.0
Wine- non-alcoholic	22	10.7	1	0.5	2	1.0
Wine- Red	30	14.6	14	6.8	8	3.9
Wine – White	25	12.2	9	4.4	9	4.4
Snacks:	< 1 pkt (<125g)		1 pkt (125g)		>1 pkt (>125g)	
Chips – potato	22	10.7	24	11.7	21	10.2
Coconut chips	21	10.2	1	0.5	1	0.5
Fruit crisps	19	9.3	3	1.5	2	1.0
Packet chips – tortilla/corn	20	9.8	24	11.7	15	7.3
Pretzel (hard)	27	13.2	7	3.4	6	2.9
Oyster mushroom biltong	19	9.3	4	2.0	1	0.5
Rice / oat cakes	32	15.6	13	6.3	7	3.4
Salted peanuts	27	13.2	19	9.3	5	2.4
Vegetable crisps	26	12.7	15	7.3	8	3.9
Vegan Droëwors	15	7.3	3	1.5	2	1.0
Biscuits:	< 1item		1-2 items		>1 items	
Biscotti	16	7.8	3	1.5	2	1.0
Biscuits (wheat free) e.g. choc chip, vanilla	12	5.9	18	8.8	14	6.8
Buttermilk/ bran rusks	13	6.3	10	4.9	7	3.4
Grain-free crackers	18	8.8	4	2.0	7	3.4
Muesli rusks	14	6.8	10	4.9	15	7.3
Bars and candy:	< 1item		1-2 items		>1 items	

Table 4.21: The amount of food items consumed from the FFQ (n = 113) continued

	Frequency of food items consumed					
	n	**%**	**n**	**%**	**n**	**%**
Granola bar	17	8.3	13	6.3	4	2.0
Peanut clusters	19	9.3	5	2.4	3	1.5
Organic dark chocolate bar	30	14.6	23	11.2	6	2.9
Organic fruit gums	20	9.8	4	2.0	5	2.4
Organic white/ brown chocolate bars	20	9.8	7	3.4	2	1.0
Trail mix bar	19	9.3	6	2.9	2	1.0
Desserts:	<½ cup		½ - 1 cup		>1 cup	
Coconut cream	26	12.7	10	4.9	8	3.9
Non-dairy cream	21	10.2	5	2.4	2	1.0
Non-dairy custard	23	11.2	2	1.0	1	0.5
Non-dairy yoghurt	21	10.2	13	6.3	10	4.9
Soy ice cream	18	8.8	6	2.9	6	2.9
Pies/ Puddings:	<1 slice		1-2 slices		>2 slices	
Egg-less cake	20	9.8	24	11.7	7	3.4
Fruit pie	18	8.8	2	1.0	1	0.5
Vegan cheesecake	18	8.8	4	2.0	2	1.0
Sweeteners:	<1 tsp		1-2 tsp		>2 tsp	
Agave	19	9.3	4	2.0	6	2.9
Coconut sugar	16	7.8	6	2.9	2	1.0
Coconut syrup	18	8.8	2	1.0	0	0
Jaggery powder	18	8.8	4	2.0	0	0
Molasses	22	10.7	6	2.9	1	0.5
Non- nutritive sweeteners e.g. Xylitol, Sucralose, Saccharin, Aspartame, Acelfame K	20	9.8	15	7.3	4	2.0
Organic date syrup	19	9.3	5	2.4	3	1.5
Organic rice syrup	18	8.8	2	1.0	1	0.5
Real maple syrup	19	9.3	12	5.9	7	3.4
Raw bee honey	20	9.8	13	6.3	1	0.5
Stevia	22	10.7	6	2.9	2	1.0
Sugar, brown	21	10.2	29	14.1	12	5.9
Sugar, white	16	7.8	13	6.3	8	3.9

4.4.2 Dietary consumption from the 24-hour recall

The 24-hour recall was completed by n = 134 of the respondents in this study. Descriptive analysis was conducted on all variables. Independent sample t-tests and Mann-Whitney tests were conducted to test for significant differences across gender. Table 4.21 to Table 4.27 shows the mean nutritional intake of macronutrients and micronutrients of meals consumed by the respondents from the 24-hour recalls. Table 4.28 shows the estimated average requirement (EAR) for adults.

Macronutrients:

From the 24-hour dietary recall results, independent sample t-tests showed that the amount of added sugar intake was significantly more for females (M = 20.5138 g) than for males (M = 13.184 g), t (73.109) = -2.063, p = 0.043.

This was the only significant difference across gender for this category regarding normally distributed variables. Mann-Whitney test showed that compared to females, males had a significantly higher intake of starch (Z = -2.122, p = 0.034), fructose (Z = -2.130, p = 0.033) and maltose (Z = -2.352, p = 0.019).

Minerals:

According to minerals, significantly higher intakes of silicon (Si) was consumed by males (M = 8394.4 μg) than females (5349.42 μg), t (31.845) = 2.589, p = 0.014. Mann-Whitney test showed that compared to males, females consumed significantly greater amounts of sodium (Na) (Z = -2.036, p = 0.042). Males consumed greater amounts of fluorine (F) than females (Z = -2.873, p = 0.004).

Vitamins:

Based on the results, a Mann-Whitney test showed that males consumed significantly higher intakes of vitamin A (carotene) (Z = -2.162, p = 0.031), vitamin A (tocotrienol) (Z = -2.637, p = 0.008), vitamin C (Z = -2.262, p = 0.024), vitamin D (tocopherol) (Z = -2.095, p = 0.036), vitamin G (tocopherol) (Z = -2.362, p = 0.018), vitamin G (tocotrienol) (Z = -2.777, p = 0.005) and lycopene (Z = -3.153, p = 0.002), compared to females.

Fatty acids and cholesterol:

The Mann-Whitney test showed that males consumed significantly more amounts of the fatty acid Myristic (C14: 1) (Z = -2.073, p = 0.038) compared to females.

Amino acids:

Independent sample tests showed that significantly more males (M = 0.4426 g) had higher intakes of serine than females (M = 0.3312 g), t (132) = 2.281, p = 0.024. According to Mann-Whitney tests, males consumed significantly higher intakes of arginine (Z = -2.022, p = 0.043), cystine (Z = -2.807, p = 0.005), glutamic acid (Z = -2.930, p = 0.003) and proline (Z = -2.393, p = 0.017) compared to females.

Other:

Mann-Whitney tests showed than males consumed significantly greater intakes of phytate (Z = -2.088, p = 0.037), malic acid (Z = -2.039, p = 0.041) and oxalic acid (Z = -2.505, p = 0.012).

Table 4.22: Dietary intake of macronutrients from the 24-hour recall (n = 134)

Macronutrients:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Energy	kJ	7893.76	7374.22	7471.15	3093.39
Moisture	g	1235.88	1092.31	1119.10	446.45
Carbohydrate	g	204.20	187.23	190.40	72.30
Added sugar	g	13.18	20.51	19.14	23.78
Fructose	g	20.19	15.66	16.50	14.67
Galactose	g	0.00	0.00	0.00	0.00
Glucose	g	14.35	12.37	12.74	12.25
Lactose	g	0.00	0.02	0.02	0.16
Maltose	g	0.40	0.15	0.19	0.46
Starch	g	20.92	16.41	17.25	18.85
Sucrose	g	18.94	17.08	17.42	18.53
Total sugars	g	55.08	46.09	47.77	40.65
Total protein	g	74.34	74.82	74.73	52.28
Animal protein	g	0.21	0.18	0.19	0.36
Nitrogen	g	2.38	2.05	2.11	1.23
Plant protein	g	73.40	73.78	73.71	52.18
Total fat	g	65.85	61.53	62.34	45.09
Total dietary fibre	g	42.41	36.35	37.48	18.73
Insoluble dietary fibre	g	10.27	8.59	8.90	5.81
Soluble dietary fibre	g	7.31	6.16	6.37	3.73
Ash	g	6.91	6.12	6.27	4.20
Lignin	g	1.16	1.68	1.16	1.41
Insoluble NSP	g	8.77	7.35	7.61	4.79
Non-starch polysaccharides (NSP)	g	16.30	13.57	14.08	8.43
Soluble NSP	g	7.24	6.13	6.34	3.73

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.23: Dietary intake of minerals from the 24-hour recall (n = 134)

Minerals:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Boron	µg	1899.64	2395.84	2303.26	2580.30
Calcium	mg	630.88	612.51	615.94	392.51
Chlorine	mg	499.88	378.00	400.73	339.14
Chromium	µg	47.31	37.93	39.68	39.55
Copper	mg	4.25	4.65	4.58	4.25
Fluoride	µg	128.68	91.66	98.57	90.55
Haem iron	mg	0.00	0.00	0.00	0.00
Iodine	µg	16.12	14.15	14.52	9.70
Iron	mg	23.28	22.95	23.01	13.39
Manganese	µg	6623.00	6088.88	6188.52	3591.09

Table 4.23: Dietary intake of minerals from the 24-hour recall (n = 134) continued

Minerals:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Magnesium	mg	558.04	530.64	535.75	336.31
Non- haem iron	mg	9.32	8.73	8.84	7.26
Phosphorous	mg	1211.24	1179.89	1184.74	656.51
Potassium	mg	4359.20	4532.31	4500.01	2938.40
Selenium	µg	15.94	12.33	13.00	12.21
Silicon	µg	8394.40	5349.42	5917.51	4822.23
Sodium	mg	675.72	1078.53	1003.38	937.41
Zinc	mg	9.82	8.84	9.02	5.37

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.24: Dietary intake of vitamins from the 24-hour recall (n = 134)

Vitamins:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
A-Carotene	µg	3098.20	1417.70	1731.23	2520.48
A-Tocopherol	mg	3.98	2.65	2.90	3.61
A-Tocotrienol	mg	0.12	0.07	0.08	0.09
B-Carotene	µg	9187.40	6183.69	6744.08	9956.73
Biotin	µg	130.87	123.57	124.93	129.93
B-Tocopherol	mg	0.14	0.08	0.98	0.14
B-Tocotrienol	mg	0.11	0.27	0.24	0.43
Cryptoxanthin	µg	281.76	192.31	209.00	440.39
D-Tocopherol	mg	0.14	0.05	0.70	0.45
D-Tocotrienol	mg	0.00	0.00	0.00	0.00
Folate	µg	480.60	432.32	441.32	268.59
G-Tocopherol	mg	0.42	0.27	0.29	0.36
G-Tocotrienol	mg	0.10	0.05	0.06	0.09
Lutein	µg	4722.44	3598.32	3808.04	7346.48
Lycopene	µg	1441.76	660.64	806.37	1091.61
Niacin	mg	15.59	15.32	15.37	9.68
Pantothenate	mg	6.15	5.87	5.92	4.66
Retinol	µg	4.84	6.11	5.88	17.88
Riboflavin	mg	1.32	1.26	1.27	0.99
Thiamine	mg	1.59	1.49	1.51	0.88
Total carotenoids	µg	10898.84	7037.93	7758.25	10772.24
Vitamin A	µg	2316.80	1722.90	1833.70	1905.82
Vitamin B6	mg	1.91	1.90	1.90	1.19
Vitamin B12	µg	1.06	1.06	1.06	1.44
Vitamin C	mg	172.52	131.89	139.47	102.71
Vitamin D	µg	3.30	3.44	3.42	4.41
Vitamin E	mg	20.32	13.56	14.82	15.51
Vitamin K	µg	265.57	209.02	219.57	296.12

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.25: Dietary intake of fatty acids (FA) and cholesterol from the 24-hour recall (n = 134)

Fatty Acids and Cholesterol:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Cholesterol	mg	4.84	3.80	4.00	8.94
C4:0	g	0.00	0.00	0.00	0.02
C6:0	g	0.01	0.02	0.02	0.05
C8:0	g	0.13	0.27	0.24	0.60
C10:0	g	0.10	0.22	0.19	0.48
C12:0	g	0.83	1.70	1.54	3.74
C13:0	g	0.00	0.00	0.00	0.00
C14:0	g	0.63	0.93	0.87	1.49
C15:0	g	0.00	0.00	0.00	0.00
C16:0	g	5.92	6.60	6.48	4.59
C17:0	g	0.00	0.00	0.00	0.00
C18:0	g	2.4	2.1	2.17	1.80
C20:0	g	0.16	0.12	0.13	0.15
C21:0	g	0.00	0.00	0.00	0.00
C22:0	g	0.33	0.23	0.25	0.33
C23:0	g	0.00	0.00	0.00	0.00
C24:0	g	0.12	0.08	0.09	0.12
C10:1	g	0.00	0.00	0.00	0.00
C12:1	g	0.00	0.00	0.00	0.00
C14:1	g	0.00	0.00	0.00	0.00
C15:1	g	0.00	0.00	0.00	0.00
C16:1	g	0.42	0.84	0.76	1.17
C17:1	g	0.00	0.00	0.00	0.00
C18:1	g	19.50	20.03	19.93	18.75
C20:1	g	0.14	0.10	0.11	0.16
C22:1	g	0.02	0.02	0.02	0.04
C23:1	g	0.00	0.00	0.00	0.00
C24:1	g	0.00	0.00	0.00	0.00
C18:2	g	22.60	18.79	19.50	18.02
C18:3	g	0.72	0.72	0.72	0.82
C18:4	g	0.00	0.00	0.00	0.00
C20:2	g	0.00	0.00	0.00	0.00
C20:4	g	0.00	0.00	0.00	0.01
C20:5	g	0.00	0.00	0.00	0.00
C22:2	g	0.00	0.00	0.00	0.01
C22:3	g	0.00	0.00	0.00	0.00
C22:4	g	0.00	0.00	0.00	0.00
C22:5	g	0.00	0.00	0.00	0.03
C22:6	g	0.00	0.00	0.00	0.00
C24:6	g	0.00	0.00	0.00	0.00
C20:3	g	0.00	0.00	0.00	0.01
Double trans FA	g	0.00	0.00	0.00	0.00
Mono-unsaturated FA	g	20.34	21.24	21.07	19.69
Polyunsaturated FA	g	23.58	19.60	20.34	18.50
Saturated FA	g	10.91	12.72	12.38	9.52
Single trans FA	g	0.00	0.00	0.00	0.00
Total trans FA	g	0.65	1.12	1.03	2.66

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.26: Dietary intake of amino acids from the 24-hour recall (n = 134)

Amino Acids:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Alanine	g	0.44	0.36	0.37	0.23
Arginine	g	3.34	2.63	2.76	1.96
Aspartic acid	g	1.16	1.02	1.04	0.71
Cystine	g	0.12	0.09	0.09	0.06
Glutamic acid	g	1.90	1.37	1.47	1.25
Glycine	g	0.39	0.31	0.32	0.22
Histidine	g	2.38	2.52	2.50	2.41
Hydroxyproline	g	0.00	0.00	0.00	0.00
Isoleucine	g	4.33	4.71	4.64	4.72
Leucine	g	7.34	7.93	7.82	7.95
Lysine	g	5.48	6.03	5.93	6.23
Methionine	g	1.36	1.44	1.42	1.31
Phenylalanine	g	4.87	5.25	5.18	5.24
Proline	g	0.51	0.36	0.39	0.26
Serine	g	0.44	0.33	0.35	0.22
Threonine	g	3.81	4.14	4.08	4.22
Tryptophan	g	2.07	2.39	2.33	2.83
Tyrosine	g	0.27	0.21	0.22	0.16
Valine	g	4.82	5.14	5.08	4.93

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.27: Dietary intake of other nutrients from the 24-hour recall (n = 134)

Other nutrients:	Unit:	Male: (n = 25)*	Female: (n = 109)*	Mean: (n = 134)*	Standard deviation (SD)*:
Alcohol	g	0.00	0.82	0.66	3.79
Caffeine	mg	0.00	0.00	0.00	0.00
Citric acid	mg	1526.00	1477.42	1486.48	1788.95
Malic acid	mg	1813.32	1439.02	1508.85	1321.45
Oxalic acid	mg	297.44	184.45	205.53	253.33
Phytate	mg	155.44	106.59	115.70	104.14
Tannins	mg	0.00	0.00	0.00	0.00
Tartaric acid	mg	184.24	129.13	139.41	516.70

* Represents mean intake by males, mean intake by females, mean intake of total population and standard deviation

Table 4.28: Estimated average requirement (EAR) for adults

Nutrients	EAR (per day):	
	Male	**Female**
Energy (kJ)	NA*	NA
Carbohydrate (g)	130 g (45-65% of total energy[b])	130 g (45-65% of total energy[b])
Added Sugar (g)	25g[a]	25g[a]
Protein (g)	56g (10-35% of total energy[b])	46g (10-35% of total energy[b])
Total fat (g)	20-35% of total energy[b]	20-35% of total energy[b]
Saturated fat (g)	< 10% [b]	< 10 % [b]
Monounsaturated fat (g)	± 10% of Energy from fat	± 10% of Energy from fat
Polyunsaturated fat (g)	6 - < 10% [b]	6 - < 10% [b]
Trans fat (g)	NA	NA
Cholesterol (mg)	< 300 mg	< 300 mg
Total fibre (g)	38 g	25 g
Insoluble fibre (g)	NA	NA
Soluble fibre (g)	NA	NA
Total Vitamin A Activity (µg retinol equivalents)	900 µg	700 µg
Vitamin B6 (mg)	19-50years – 1.3 mg 51->70 years – 1.7 mg	19- 50 years – 1.3 mg 51- >70 years – 1.5 mg
Vitamin B12 (µg)	2.4 µg	2.4 µg
Vitamin C (mg)	90 mg	75 mg
Vitamin D (µg)	15 µg	15 µg
Vitamin E (mg)	15 mg	15 mg
Vitamin K (µg)	120 µg	90 µg
Biotin (µg)	30 µg	30 µg
Folate (µg)	400 µg	400 µg
Pantothenic acid (mg)	5 mg	5mg
Riboflavin	1.3 mg	1.1 mg
Thiamine (mg)	1.2 mg	1.1 mg
Calcium (mg)	19-70 years -1000 mg >70 years – 1200 mg	19- 50 years – 1000mg 50->70 years – 1200mg
Chloride (g)	19-50 years – 2.3 g 51 – 70 years – 2.0 g >70 years – 1.8 g	19-50 years – 2.3 g 51 – 70 years – 2.0 g >70 years – 1.8 g
Chlorine (mg)	550 mg	425 mg
Chromium (µg)	19-50 years – 35 µg 51- > 70 years – 30 µg	19-50 years – 25 µg 51- > 70 years – 20 µg
Copper (µg)	900 µg	900 µg
Fluoride (mg)	4 mg	3mg
Iodine (µg)	150 µg	150 µg
Iron (mg)	8mg	19 – 50 years – 18mg 51 - > 70 years – 8mg
Manganese (mg)	2.3 mg	1.8 mg
Magnesium (mg)	19-30 years – 400mg 31 ->70 years – 420mg	19-30 years – 310mg 31- >70 years – 320mg
Phosphorus (mg)	700 mg	700 mg
Potassium (mg)	3400 mg	2600 mg
Niacin (mg)	16 mg	14 mg
Selenium (µg)	55 µg	55 µg
Sodium (mg)	1500 mg	1500 mg
Zinc (mg)	11 mg	8 mg

*NA – Not Applicable a. WHO recommendation b. Institute of Medicine recommendation

Figure 4.1 to Figure 4.3 shows the EAR compared against mean intake for male and female respondents.

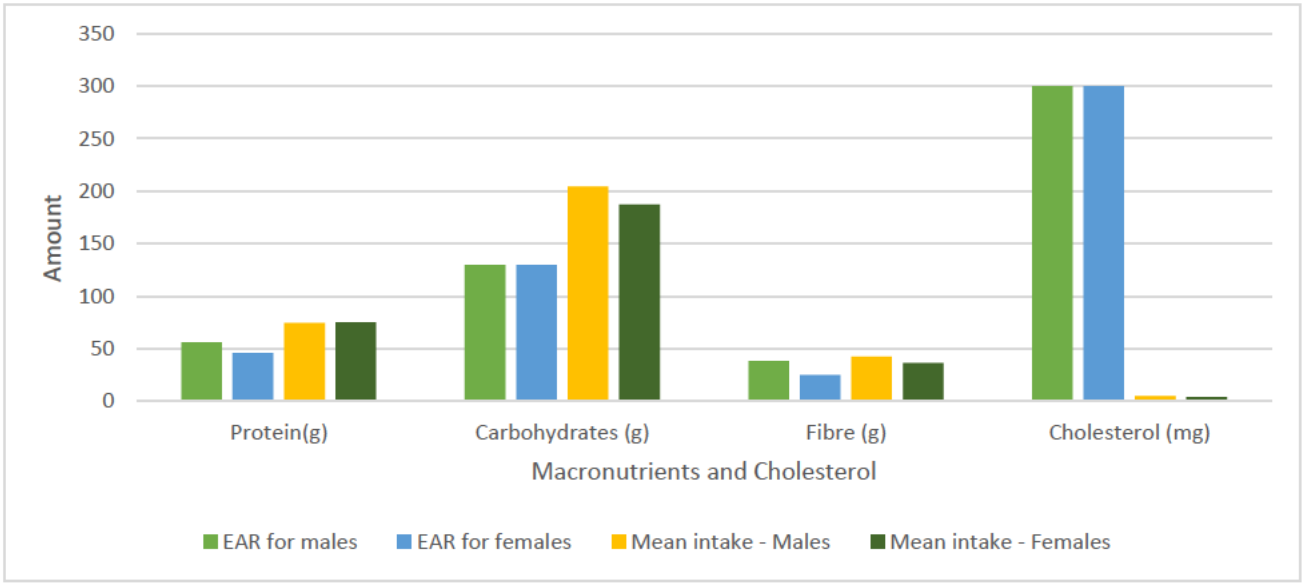

Figure 4.1: The EAR compared against mean intake for male and female respondents

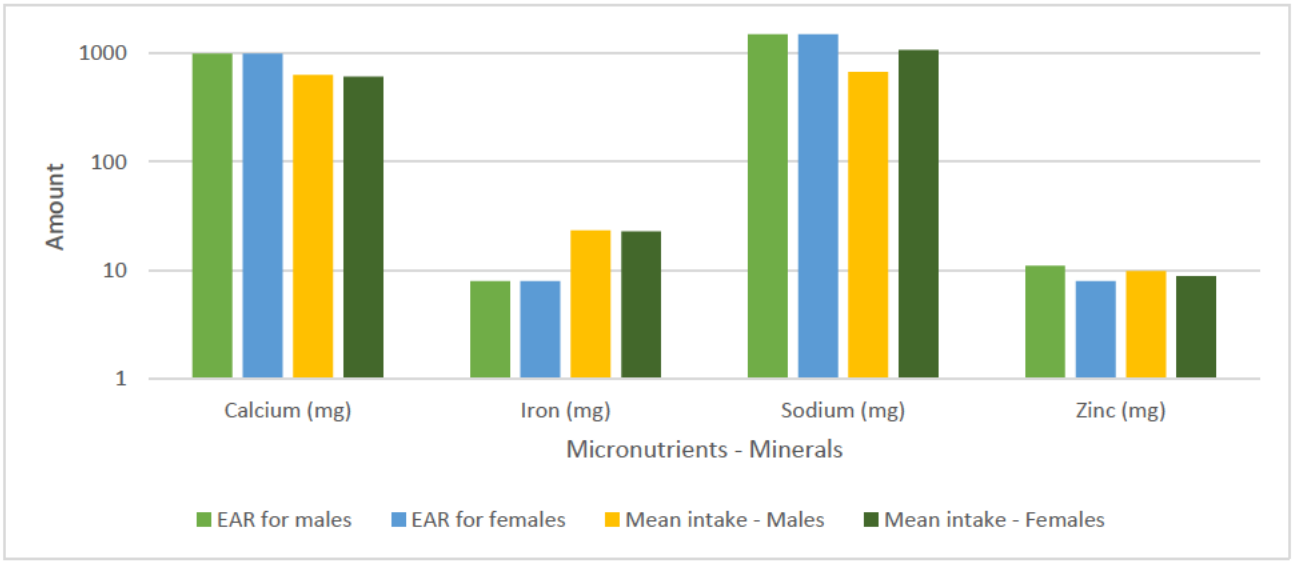

Figure 4.2: The EAR compared against mean intake for male and female respondents.

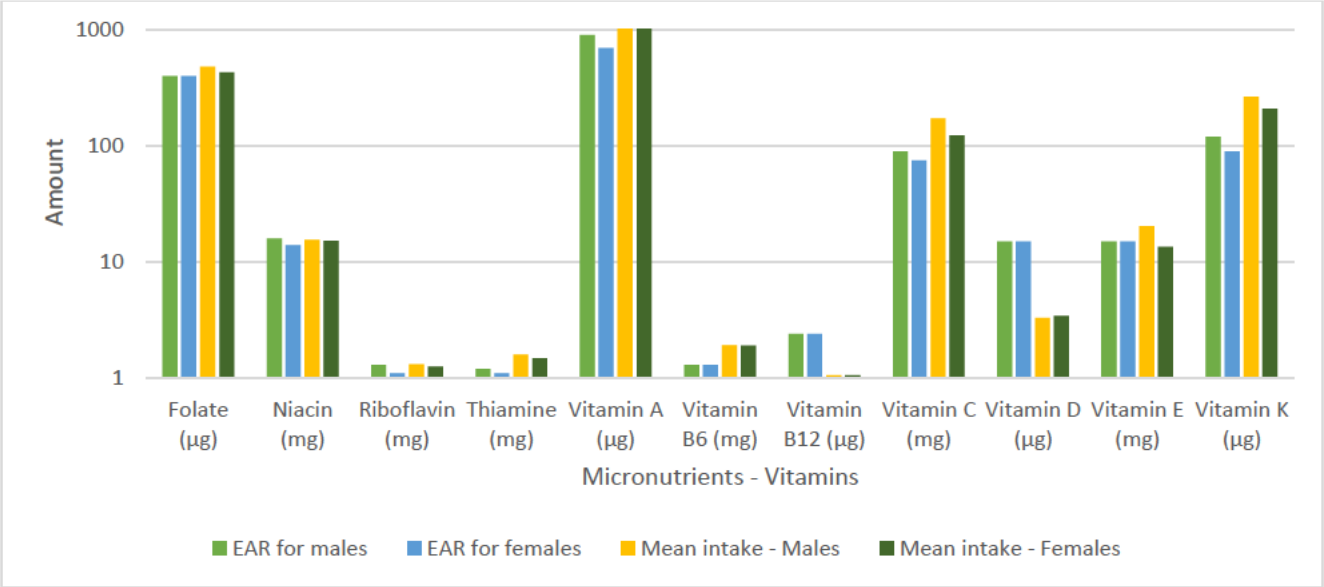

Figure 4.3: The EAR compared against mean intake for male and female respondents.

4.5 Summary

To summarise, data was collected from 205 respondents from the SAVS Facebook page. A total of (n = 113) respondents completed the FFQ and (n = 134) respondents completed the 24-hour recall. The first objective was to determine the demographic characteristics of the respondents. A greater percentage of females (82.4%, n = 169) than males (17.6%, n = 36) participated in the study and most were categorised under the White race group (82.4%, n = 169). Most of the respondents resided in the Gauteng province (43.9%, n = 90). Most of the respondents formed part of the 18-29 year age category (29.3%, n = 60), had either a diploma or degree (37.1%, n = 76), were "single" according to marital status (53.2%, n = 109) and had an income of between R25 601 - R51 200 per month (23.4%, n = 48). A significant number of respondents were following a diet for 1 - <3 years (38.5%, n = 79). Most of the respondents consumed nutritional supplements (72.7%, n = 149), did not engage in smoking (83.9%, n = 172), consume alcoholic beverages (60%, n = 123) and participated in regular physical activity (84.9%, n = 174) for at least 30 minutes - <1 hour on average in a day (41.5%, n = 85).

The second objective was to determine the motives for following a vegan diet. Most of the respondents strongly agreed that the ethical concern for animals (preventing cruelty, animal rights and welfare) was the main motive for their decision to follow a vegan diet (83.9%, n = 172) and (71.2%, n = 146) agreed that since they began following the diet, their motivation did not change. Most of the respondents strongly agreed that reading ingredient lists on products (42.4%, n = 87) assisted them in their transition into following a vegan diet. A significant

number of respondents felt that their transition was “moderately easy” (35.1%, n = 53) and felt “excitement and enthusiasm” at the beginning of the transition (29.3%, n = 60).

The third objective was to determine the challenges associated with following a vegan diet and how these challenges are overcome. Most respondents did not experience any financial challenges while following the vegan diet (74.6%, n = 153) and purchased most of their vegan food items from a supermarket (86.3%, n = 177). A significant number of respondents strongly agreed indicated that finding vegan meal options in restaurants was the main challenge faced while following the diet (40.5%, n = 83) and research on the internet assisted in overcoming challenges (46.8%, n = 96). Most of the respondents strongly agreed that vegan recipes are easily accessible (58.5%, n = 120).

The fourth objective was to determine the nutritional quality of dietary intake compared to recommendations (EARs) and to identify the variety of food groups and types of processed food consumed in the vegan diet. According to results from the FFQ, a variety of food groups were consumed by the respondents with bananas (22.4%, n = 46), cooked broccoli (36.1%, n = 76) , whole-wheat bread (18.0%, n = 37), white or brown basmati rice (20.0%, n = 41), chickpeas (32.2%, n = 66), olive oil (20.5%, n = 42), potato chips (19.0%, n = 39), egg-less cake (17.1%, n = 35), brown sugar (17.1%, n = 35) and coffee decaffeinated or regular (29.3%, n = 60) being the most commonly consumed food items. Soy milk was the most commonly consumed PBMA, at least once a day (21.0%, n = 43) and soy products were most commonly consumed meat alternative, consumed at least once a week (28.8%, n = 59).

The 24-hour recall showed that the respondents in the study met their EARs daily requirements for protein, fat and carbohydrates were within the range percentages of total energy. The EARs for fibre, iron, vitamin C, vitamin B6, vitamin A, thiamine, riboflavin, folate and vitamin K were also met by the respondents. Females (M = 20.51g) consumed higher amounts of added sugar than males (M = 13.18g), t (73.109) = -2.063, p = 0.043. The respondents had a low intake of cholesterol, saturated fat and mono-unsaturated fatty acids (MUFA) and higher intakes of poly-unsaturated fatty acids (PUFA). Females met their EARs for zinc and niacin, 9.02 mg and 15.32 mg respectively, while males were below their EAR, 9.8 mg and 15.59 mg respectively. Overall the respondents were lacking in calcium, sodium, vitamin D, vitamin B12 and vitamin E, as EARs were not met.

The next chapter will discuss the results in comparison with previous findings reported in Chapter 2.

CHAPTER 5: DISCUSSION

The purpose of the study was to determine the motives and challenges facing South African vegans and the nutritional quality of their diet. This chapter will discuss the results of each objective presented in Chapter 4 and compare these results to previous literature presented in Chapter 2.

5.1 The response rate and demographic characteristics of the study population

The study was completed by 233 respondents who answered an online questionnaire posted on the South African Vegan Society (SAVS) Facebook page. However, due to 28 of the questionnaires not being filled in correctly, the data analysis consisted of only 205 questionnaires. Although the page had 9 819 members at the time, only South African respondents were allowed to complete the questionnaire. The questionnaire was initially posted on the SAVS page on the 14th of August 2019 and re-posted twice thereafter. According to Van Mol (2017), reminders may have an influence on response rates, as it can increase response rates after the initial invitation for participation. After consulting with the statistician regarding the reduced responses despite posting reminders, a decision was made to close the questionnaire after it had been online for two full months.

The sample population comprised predominantly of female (n = 169, 82.4%) and White respondents (n = 169, 82.4%). This finding is similar to the study by Radnitz *et al* (2015), where an international sample of 246 vegans comprised of predominantly female respondents (n = 146) with the most being White or Caucasian decent (n = 168). Another study by Dyett *et al* (2013), conducted in the United States with 100 vegan respondents, reported more female (n = 76) than male vegans (n = 24) respondents. A large cohort observational study by Alles *et al* (2017), conducted in France with 93 823 respondents of which 789 followed the vegan diet, found that females (n = 595) were more likely to follow the vegan diet than males (n = 194). This result was expected, as females tend to follow vegetarian diets and diets that promote weight control (Tam, Yassa, Parker, O'Connor & Allman-Farinelli 2017).

Previous literature also reported that females were more likely to omit specific food groups from their diet (especially meat) due to motives such as health benefits (Jun, Arendt & Kang 2016), animal welfare or environment preservation (Ruby 2012). Therefore, females are more inclined to follow vegetarian or vegan diet to decrease their consumption of meat (Hartmann & Siegrist 2017). According to race groups, Dyett *et al* (2014) found that more Caucasian or White respondents (n = 71) answered and completed the online survey compared to other race

groups such as Black (n = 13), Asian (n = 10) and other races (n = 6) (Dyett *et al* 2013). A research review by Ruby (2012), showed that ethnicity is significantly related with meat consumption, where Caucasian respondents consumed less meat when compared to Black and Asian respondents. In South Africa, the consumption of meat is also associated with ethnicity, as there is an increased growth of meat as a protein source especially among Black African consumers (Bisschoff & Liebenberg 2017). This is because meat is of significance in most Black African traditional and cultural ceremonies such as weddings and funerals (Liebenberg 2016). Indians or Asians in South Africa are more likely to consume a reduced quantity of meat, as Muslims consume only Halaal animal products and Hindus avoid consuming beef (Mohd-Any, Mahdzan & Cher 2014).

In terms of demographics, most of the respondents resided in Gauteng Province (n = 90, 43.9%) and their marital status was single (n = 109, 53.2%). This could be possibly due to the majority of respondents being in the 18 - 29 year age category. This finding was in line with other studies were vegans were more likely to be single (Davey *et al* 2003) or to live alone without any children (Alles *et al* 2017) in comparison to omnivores. Most of the respondents formed part of the 18 - 29 year age category (n = 60, 29.3%), had a diploma/degree as their highest level of education (n = 76, 37.1%) and had a total monthly income between R25 601 – R51 200 (n = 48, 23.4%). In the study by Dyett *et al* (2013), most of the vegan respondents were between the 25 - 39 year age category (n = 44) and had a tertiary level of education (n = 47). However, in the study by Alles *et al* (2017), most of the vegans were in the 30 - 50 year age category (n = 378), with higher levels of education (n = 267) compared to the sample in this study. As reported previously, non-meat eaters are usually younger than meat-eaters (Sobiecki, Appleby, Bradbury & Key 2016; Rizzo *et al* 2013; Bedford & Barr 2005). The study showed a significant relationship between gender and education level. However, the hypothesis that females with a higher level of education were more likely to follow a vegan diet is rejected. Interestingly, the findings showed males with some schooling or other qualifications were more likely to follow the diet, even though males formed the minority of the sample.

A strict vegan diet was followed by bulk of the respondents (81.5%, n = 167), and most of the respondents indicated following the vegan diet for between 1 - 3 years (38.5%, n = 79) followed by 3 - <5 years (14.1%, n = 29). A similar study by Kerschke-Risch (2015), which included 852 vegans, reported that most of the study respondents followed the vegan diet for 1 to < 2 years (27.6%, n = 234), followed by 2 to < 5 years (24.4%, n = 207). However, according to another study by Janssen *et al* (2016), conducted in Germany, based on one-on-one interviews

with 329 vegans following the diet, on average the respondents of the study were following the diet for 3.8 years. In the study, 22% of the respondents followed the diet for 3 - 4 years, while 22.7% followed the diet for 5 years and more. When compared to the study by Kerschke-Risch (2015), this study showed that a greater percentage of individuals were following the vegan diet for a relatively longer period of time (Janssen *et al* 2016). This shows that following a vegan diet may become a long-term diet and lifestyle change, rather than a passing trend.

Smoking was not common among the respondents as the majority did not smoke (n = 172, 83.9%), however, alcoholic beverages were consumed by most of the respondents in this study (n = 123, 60.0%) with the most common frequency being "less than once a week" (n = 56, 27.3%). Similar to another study, it was found that vegans in general smoked less and consumed alcohol less frequently in comparison to omnivores and vegetarians (Orlich *et al* 2013). It was found that in certain studies, smoking was associated with the motivation for following a vegan diet. A study by Heiss *et al* (2017) conducted in the United States with a sample of 358 vegan respondents, found that "ideological" or "ethical" vegans were more likely to indicate that they smoked either regularly or socially. However, "health motivated" and "other" vegans were more likely to indicate that they did not smoke. This is similar to findings by Radnitz *et al* (2015), where "ethically motivated" vegans were more likely to smoke than "health motivated" vegans. Health motivated vegans consider themselves more "health conscious" and are therefore less likely to smoke. According to Dyett *et al* (2013), health motivated vegans often practise healthier lifestyle behaviours such as exercising regularly, minimal consumption of alcohol and not engaging in smoking.

Vitamin and mineral supplements were taken by most of the respondents (n = 149, 72.7%). The most commonly consumed supplement indicated by the respondents was individual vitamin B12 supplements or a multivitamin supplement. If respondents did not understand the term "supplements", respondents were able to contact the researcher for further information on how to answer this question. According to Haddad *et al* (1999a), vegans are more likely to consume supplements of single nutrients in comparison to non-vegan individuals. The increased incidence of vitamin B12 deficiency is found in both vegetarians and vegans as plant foods do not contain vitamin B12 unless fortified, such as breakfast cereals (Pawlak, Parrott, Raj, Cullum-Dugan & Lucus 2013). It is suggested by Baroni, Goggi, Battaglino, Berveglieri, Fasan, Filippin, Griffith, Rizzo, Tomasini, Tosatti, Battino (2019), that through supplementation, all vegans should meet their vitamin B12 requirements. A recent Spanish study by Gallego-Narbón, Zapatera, Barrios & Vaquero (2019), investigated the vitamin B12

and folate status of healthy vegans (n = 54) and lacto-ovo vegetarians (n = 49), and found that 72.8% of the vegan respondents supplemented with vitamin B12. This shows that vegans are aware of the increased risk of subclinical deficiencies in non-users of supplements, and health professionals should emphasise the need for vitamin and mineral supplements in all vegetarian diets (Gallego-Narbón *et al* 2019).

Physical activity was performed by the majority of respondents (n = 174, 84.9%), whereby low intensity physical activity was done "everyday" (n = 48, 23.4%), moderate physical activity was done "once a week" (n = 37, 18.0) and high intensity physical activity was done "twice a week" (n = 27, 13.2). The duration of physical activity conducted by respondents on an average day was 30 minutes to less than 1 hour (n = 85, 41.5%). A cross sectional German study conducted by Menzel, Biemann, Longree, Isermann, Mai, Schulze, Abraham & Weikert (2020), found that vegans (n = 36) participated in more hours of physical activity a week (2.8 hours per week) compared to omnivores (n = 36) (2.3 hours per week). Menal-Puey *et al* (2018), conducted a Spanish consumption and lifestyle cross-sectional study with a total of 102 respondents who were vegan (n = 40) and vegetarians (n = 62). It was found that there were no significant differences in the number of minutes of physical activity per week among vegans (261.8 ± 191.7) and vegetarians (247.7 ± 238.7). An internet-based survey, conducted in Germany by Vollmer, Keller & Kroke (2018) investigated the vegan diet followed by 1924 respondents. Of the sample, 1344 reported on their physical activity, more than half of the respondents reported that they performed some physical activity for 3 or more days a week (58.1%, n = 780). This indicates that most respondents followed a strict vegan diet and engaged in healthy lifestyle activities in line with findings from international studies.

5.2 The motives for following a vegan diet

A list of 16 possible motives were listed in a Likert scale type question to be answered by the respondents. The majority of respondents strongly agreed (83.9%, n = 172) that the ethical concern for animals (preventing cruelty, animal rights and welfare) including protecting endangered species (44.9%, n = 92) was their main motivation for following a vegan diet. Therefore, the hypothesis that ethical reasons would be the main motive for becoming a vegan is accepted. The second main motivation was protecting the environment (59.5%, n = 122) and the effect of animal product consumption on climate change (49.8%, n = 102) including reducing the carbon footprint (49.8%, n = 102), saving water (45.9%, n = 94) and preventing pollution (42.4%, n = 87). The respondents strongly agreed that the third main motive were

health reasons such as following the diet to improve health (41.5%, n = 85), personal well-being (42.4%, n = 87) and to prevent diseases and illnesses (30.2%, n = 62). This is in line with the international model of motives for following a vegan diet presented in Figure 2.1 in Chapter 2.

The three main motives for following a vegan diet were also similar to the study by Janssen *et al* (2016), this included motives associated with animal agriculture, animal rights and welfare (summarised into "animal related motives") (89.4%), this is was followed by health and personal well-being (summarised into "self-related motives) (69.3%) and lastly concerns related to protecting the environment, climate change and sustainability of the ecosystems (summarised into "environment-related motives) (46.8%). However, the respondents in this study showed a greater motivation towards protecting the environment rather than the health benefits received from following the diet.

According to Kerschke-Risch (2015) conducted in Germany, both males (n = 174) and females (n = 679) overall indicated that reports on factory farming (SD = 4.4) followed by climate protection (SD = 3.8) than health which came third as major motives (SD = 3.2). However, in the study by Dyett *et al* (2013), contrasting results were discovered. Out of one hundred vegans who participated in the study, 47% indicated health beliefs as the main vegan motive, 40% mentioned animal welfare while religious and other motives were indicated by 13% of the respondents. Some individuals do choose to follow plant-based diets for health promotion and the prevention of diseases (Sticher, Smith, & Davidson 2010). These diets may also be used for disease treatment and management (Trapp, Barnard & Katcher 2010).

Motives such as preventing the exploitation of humans, human rights and world hunger are categorised as "social justice" (Janssen *et al* 2016). A lower percentage of respondents in this study strongly agreed that social justice such as world hunger could be reduced by feeding nutritious grains to the underprivileged instead of to farm animals (41.0%, n = 84), as a motivating reason for following the diet. The respondents slightly agreed that protecting factory and farm workers from unsafe conditions (24.4%, n = 50) contributed to their motives. These motives differ from the international model of motives found in Figure 2.1 in Chapter 2.

In the present study, respondents indicated that religious beliefs (56.6%, n = 116) and family tradition and/or friends following the diet (56.1%, n = 115) were their least motivating factors to follow the diet. These motives were found in the international model of motives in Figure 2.1 in Chapter 2. This is similar to the study by Janssen *et al* (2016), as 5% of the respondents indicated having motives related to the food industry and the aversion to capitalism and less

than 3% of the respondents indicated being motivated by "other" motives such as family members following the diet and spirituality. Social factors also played a minor role in the study by Waldman *et al* (2003).

As literature suggests, there are numerous factors that impact and motivate an individual to begin following a vegan diet. These reasons range from the concern of animals, personal health and well-being, religious beliefs and dislike toward meat (Ruby 2012). Other reported reasons included following the diet for losing weight, political reasons, taste profiles and reducing costs (Hoffman *et al* 2013).

A further question related to motivations was presented to the study respondents as to whether their initial motivation had changed after following the vegan diet. The results showed that a significant number of respondents (71%, n = 146) had not changed their initial motivation for following a vegan diet. According to Timko *et al* (2012) and Beardsworth & Keil (1992), projected motivations for following a specific diet might transform over a period of time. In an American study by Timko *et al* (2012), with 486 respondents following different diets, it was found that most respondents were more likely to continue with their chosen diet for the same reasons that they started following a particular diet. Individuals who followed plant-based diets (inclusive of vegans, vegetarians and semi-vegetarians) in the study specified that they either sustained the diet due to habit or a dislike for meat. However, ethical reasons followed by health reasons, provoked the change of diet from an initial omnivore diet to a plant-based diet according to the study.

Many factors may assist an individual to transition into a vegan diet. In this study, 13 possible assisting factors were proposed to the respondents in a Likert scale question. Most of the respondents "strongly agreed" that reading ingredient lists on products (42.4%, n = 87) assisted their transition, this was followed by experimenting with vegan recipes (37.6%, n = 77). The respondents "strongly disagreed" that visiting a dietitian (50.2%, n = 103) assisted them during their transition. Ten of the assisting factors were further categorised into 3 groups namely: factors associated with vegan places/ books (vegan shops, health stores, vegan cookbooks/ magazines/ newspapers, visiting a vegan restaurant), factors involving food experimentation (experimenting with replacing dairy and meat products with plant-based alternatives, experimenting with vegan recipes, reading ingredient lists on products, becoming vegetarian first prior to becoming vegan) and social factors (social media and/or the internet, vegan

groups). Respondents showed a significant agreement that experimenting with food assisted them the most during their transition into the diet.

Steele (2013), mentioned that there are a number of influences that assist an individual to follow a vegan diet, besides initial motivations. These influences include conversations and relationships with other vegans, media influences such vegan propaganda which includes vegan books, DVD's and documentaries, health concerns or PETA (People for the Ethical Treatment of Animals) events.

5.3 The challenges associated with following a vegan diet

The present study reported on the challenges faced by the vegan respondents. Transitioning into a vegan diet can either be an easy or difficult process depending on the individual. The respondents in this study (n = 197) were given six words to describe their transition into the diet. These words were arranged in a Likert scale type question ranging from "very easy", "easy", "moderately easy", and "moderately difficult", "difficult" and "very difficult". Most of the respondents described the transitioning process to be "moderately easy" (35.1%, n = 72), followed by "easy" (25.9%, n = 53). The respondents further stated that they felt "excitement and enthusiasm" (29.3%, n = 60), followed by being "determined" (22.0%, n = 45) and "optimistic" (20.0%, n = 41). McDonald (2000) stated that vegans experience emotions such as "grief, sadness and guilt" before transitioning into a vegan diet. These emotions may be sparked by people (friend or partner becoming vegan), books such as *The Face on Your Plate,* certain documentaries such as *Earthlings,* events (PETA event on vivisection) or a health issue (family member or individual diagnosed with heart condition) (Steele 2013).

The book titled *The Face on Your Plate*, contains interesting views on the abuse and injustice done to farm animals that are raised for human consumption. This book highlights becoming a vegan or vegetarian and how to consume less meat. The 2005 American documentary named *Earthlings,* exposes animals at factory farms that endure suffering, research labs, puppy mills and other places which exploit animals for human needs and economic purposes. This documentary includes footage attained through the use of hidden camera's showing the daily practices of some of the largest industries in the world that involve animals. The organisation PETA follows the simple principle that animals should not be experimented on, be eaten, be worn, used for entertainment or abused in any other way. PETA provides education to policy makers and public awareness about animal abuse and promotes the kind treatment of animals.

Overall from the responses, it can be noted that vegans felt positive emotions at the beginning of their transition. Fear was the least felt emotion among the respondents (0.5%, n = 1). Most of the respondents in this study reported that they do not incur any financial challenges by following a vegan diet (74.6%, n = 176) and purchase most of their food from a supermarket (86.3%, n = 177). Seven other challenges were listed using a Likert scale type question. The respondents "strongly agreed" that finding vegan options in a restaurant was the main challenge (40.5%, n = 83). Therefore the hypothesis that the respondents' main challenge would be would be to find suitable vegan menu items when eating out is accepted. A study by Steele (2013) conducted in the United States, where 17 vegans were interviewed, also found that the biggest obstacles for the respondents were deciding what food to order from a restaurant as well as other social situations. For example, it was mentioned that going to a restaurant with friends was difficult, as the word "vegan" was misunderstood by many waitrons. Respondents in the study also indicated that although giving up specific foods was a challenge, discovering new vegan foods in the market assisted in overcoming the challenges; this is similar to the findings of the present study. Respondents in the present study "strongly disagreed" that avoiding meat and meat products was a challenge while following the diet (32.7%, n = 67).

The respondents "strongly agreed" that research on the internet (46.8%, n = 96) was the best way to overcome any challenges experienced while following the diet. A cross-sectional study by Cramer, Kessler, Sundberg, Leach, Schumann, Adams & Lauche (2017), conducted in the United States showed similar findings. The study involved a national representative sample (n = 35 525), to examine the prevalence of following vegetarian and vegan diets for health reasons. According to the respondents, research on vegan and vegetarian diets was more often obtained from the internet (44.6%), this was followed by books, magazines or newspapers (41.2%) and health food stores (27.6%). Although, it can be noted that individuals should be aware that not all information on the internet is based on scientific evidence (Alnemer, Alhuzaim, Alnemer, Alharbi, Bawazir, Barayyan & Balaraj 2015).

Most of the respondents "strongly disagreed" that visiting a dietitian (42.0%, n = 86) could assist in overcoming challenges. Although, visiting a dietitian was unlikely done by the present study respondents, vegans are recommended to consult a dietitian (Fields *et al* 2016). A dietitian consult is especially essential if vegan diets are being followed by the elderly, children or pregnant women, as careful meal and menu planning should be done to ensure the individual meets their nutritional requirements (Britton 2003). A study by Van Rensburg & Wiles (2019), conducted in South Africa consisting of 101 dieticians in the KwaZulu-Natal province, found

that although dieticians received inadequate training about a whole-food plant-based diet at university level; a significant sample of the respondents were confident in prescribing the diet.

Respondents were asked about their agreement to statements regarding the vegan diet. From the three statements, most of the respondents "strongly agreed" that vegan recipes are easily accessible (96.1%, n = 197) and "agreed" that there is an adequate range of vegan products at their nearest supermarket or retail store (26.3%, n = 54). According to Dhont & Hodson (2020), vegan product availability has grown extensively in supermarkets, and well-known brands and companies have launched vegan alternatives to their popular meals. Most of the respondents "strongly disagreed" that it costs more to follow a vegan diet than a diet that includes animal food products (35.6%, n = 73%). Recently, a number of vegan cookbooks, magazines and blogs with vegan recipes have been published on the internet. The recipes that use traditional meat products can now be substituted for plant-based products in order to prepare vegan meals (Hart 2018). Furthermore, supermarkets offer exclusively vegan products, which can be seen as proof of a corresponding increase in a large group of consumers (Kerschke-Risch 2015). The study by Katcher *et al* (2010), conducted in the United States, investigated two groups of people following a vegan nutrition programme at a worksite. The first group were given instructions on how a low-fat vegan diet should be followed (n = 68) and the second group received no instructions about their diet (n = 45) for 22 weeks. Respondents following the vegan diet reported overall contentment with the diet, as well as a significant reduction in the expense of purchasing food products. Major supermarkets and health stores in South Africa have increased their range of plant-based products available to vegans due to the rise in demand of constructing meat-free meals (Independent Online 2020a). Local online shopping stores have a wide range of vegan-specific products which offers delivery services in South Africa (Faithful to Nature 2020). Therefore, the results of the present study relate similarly to research.

5.4 The nutritional quality of a vegan diet

Although, there are numerous favourable health benefits related to the consumption of a vegan diet, concerns still remain about the nutritional quality of this strict dietary pattern (Craig 2009). Perceptions remain that the vegetarian diet, particularly the vegan diet, is lacking in important nutrients including protein, iron, vitamin B12 and calcium (Rizzo *et al* 2013; Farmer *et al* 2011; McEvoy, Temple & Woodside 2012; Deriemaeker *et al* 2010; Gilsing *et al* 2010; Appleby, Roddam, Allen & Key 2007). At the beginning of the questionnaire, the respondents were questioned about their agreement to five statements regarding the nutritional quality of the

vegan diet. Most of the respondents "strongly agreed" that a vegan diet is nutritionally complete and adequate for a healthy lifestyle (65.9%, n = 136). The respondents also "strongly disagreed" that the vegan diet does not provide a feeling of satiety (63.4%, n = 130). Due to the high fibre content in many vegan diets, individuals could reach a feeling of satiety much quicker than those following an omnivorous diet (Marlett, McBurney & Slavin 2002). Respondents indicated that they visited a restaurant and ordered a vegan meal "once a month" (37.6%, n = 77) followed by "less than once a month" (27.8%, n = 57). According to the study by Steele (2013), conducted in the United States, vegans visited restaurants less often due to difficulty finding suitable vegan options on the menu. Several vegans stated that they consumed mainly salad, baked potato or potato fries when going out to eat and the variety of meals were limited compared to eating at home. However, recently the number of exclusively vegan restaurants are increasing (Crimarco, Turner-McGrievy, Botchway, Macauda, Adams, Blake & Younginer 2019) and a number of major chain restaurants have added vegan options to their menus (Dhont & Hodson 2020).

This rise is similar in South Africa as many retailers and restaurants say that there is an increase in demand by consumers who request plant-based food options. South Africa was also identified as the only African country with a fairly large vegan group. This was according to Goole trends data (Independent Online 2020b). One of South Africa's most popular restaurants, Spur Steak Ranches, has introduced its first vegan-friendly and plant-based menu across the country. The chief operating officer said that "they have included options on their menu that makes it possible for a group of diverse people to get together and enjoy a variety of meal options, and that it is therefore important that the addition of the plant-based options is well-thought-out and has mouth-watering items to excite everyone" (Independent Online 2019b). According to HappyCow's online healthy eating guide restaurant listings, there are currently 29 vegan-specific restaurants, 75 vegetarian-specific restaurants and 287 restaurants with vegetarian options in South Africa (HappyCow 2020). The vegan South African directory, is an online vegan-friendly website to find restaurants, shops, food and drinks, recipes, products and accommodation. The website also offers an option to become a volunteer to manage vegan listings in your particular province. According to this website, there are currently also 29 vegan-specific restaurants listed nationwide (Vegan South Africa 2020).

In the present study, both a FFQ and 24-hour recall was conducted to gather dietary data from the respondents. Out of a total of n = 205 respondents completing Section A to Section D of the questionnaire, only n = 134 respondents completed the 24-hour recall and n = 113 completed

the FFQ. Both of these dietary tools were at the end of the questionnaire, and possibly due to respondent fatigue, half of the respondents submitted the questionnaire without completing the section. Although, 24-hour recalls require a low respondent burden (Arab, Wesseling-Perry, Jardack, Hendry & Winter 2010), it does still require respondents to remember what they had consumed during the previous 24-hours therefore an online self-administered 24-hour recall may become tedious and time consuming, especially if the respondents were completing the questionnaire during work or any other daily activity.

The FFQ consisted of 291 food items and this was done to include a wide variety of food products and food categories to provide an indication of frequency and amount of common foods consumed in the vegan diet. However, online respondents may have felt that due to the length of this section, it would be time consuming to complete and this led to many respondents failing to complete this section of the questionnaire. The respondents also required a device with adequate Internet signal. The cost of using the Internet for longer periods of time may also have played a role in the decrease in respondents. Completing these sections required reading and computer literacy and it is a possibility that for many of the respondents, it was their first time completing a 24-hour recall and FFQ, therefore the results should be interpreted with caution.

Hu (2002) mentioned that the assessment of nutritional quality of a diet requires the use of different indices to analyse a dietary pattern rather than a more reductive nutrient method. Carroll, Midthune, Subar, Shumakovich, Freedman, Thompson & Kipnis (2012), suggested the combination of 24-hour recalls and a FFQ, as it has shown to improve a wider range of dietary components. The convenience of web-based 24-hour recalls and FFQ tools allows a possibility to reach a wider sample population. However, it is important to understand that these dietary assessment tools are subject to errors of measurement, and it is assumed that respondents are unbiased with their usual food intake. Taking this into account, a one day, 24-hour recall and FFQ were methods used to obtain dietary information and assess the nutritional intake of the study population respectively.

A number of studies have used FFQ's to analyse the dietary intake of vegan populations (Sobiecki *et al* 2016; Clarys *et al* 2014; Dyett *et al* 2014; Waldmann, Dorr, Koschizke, Leitzmann & Hahn 2006; Waldmann, Koschizke, Leitzmann & Hahn 2005; Waldmann *et al* 2003). In the present study, a vegan-specific FFQ which consisted of 291 food items was used, and categorised into food groups to identify the food products and variety within food group.

The FFQ was constructed in line with the FFQ done by Dyett *et al* (2014) which was conducted in the United States and consisted of a 252 item FFQ also listed in food categories.

5.4.1 The food frequency questionnaire

According to the findings of the present study, from the starches food group category, the most frequently consumed items were whole-wheat bread "once a week" (18.0%, n = 37) (1 - 2 slices), white bread rolls "once a week" (½ – 1 small item) and pasta plain and eggless (21.0%, n = 43) (½ - 1 cup). The starches consumed "never/rarely" were French bread (43.4%, n = 89) (<1 slice), cornbread (52.7%, n = 108) (<½ small item) and organic black noodles (52.7%, n = 108) (<½ cup). This could be due to the unavailability of these items in the nearest supermarkets or the taste and texture of these items are not palatable by the respondents. In the category of grains, white or brown basmati rice was most commonly consumed by the respondents (20.0%, n = 41) (½ - 1 cup) "at least once a month" and muesli was the most consumed breakfast cereal (8.3%, n = 17) (<½ cup) "at least once a week". According to Hever (2016), meals should include whole-grains as it increases energy, provides a feeling of fullness and assists with the flexibility in planning meals and menus for those who follow plant-based diets. Clarys *et al* (2014), also found that the intake of starch was highest in vegans and lowest in omnivores.

Under the vegan meat and milk substitute category, ½ to 1 cup of soy products were most frequently consumed by the respondents "at least once a week" (28.8%, n = 59). According to Radnitz *et al* (2015), soya products are most frequently consumed for the health benefits, especially if these products are minimally processed (D'Adamo & Sahin 2014). The most frequently consumed milk substitute was soy milk "at least once a day" (½ – 1 cup) (21.0%, n = 43). This finding is similar to the study by Elorinne *et al* (2016) which investigated the nutritional status as well as food and nutrient consumption of vegans in Finland (n = 22) and non-vegans (n = 19). It was found that most vegan respondents consumed soy milk drinks on a daily basis. The study by Elorinne *et al* (2016), mentioned that most vegan respondents consumed enriched soy and oat milk daily. Soy milk is known for having a good source of high-quality proteins, iron and B vitamins. The acceptability of soy milk is increasing, despite its previously perceived "beany" flavour profile. Manufacturers of soy milk are finding different processing techniques to alter flavour and odour of the milk, thus making it more acceptable to consumers (Yu, Liu, Hu & Xu 2017).

Vegan cheese was consumed “at least once a month” by the respondents (1 - 2 slices) (22.0%, n = 45), while an egg replacer was “never/rarely” used (< 1tsp) (42.0%, n = 86). According to the Mail & Guardian (2018), although vegan and plant-based conventional foods are becoming increasingly popular in the South African market, the costs of these products are more than the animal versions. For the example, in a popular supermarket in South Africa, the cost of 200 g of dairy free cheddar cheese is R77.99 compared to 240 g dairy cheddar cheese which costs R44.99 (Woolworths Online 2020). Most vegan cheese can be found at major grocery stores in South Africa, however the types may vary (Independent Online 2019a). Due to the availability and cost of vegan cheese, home-made versions may be encouraged. Egg replacers are commonly used as a forming and emulsifying agent, especially during baking. Egg replacers are common in vegan diets or among individuals who suffer from egg allergies as it assists in making food items such as mayonnaise, cheese and cakes (Meurer, de Souza & Marczak 2020). Commonly used examples of egg replacers in baking include mashed banana, applesauce, silken tofu, ground flax seeds mixed with water and dairy-free yoghurt (Bigger Bolder Baking 2019).

A high frequency of consumption was seen for leafy vegetables most especially spinach which was consumed “at least once a week” (>1 cup) (24.9%, n = 51) by the respondents. Mustard greens were least frequently consumed (<½ cup) (45.4%, n = 93). Mustard greens are a type of spinach. Seeds for mustard greens can be purchased online in South Africa and it is usually used in fresh snacks and salads. The plant is originally from the USA (Seeds for Africa 2020). Broccoli was most commonly consumed by the respondents under the non-leafy vegetable category “at least once a week” (½ - 1 cup) (36.1%, n = 74). Cassava was least consumed by the respondents (<½ cup) (52.2%, n = 107). Due to increased poverty and food insecurity in Africa, including South Africa, a cassava starch extraction factory has been in operation ever since the late 1990’s in South Africa (Allemann 2003). This root vegetable is cultivated in warmer regions in Limpopo, Mpumalanga and Kwa-Zulu Natal in South Africa (Allemann & Dugmore 2003). Therefore, due to the increase in its popularity in the country, cassava was included in the list of non-leafy vegetables.

Tomato sauce, pasta sauce and salsa was the most frequently consumed vegetable condiment “at least once a week” (<½ cup) (24.9%, n = 51), while tomato juice was least consumed (<½ cup) (48.8%, n = 100). The mixed food category consisted of two food items. Respondents consumed vegan pizza (>3 slices) (32.7%, n = 67) more frequently than vegan lasagne (<1 - 3 slices) (36.1%, n = 74). The study by Larsson & Johansson (2002), conducted in Sweden,

investigated the nutritional status and dietary intake of young vegans and omnivores. The study found that both groups had similar intakes of mixed foods such as pizza and pies and young "ethical" vegans were different from vegetarians who were more health conscious in previous studies (Freeland-Graves, Greninger, Graves & Young 1986). Vegans consumed a significantly less amount of pizza compared to those following other diets (Papier, Tong, Appleby, Bradbury, Fensom, Knuppel, Perez-Cornago, Schmidt, Travis & Key 2019), this may be due to consumer willingness to try and acceptability of vegan mixed food products.

In the peas and beans category, chickpeas was consumed "at least once a week" by the respondents (½ – 1 cup) (32.2%, n = 66). Chickpeas or garbanzo beans, are well-known in the family of legumes. Traditionally, chickpeas have been part of many meals due to its nut-like flavour in food and sensory profiles (Deosthale 1982). Respondents indicated "never/rarely" consuming navy beans (<½ cup) (48.8%, n = 100). Navy bean, also known as haricot beans can be purchased in retail shops in South Africa. The beans can be purchased in the dry form as well as canned in brine (Woolworths Online 2020). At the time of the study, it is possible that South African vegans did not relate to the term "navy beans". The most commonly consumed bean product was baked beans "at least once a month" (<½ cup) (17.6%, n = 36), while refried beans was least commonly consumed (<½ cup) (46.8%, n = 96). Refried beans is a common Mexican food product that can either be homemade or purchased in canned form online in South Africa (Manicaa Online 2020). Different type of legumes form an integral part of vegetarian and vegan diets, mainly due to its numerous health benefits such as the management of weight, diabetes, hyperlipidaemia and hypertension. Legumes provide the body with carbohydrates, B vitamins, phosphorous, iron, copper, magnesium, manganese, zinc and fibre. They are naturally lower in fat, free of saturated fat and cholesterol (Polak, Phillips and Campbell 2015). It is important to note that legumes have a comparable nutritional profile to both protein and vegetable food categories. Legumes are also known as a good source of dietary protein and may be used to achieve nutrient requirements of both food categories (Wallace, Murray & Zelma 2016; Baloch & Zubair 2010; Sandberg 2002). Therefore, due to these benefits, vegans are encouraged to continue consuming a wide variety of legumes.

In the fruit category, banana was most commonly consumed by the respondents "at least once a day" (½ - 1 medium item/ cup) (22.4%. n = 46). The least consumed fruit was persimmons (<½ medium item/cup) (49.3%, n = 101). Dried raisins were consumed "at least once a month" (<½ cup) (14.1%, n = 29) and dried pomegranates was least commonly consumed (<½ cup) (52.2%, n = 107). Orange juice freshly prepared was most frequently consumed by the

respondents “at least once a month” (<1 cup) (12.7, n = 26). Coconut water was least consumed (<1 cup) (43.9%, n = 90). Higher intakes of fruit are typical vegan and vegetarian diets. Fruit is known as a main contributor to carbohydrates and sugars (Craig 2009). Higher fruit intake is commonly consumed by vegans that are motivated by improving their health (Radnitz *et al* 2015). Fruit is encouraged in the vegan diet as it is rich in fibre, folic acid, antioxidants and phytochemicals and it is believed to reduce cholesterol levels (Mann 2014).

Under the fats category, olive oil was consumed “at least once a day” (1 - 2 tsp) (20.5%, n = 42) by the respondents, followed by peanut butter consumed at least once a week (>2 tsp) (19.0%, n = 39) and almonds was the most consumed nut “at least once a month” (<½ cup) (12.7%, n = 26). The least consumed fats were soybean oil (<½ cup) (51.7%, n = 106) and hazel nut butter (<1 tsp) (51.7%, n = 106). The fat spread most frequently consumed is dairy free margarine “at least once a week” (1 - 2 tsp) (15.6%, n = 32), while organic coconut butter is least consumed (<1 tsp) (47.3%, n = 97).

The most frequently consumed dressing was hummus consumed “at least once a week” (>2 tsp) (22.4%, n = 46) and least consumed is peri – peri vegan mayonnaise (<1 tsp) (46.3%, n = 95). In the Western culture, hummus is made by cooking and mashing chickpeas to be used as a dip or spread. This spread is usually blended with olive oil, juice from a lemon, tahini and a variety of spices. Although there is a comparable nutrient profile between chickpeas and hummus, they cannot be compared nutritionally. For example, when hummus is commercially prepared, the bioavailability and profile of nutrients found in chickpeas may be altered. The chickpeas in hummus makes it a good source of protein, resistant starch, poly-unsaturated fatty acids, fibre, vitamins and minerals such as folate, potassium, calcium and magnesium. This may be especially essential to vegans and those following plant-based diets, to replace common spreads and dips to hummus to increase diet quality (Wallace *et al* 2016).

In the snacks category, potato chips were more frequently consumed “at least once a month” by the respondents (1 packet, 125 g) (19.0%, n=39), wheat-free biscuits (1-2 items) (11.7%, n = 24) and organic dark chocolate bars (<1 item) (17.1%, n = 35). The least frequently consumed snacks were coconut chips (<1 packet (<125g) (51.2%, n = 105), biscotti (<1 item) (52.2%, n = 107) and peanut clusters (<1 item) (48.3%, n = 99). Vegan peanut clusters can be homemade or purchased online (Karibaa Online 2019). The most frequently consumed in the dessert category was non-dairy yoghurt (<½ cup) (10.7%, n = 22) and egg-less cake “at least once a month” (1-2 slices) (17.1%, n = 35). The least commonly consumed dessert was soy ice cream

(<½ cup) (45.9%, n = 94) and fruit pie (<1 slice) (51.2%, n = 105). The vegetarian resource group suggests that it is easy to meet protein requirements if the calorie intake is adequate and this can be achieved by consuming calorie dense foods or multiple meals or snacks during the day. The consumption of vegan snacks are very similar to non-vegans. These snacks include vegetable chips, popcorn and pretzels. It is a common myth that the vegan diet is characterised by excluding sugar and sweets from the diet, however, this is hardly true as vegans consumed various vegan-friendly desserts and snacks (Mann 2014). According to Radnitz *et al* (2015), the consumption of sweets also depends on whether vegans are following the diet for health or ethical reasons, as ethical motivated vegans in the study consumed significantly more sweets per day ($p < 0.01$). Ice-cream is known as an innovative, "luxury" product and although dairy-free vegan ice-creams are a growing trend in the market, the cost is more than traditional dairy ice-creams. These ice-creams are made of fruit and vegetable juices as well as PBMAs, especially coconut milk. Frozen fruit and vegetable pieces are also used, which increases the cost of manufacturing vegan ice-cream (Palka & Newerli-Guz 2018). Similarly in South Africa, vegan ice-cream can only be found in big retail supermarkets which stock a variety of vegan products and vegan-specific restaurants and stores or be homemade.

Under the category of spreads and sweeteners, respondents indicated that jam in different flavours is the most commonly consumed spread "at least once a month" (1 - 2 tsp) (13.2%, n = 27), while brown sugar is the most consumed sweetener "at least once a day" (1 - 2 tsp) (17.1%, n = 35). Due to the dependence of white sugar, there is a vast development of white sugar substitutes (Abdullah, Rianse, Iswandi, Taridala, Rianse, Zulfikar, Baka, Abdi, Cahyono, Widayah & Baka 2015). One of these substitutes widely consumed is brown sugar which was able to take over from white sugar in the market as a substitute sweetener that provides health benefits (Kim & Han 2013). In South Africa, sugar is manufactured from crushing and refining sugar cane. This is done in a sugar cane mill, to produce raw sugar by extracting cane juice from sugar cane, however this raw sugar cannot be consumed by humans until foreign particles, molasses and impurities are extracted. Granular brown sugar is formed when the remaining juice is crystallised and further refining procedures form white sugar. Both white and brown sugar is used by household consumers (direct consumption), industries involved in food processing (industrial consumption) and manufactures involved in beverage, baking and confectionery (Chisanga, Gathiaka, Nguruse, Onyancha & Vilakazi 2014).

Organic chocolate spread (<1 tsp) (49.3%, n = 101) and coconut syrup (<1 tsp) (52.7%, n = 108) were least frequently consumed by the respondents. In the beverages category, the

respondents indicated frequently consuming decaffeinated or regular coffee “at least once a day” (1 - 2 cup) (29.3%, n = 60) and sugar-sweetened beverages “at least once a month” (<1 cup) (11.2%, n = 23). The least consumed beverages was fruit flavoured juice (<1 cup) (45.9%, n = 94) and non-alcoholic wine (<1 cup) (48.8%, n = 100). Mchiza, Steyn, Hill, Kruger, Schönfeldt, Nel & Wentzel-Viljoen (2015), conducted a study in South Africa, reviewing dietary surveys among the adult population from year 2000 to 2015. The findings show that South Africans frequently consumed an average of two cups of tea per day. The increased intake of sugar is mainly due to the consumption of sugar-sweetened beverages (SSB) and studies have confirmed that SSB is a frequently reported beverage among South Africans (Tydeman-Edwards 2012).

Vorster, Kruger, Wentzel-Viljoen, Kruger & Margetts 2014), stated that the proportion of adults consuming SSB has doubled over five years. The overconsumption of sugar intake promotes weight gain and increases the risk for NCD’s. According to the study by Radnitz *et al* (2015) conducted in Germany, vegans who were motived by ethical reasons, consumed a greater amount of high polyphenol beverages ($p < 0.01$), while fruit juice was more frequently consumed per month ($p = 0.03$) by those who followed the diet for health reasons. High-polyphenol beverages are of plant-origin and include beverages such as coffee, tea, cocoa drinks, fruit juice, wine, cider and beer (Ito, Gonthier, Manach, Morand, Mennen, Remesy & Scalbert 2005). Most of the respondents in the present study, also followed the vegan diet for ethical reasons and consumed higher amounts of coffee and fruit juices, therefore this study findings are similar to the study findings of Radnitz *et al* (2015).

The VegPlate is a common tool used by vegans and vegetarians to plan healthy diets to meet nutritional requirements. The number of recommended serving sizes in the VegPlate guidelines are based on the kilocalories (kCal) of the diet. In the present study, the respondents consumed a mean energy intake of 1785.65 kCal, therefore the 1800 kCal VegPlate serving size recommendations will be used. Table 5.1 shows the VegPlate model serving size recommendations compared to the results extracted from the 24-hour recall and FFQ of the present study.

Table 5.1: VegPlate model serving size recommendations compared to the findings from the 24-hour recall and FFQ of the present study

	VegPlate serving sizes	**Present study findings from the 24-hour recall and FFQ**
Energy intake	1800 kCal	1785.65 kCal
Grains	9 servings	6-8 servings
Protein-rich foods	3 servings	2-3 servings
Vegetables	6 servings	3-6 servings
Fruit	2 servings	2-4 servings
Nuts and seeds	2 servings	3-5 servings
Fat	1 serving	1-2 servings
Calcium-rich foods	6 servings	3-4 servings
Omega-3 rich foods	2 servings	3-5 servings

From Table 5.1, it can be seen that the respondents are required to consume more grains such as cereals which are ready-to-eat, whole cereals, bread and crackers and calcium-rich foods such as non-dairy milk made from cereals enriched with calcium, soy milk, soy yoghurt enriched with calcium and calcium-rich vegetables in order to meet the requirements of a healthy diet based on the VegPlate model serving size recommendations.

5.4.2 The 24-hour recall

5.4.2.1 Macronutrient intake

According to the 24-hour recall, the respondents in the present study consumed a mean energy intake of 7471.15 kJ. Females had a mean energy intake of 7374.22 kJ and males had a mean energy intake of 7893.76 kJ. In order to convert to kCal, a formula must be applied (1 kcal = 4.18 kJ) (Mendoza, Drewnowski, Cheadle & Christakis 2006). Therefore, in kcal the mean energy intake in this study is 1785.65 kCals. According to the study by Clarys *et al* (2014), conducted in Belgium, compared the nutritional quality of a vegan diet (n = 104), vegetarians (n = 573), semi-vegetarians (n = 498), pesco-vegetarians (n = 145), and omnivores (n = 155). In the vegan group it was found that the mean average intake was 2383 kCal. The vegan diet had the lowest energy intake compared to the other diets. Previous studies have found that using one 24-hour recall has limitations and underreporting is common (Gibson, Charrondiere & Bell 2017).

The Institute of Medicine calculated acceptable macronutrient distribution ranges, which included carbohydrates (45 to 65% of total energy), protein (10 to 35% of total energy) and fat (20 to 35% of total energy) (Manore 2005). The mean total protein consumed according to the

present study respondents was 74.73 g (18.5% of total energy from protein), whereby females consumed a mean total protein intake of 74.82 g and males 74.34 g. This value is slightly lower when compared to the mean total protein consumption of 82 g in the study by Clarys *et al* (2014). The EAR for protein for males is 56 g and females is 46 g (based on 0.8 grams protein per kilogram of body weight for the reference body weight) (Institute of Medicine, Food and Nutrition Board & Committee to Review Dietary Reference Intakes for Vitamin D and Calcium 2011). Taking into account the age group of the respondents in the present study, the respondents are over the EAR following a vegan diet as seen in Figure 4.1.

The mean total fat consumption was 62.34 g (33.7% of total energy from fat), with females consuming a mean of 61.53 g and males 65.85 g. This is in line with the study by Clarys *et al* (2014), which found that the average total fat among the respondents was 68 g. However, other studies found mean total fat consumption is much higher among vegan respondents, for example in the study by Kristensen *et al* (2015), conducted in Denmark with seventy vegan respondents, the mean total fat was 86.7 g for men and 74.0 g for women.

In the present study, females consumed a mean intake of 187.23 g of carbohydrates and males 204.20 g. Although the respondents in the study consumed relatively lower mean intakes of carbohydrates (190.40 g) (47.36% of total energy from carbohydrates) compared to other studies (Kristensen *et al* 2015; Clays *et al* 2014), the value is more than the EAR for carbohydrates for males and females which is 130 g per day (Institute of Medicine *et al* 2011) as seen in Figure 4.1. In the study by Kristensen *et al* (2015); vegan respondents consumed a mean carbohydrate value of 336 g, while in the study by Clarys *et al* 2014, men consumed 339 g while females consumed 221.7 g.

The mean fibre intake consumed by the respondents is 37.48 g. Male respondents consumed a mean of 42.41 g and females 36.35 g. These values are greater than the EAR intakes, of 38 g for males and 25 g for females (Institute of Medicine *et al* 2011) as seen in Figure 4.1. Vegetarian and vegan diets are known to be high in dietary fibre (Key *et al* 2006), therefore this was expected in the present study. Furthermore, the vegan diet is widely promoted due to its high dietary fibre content which assists with metabolic and gastrointestinal functions (Clarys *et al* 2014).

5.4.2.2 Micronutrient intake

According to micronutrients from the 24-hour recall, females consumed a mean intake of 8.84 mg of zinc, while males consumed 9.82 mg. The mean intake of zinc was 9.02 mg. The EAR

for zinc is 11 mg per day for males and 8 mg a day for females (Institute of Medicine *et al* 2011). In the present study, females consumed more than the EAR (8.84 mg), while males did not reach their recommended intake for zinc (9.82 mg) as seen in Figure 4.2. Similarly, the study by Kristensen *et al* (2015), showed that females consumed 8.6 mg of zinc and males consumed 10.5 mg, below the EAR for zinc for males. The low intake of zinc in vegetarian and vegans diets is mainly due to phytate or other inhibitors typically found in these diets that decrease the absorption of zinc (King 2011). Therefore, well-planned diets are encouraged which include legumes, nuts, seeds, fruit, vegetables and whole-grain products to enhance absorption (Saunders, Craig & Baines 2013).

The mean calcium intake for males was 630.88 mg and female respondents was 612.51 mg, while the overall mean intake was 615.94 mg. These mean intakes are far below the recommended EAR of 1000 mg (Institute of Medicine *et al* 2011) as seen in Figure 4.2. This finding is similar to a cross-sectional, German vegan study (GVS) by Ströhle *et al* (2011), which included 154 vegan respondents. In the study, mean daily calcium intakes were below the EAR for all vegans (839.8 ± 296.1). Other studies have also shown that calcium intakes for vegans are below the recommended intakes (Kristensen *et al* 2015; Clarys *et al* 2014; Craig & Mangels 2009; Davey, Spencer, Appleby, Allen, Knox & Key 2003).

The mean iron intake was 23.01 mg, with females consuming a mean intake of 22.95 mg and males 23.28 mg. These values are above the EAR for all aged groups of men and postmenopausal women is 8 mg per day and premenopausal women is 18 mg per day (Institute of Medicine *et al* 2011) as seen in Figure 4.2. This finding is similar to the study by Clarys *et al* (2014), where the mean iron intake was 23 g. Although this finding is favourable, it will not automatically result in the iron status being optimal, since non-haem iron absorption is less efficient in vegans (McEvoy *et al* 2012; Craig 2009). Iron is known to have a reduced bioavailability in plant-based foods (Kristensen *et al* 2015).

The respondents mean intake of sodium was 1003.38 mg, with females consumed a mean intake of 1078.53 mg and males 675.72 mg. However, in the study by Kristensen *et al* (2015), males (2068 mg) consumed higher amounts of sodium compared to females (1589 mg). This could be due to the fact that the present study consisted of a significantly higher amount of females (82.4 %). WHO (2012) recommends that adults have a sodium intake of less than 2000 g per day. The EAR for sodium is less than WHO guidelines, with 1500 mg a day for males and

females (Institute of Medicine *et al* 2011). The respondents in the present study were consuming less than the recommended intake for sodium as seen in Figure 4.2.

The mean intake of vitamin D in the present study was 3.42 μg, with females having a mean intake of 3.44 μg and males 3.30 μg. The EAR for vitamin D for both males and females is 15 μg (Institute of Medicine *et al* 2011) as seen in Figure 4.3. The consequence of reduced vitamin D consumption leads to lower absorption of phosphorous and calcium, which may affect bone metabolism (Kristensen *et al* 2015). In the present study, vegans consumed a very low vitamin D intake compared to what previous studies have found (Davey *et al* 2003; Haddad *et al* 1999a). This may be due to low availability of vitamin D fortified foods, which needs to be produced on a wider scale (Kristensen *et al* 2015). Turner-McGrievy *et al* (2008) suggested that vegans consume fortified products in their vegan diet, while Larsson & Johansson (2002) advised that if sun exposure is insufficient, vitamin D supplements can be used.

The respondents in the study had a mean vitamin B12 intake of 1.06 μg, with males and females having a mean intake of 1.06 μg. This value is lower than the EAR for males and females of 2.4 μg (Institute of Medicine *et al* 2011) as seen in Figure 4.3. This finding is similar to other studies conducted (Elorinne *et al* 2016; Kristensen *et al* 2015; Larsson & Johansson 2002). These findings are expected as the presence of vitamin B12 or vitamin B12 in plant-based diets depends on the inclusion or exclusion of foods of animal origin (milk, dairy and eggs), the consumption of foods fortified with vitamin B12 or the use of vitamin B12 supplements. Therefore, vegans have higher rates of deficiency compared to vegetarians and omnivores (Pawlak *et al* 2013). Supplements are cost effective, when consumed in adequate doses, are highly effective in preventing and treating vitamin B12 deficiency (Donaldson 2000). However, many people following plant-based diets refuse to use vitamin B12 for a number of reasons (Antony 2003). The largest misconception is the belief that people have adequate vitamin B12 stores and the deficiency takes a number of years to develop (Allen 2009), however this is unlikely especially in long-term vegans and vegetarians (Pawlak *et al* 2013).

5.4.2.3 Fatty acids and cholesterol intake

The vegan diet is known to be lower in cholesterol and saturated fat compared to other diets (Craig 2009). According to the present study findings, the mean cholesterol intake was 4.0 mg, with females having a mean intake of 3.80 mg and males 4.84 mg. The EAR for cholesterol is less than 300 mg (Mann & Truswell 2002) as seen in Figure 4.1. This finding is similar to other studies (Elorinne *et al* 2016, Kristensen *et al* 2015, Clarys *et al* 2014). One of the main benefits

of plant-based diets is the low amounts of cholesterol, as the diet contains plenty of nuts, seeds, legumes and cereals and are rich in plant sterols (Ågren, Tvrzicka, Nenonen, Helve & Hänninen 2001). Compared to omnivores, vegans also consumed very low amounts of saturated fatty acids (Kornsteiner, Singer & Elmadfa 2008). In the present study, the mean intake of saturated fat consumed by the respondents was 12.39 g, with females consuming a mean of 12.72 g and males 10.91 mg. This finding is relatively low compared to the Dietary Guidelines for Americans 2015 – 2020, which recommended a limitation on the consumption of saturated fat to be <10% of energy (United States Department of Health and Human Services 2015).

The present study showed the mean intake of mono-unsaturated fatty acids (MUFA) was 21.07 g, females consumed a mean intake of 21.24 g and males 20.34 g. The mean intake of poly-unsaturated fatty acids (PUFA) was 20.34 g, with females consuming a mean intake of 19.60 g and males 23.58 g. PUFA should contribute 6 - <10% of total energy and MUFA should make up the remainder of energy from total fat, typically ± 10% (Smuts & Wolmarans 2013). According to the present study, the respondents consumed 10.7% of energy from MUFA and 10 - 35% of energy from PUFA. These findings are in line with other studies as the vegan diet is lower in MUFA and cholesterol and higher in PUFA when compared to other diets (Kristensen *et al* 2015; Clarys *et al* 2014). Therefore, similar to the study by Elorinne *et al* (2016), the present study showed a favourable fatty acid profile.

5.4.2.4 Other micronutrient intake

According to the present study, respondents met the EAR for many other micronutrients. The average intake of vitamin B6 among the respondents in the present study is 1.90 mg, while females consumed a mean intake of 1.90 mg and males 1.91 mg. The respondents met the EAR for vitamin B6 which is 1.3 mg for males and females between the ages of 19 and 50 years, 1.7 mg for males above the age of 51 years and 1.5 mg for females over the age of 51 years (Institute of Medicine *et al* 2011) as seen in Figure 4.3. The respondents consumed a mean intake of vitamin A was 1833.70 µg, which was above the EAR for men (900 µg) and women (700 µg) (Institute of Medicine *et al* 2011) as seen in Figure 4.3.

In the present study, females consumed a mean vitamin A intake of 1722.90 µg and males 2316.80 µg. The respondents also consumed mean intakes of thiamine (1.51 mg) and riboflavin (1.28 mg), above the EAR as seen in Figure 4.3. Females in the study consumed mean intake of 1.49 mg of thiamine and 1.26 mg of riboflavin, while males had a mean intake of 1.59 mg of thiamine and 1.32 mg of riboflavin. The EAR for thiamine is 1.2 mg for adult males and 1.1

mg for adult females and the EAR for riboflavin is 1.3 mg for adult males and 1.1 mg for adult females (Institute of Medicine *et al* 2011). The mean intake of folate in the present study is 441.33 µg, whereby females has a mean intake of 432.32 µg and males 480.60 µg. This intake exceeds the EAR for folate which is 400 µg (Institute of Medicine *et al* 2011) as seen in Figure 4.3. The respondents consumed a mean intake of 219.70 µg of vitamin K, with females having an intake of 209.02 µg and males 265.57 µg. This exceeds the EAR of 120 µg for adult males and 90 µg for adult females (Institute of Medicine *et al* 2011) as seen in Figure 4.3. These nutritional outcomes are similar to other studies (Elorinne *et al* 2016; Clarys *et al* 2014; Waldmann *et al* 2003; Larsson & Johansson 2002). The hypothesis that South African vegans would not meet their EARs for vitamin B12, vitamin D and calcium, which was based on the findings of international studies, is accepted. The EAR for sodium was also not met by the respondents. The EAE for zinc and niacin was only met by females and the EAR for vitamin E was only met by males. Vitamin B12, vitamin D, calcium and sodium were lacking in the vegan diet consumed by the respondents in the present study.

5.5 Summary

The demographic characteristics of the present study were similar to that of the demographics from international studies. A greater percentage of the respondents were female and were White. The age group, education level and level of physical activity of the respondents were also consistent with vegans from different countries. A significant portion of the population consumed supplements to assist in improving their nutritional status while following a vegan diet. The ethical concerns for animals surrounding animal rights and welfare and preventing cruelty was found to be the strongest motivation among the respondents for following a vegan diet. The main challenges of following a vegan diet faced by the respondents in society was finding vegan options in a restaurant. However, avoiding meat and meat products was not seen as a challenge by the respondents. There was a significant agreement that that research on the internet was the best way to overcome any challenges that they experienced while following the diet.

The findings from the FFQ revealed that there were a variety of intake from different food groups. The groups with the most intake included that from typical vegan diets internationally, whereby whole-wheat products, fruit and vegetables and dairy-free alternatives made up most of the respondents diet. The most frequently consumed PBMA was soy milk, while soya products were the most favoured meat substitute. Soy milk remains as one of the most popular

PBMA consumed by vegans, while varieties of soya products are increasing. The 24-hour recall revealed that although respondents met their EARs for most nutrients, the diet showed to be lacking in calcium, sodium, vitamin D and vitamin B12, similar to the findings from international studies. Therefore, strategies to prevent or reduce nutritional deficiencies in the vegan diet need to be established. The conclusion and recommendations based on the study findings will be presented in the following chapter.

CHAPTER 6: CONCLUSION

6.1 Introduction

Vegetarian diets particularly the vegan diet, are becoming increasingly popular mainly due to an increase in awareness of preventing cruelty towards animals, protecting the environment and its resources, as well as several health benefits associated with following the diet. Interest in the vegan diet has risen in South Africa over the past few years with social movements being established to focus on reaching out to the public and providing support to those who choose to follow a vegan diet or lifestyle. Moreover, there is a growing rate of vegan-friendly restaurants in South Africa and many restaurants are including vegan options to cater for this group of patrons. However, following a vegan diet does have nutritional concerns, as research has shown that the diet can be deficient in many essential nutrients. Therefore, correct supplementation, choosing fortified food products and planning a healthy diet is important to meet the daily requirements of nutrients and ensure adequate functioning of the body.

The decision to follow a vegan diet involves individuals having either single or multi-factored motivations that influence the initial transition. Along with transitioning from a vegetarian or omnivorous diet to a vegan diet, many individuals will face challenges socially and personally. This study aimed to determine the challenges associated with becoming a vegan and how these challenges were overcome. Many valid questions arose regarding the nutritional intake of South African vegans and whether the diet was nutritionally complete and sustainable. Although following a vegan diet is a growing trend worldwide, there is still a paucity of data especially in South Africa compared to the growth in international research. Therefore, the main purpose of this study was to determine the motives and challenges facing South African vegans and the nutritional quality of their diet.

This chapter will conclude with discussing the results of the study in line with the objectives. It will address the limitations of the study and recommendations for future research.

6.2 Conclusions of the study

6.2.1 The demographics of the study sample

The study population consisted of more female than male respondents and the White race group made up majority of the population. A significant number of respondents resided in the Gauteng Province, were single and were in the age category of 18 to 29 years and 40 to 49

years. Most of the respondents had either a degree or post-graduate education level and earned an income of R25 601 to R51 200 per month.

A significant number of respondents followed a vegan diet for a duration of 1 to < 3 years. According to lifestyle factors, most of the respondents consumed alcoholic beverages, participated in physical activity with different intensities and varying durations and did not consume cigarettes.

6.2.2 The motives regarding the vegan diet

The motives for following a vegan diet were measured using a variety of possible options including ethical, environmental and health related motives. The study findings showed that most of the respondents agreed that the ethical concern for animals (preventing cruelty, animal rights and welfare) was the main motive for following a vegan diet. This was followed by environmental concerns and the effect of animal product consumption on climate change, and lastly, improving health. This provided a good understanding as to what motivates South Africans to follow a vegan diet. Once the motives of the study population were established, the factors that assisted the transition to a vegan diet were investigated. Based on the findings, the study population indicated that experimenting with vegan food such as reading ingredient lists on products and experimenting with vegan recipes assisted them more than social factors and vegan books, magazines, newspapers or places such as vegan shops and health stores.

6.2.3 The challenges associated with following a vegan diet

The analysis showed that a significant number of respondents specified that it was “easy” to transition into a vegan diet and excitement and enthusiasm was the main emotions that were felt during the process. Most of the respondents agreed that there were no financial challenges to following a vegan diet and the vegan diet did not cost more than a diet that included animal products. This may have contributed to the financial accessibility of being able to follow the vegan diet. Most respondents purchased their food from a supermarket rather than health food shops and online websites. According to the respondents, the main challenge with following a vegan diet was finding vegan meal options in restaurants. Research on the internet assisted the majority of respondents to overcome challenges while following the vegan diet as opposed to visiting a dietitian or talking to or educating friends and family regarding their choice of diet.

6.2.4 The nutritional quality of the vegan diet

The findings from this section of the study showed that most of the respondents agreed that following a vegan diet was nutritionally complete and adequate for a healthy lifestyle. The FFQ, was analysed to find which foods were most commonly consumed by the respondents. The food items such as whole-wheat bread, white bread-rolls, pasta plain and eggless, white or brown basmati rice, and muesli were most commonly consumed in the starches, cereals and grains categories. In the categories of meat and milk substitutes and mixed foods; soya products, soy milk and vegan pizza was most commonly consumed. In the categories of vegetables, fruit, peas and beans; spinach, broccoli and vegetable condiments such as tomato sauces, pasta and salsa; banana, dried raisins, freshly prepared orange juice, followed by chick peas and baked beans as a bean product was most commonly consumed by the respondents. In the category of fats and dressings; olive oil, peanut butter, almonds, dairy-free margarine and hummus was most commonly consumed by the study population. The most commonly consumed snacks and desserts included potato chips, wheat-free biscuits, organic dark chocolate bars, non-dairy yoghurt and egg-less cakes. Different flavours of jam and brown sugar was most commonly consumed in the spreads and sweeteners categories. The most commonly consumed beverages included decaffeinated or regular coffee and sugar-sweetened beverages.

The finding of the 24-hour recall showed that the respondents met some of the estimated average requirement (EAR) of certain macronutrients and micronutrients. Overall, the mean energy intake was slightly below energy intakes from international studies conducted on adults. The respondents showed a favourable fat intake, and protein and carbohydrates were within the percentage range of total energy contributions according to EAR guidelines for macronutrients. Based on the analysis, respondents met their EARs for fibre, iron, vitamin C, vitamin B6, vitamin A, thiamine, riboflavin, folate and vitamin K. However, the respondents did not meet their EARs for calcium, sodium, vitamin D, vitamin B12. Males met their EAR for vitamin E, while females did not meet the daily requirement. Females met their requirements for niacin and zinc, while males did not meet the daily requirement. Females also consumed more added sugar than males. Overall the respondents had a reduced consumption of cholesterol, saturated fat and MUFA intake and an increased consumption of PUFA. Overall the findings of this study was similar to international research.

6.3 Study limitations

Due to cost and time limitations, the study could not be conducted for an extended time to allow a greater number of respondents to participate. However, the questionnaire was released online and overtime the number of responses decreased. Increased responses can be obtained by sending reminders or emailing potential respondents prior to the study, explaining the value of the study, content of questions and average time taken to complete those questions. One of the limitations of the study is that the sample population was representative of the South African vegan community. A possible bias could be presented between vegans using the SAVS platform on Facebook when compared to other vegan society members. It is also important to note that there could be a number of vegans who do not belong to any society. SurveyMonkey estimated the average completion time of the questionnaire to be between 25 to 30 minutes, and this may be the reason why the attrition rate was increased during the completion of section C and D of the questionnaire. Researchers should consider the actual time spent on completing the questionnaire and if the study requires respondents to collect relevant information such as 24-hour recall records for the questionnaire, this should be communicated to the respondents prior to the study. During the study, weekly reminders should also be sent to potential respondents. However, compared to other studies, the present study population seemed adequate for the time frame that was provided in collecting respondents' data. The study was limited to South African vegans who had access to Facebook and the internet, therefore it was a small sample population as some individuals may not have access to social media sites or the internet. Respondents were also provided with the researchers personal contact details if they had any queries or questions regarding the questionnaire.

Carefully planned FFQ and 24-hour recalls have great potential to assess the nutritional intake of any study population. The FFQ which was based on the work of others, was long, as it included all possible foods included in a vegan diet and therefore required time to complete. This had to be done to increase the variety of food items presented in the FFQ, as selecting food groups would not have been a true reflection of foods frequently consumed by the study population. A 24 - hour recall was the other dietary assessment tool used in the study. The 24 - hour recall could only be conducted for 1 day due to the time frame for completing the study and the nature of the study being on an online group. The respondents were requested to indicate the time and place they consumed a meal, preparation method and ingredients as well as the quantity of food consumed in the previous 24 - hours. The respondents had to also indicate any condiments and beverages consumed in the previous 24 - hours. The survey

programme that was used in the study, allowed only a single submission per respondent at the time of completing the questionnaire and respondents could not save and complete the questionnaire at another time. Therefore, only one 24 - hour recall could be requested in the questionnaire. An example of a 24 - hour recall was provided in the questionnaire. Although SurveyMonkey was an excellent platform to conduct this study, unfortunately it had a few flaws in hindsight, as it did not allow the researcher to upload a large attachment with food photographs. This meant that the researcher had to email the food photographs to each subject. Therefore, the results of the 24 - hour recall should be interpreted with caution. Ideally, if time allowed, the researcher would have phoned each respondent to guide them through the process of the 24 - hour recall and FFQ, but this would have been a lengthy and costly process. This may be the reason why the attrition rate was high in the second part of the questionnaire which included the FFQ and 24 - hour recall as these sections were lengthy to complete. The respondents did have the researchers contact details if they needed any clarity on the questionnaire. Although an example and tool was provided, respondents could have over- or underestimated individual food items and whole meals consumed. Future research should focus on ways to reduce attrition rates especially in questionnaires that involve dietary assessment measures.

The nutritional analysis focused on the nutrients acquired from the diet and did not take into account the impact of the different supplements consumed by the individuals in the study population. Another limitation was that the vegan diet may be considered non-conventional and not all foods were available on the Food Finder programme database. However, this was overcome, as the researcher used recipes and online shopping to find the ingredients of these vegan food items.

6.4 Recommendations based on the results of the study

6.4.1 Recommendations for dietetic practice

The interest surrounding plant-based diets especially vegan diets is increasing both internationally and in South Africa, as more individuals are concerned about animal ethics, protecting the environment and general public health benefits. International research on how the vegan diet is now being practiced by different age and race groups has increased. The majority of dietitians agree that the vegan diet can be nutritionally adequate. Therefore, dietitians should stay updated on the findings of vegan diets including the nutritional quality of the diet and its role in preventing and treating NCD's. Dietitians are more likely to be

associated with clients from middle to higher income categories in private practice, therefore there is a greater possibility that these clients will show more interest in the vegan diet. They should be able to provide additional information in the form of pamphlets, sample meal plans, recipes, and one-on-one counselling sessions, cooking classes or providing links to peer reviewed scientific articles on the internet. In the government setting, dietitians can encourage and motivate clients to reduce or limit the consumption of animal products and increase the intake of plant-based foods to follow a more sustainable and cost-effective diet and improve health and well-being.

The vegan diet is less economically taxing in that it saves the environment and its resources which are needed for future generations. Dietitians should therefore be aware of the names of vegan food products on the market, the ingredients, cost and nutritional quality of these products, as well as general healthy eating guidelines in order to assist individuals to reach their daily requirements of macro and micronutrients, including the use of supplementation. Food insecurity in South Africa is still on the rise in many parts of the country and many individuals cannot afford to include meat and meat products in their usual dietary patterns. These individuals who do not have sufficient income for food on a daily basis, may find it difficult to begin following a restrictive diet with selective food products. Other individuals who consume meat as part of their tradition and culture, may not want to omit meat from their diet, despite the advice given by health professionals to reduce the intake of meat and processed meat products to benefit their health.

6.4.2 Recommendations for consumers, food companies and restaurants

The market for meat and milk substitutes has recently increased and many more companies have begun to manufacture both vegan and vegetarian substitutes to meat, including well-known meat producing companies. Many meat substitutes are not enjoyed by the overall plant-based diet population and companies who manufacture these products should work to improve the appearance, taste and texture of these products, without compromising the cost. The companies should market and target their products not only to existing vegans, those following a plant based diet and vegetarians but also the segment of meat-eating consumers. Companies should also provide clear instructions on how to prepare these meat substitutes and possibly include recipes to assist consumers. Packaging and labelling should be appealing and the cost of these products should be in line with other competitors.

The market for PBMA is increasing in demand as individuals are replacing cow's milk for medical or lifestyle reasons such as following a plant-based and vegan diet. It is important that companies are able to fortify these PBMA with the adequate nutrients so that individuals can reach their daily requirements for what they are losing by not consuming cow's milk. Consumers should be aware of the brands that are fortified in order to maintain a healthy diet. Companies should also try to improve the taste and texture of some PBMA as some plant milks are stigmatised for their unpalatable profiles and high cost compared to cow's milk.

The number of vegan only restaurants is increasing around South Africa. Non-vegan restaurants should be able to imitate traditional dishes or beverages using meat or milk substitutes, to accommodate vegan consumers. Restaurant staff should be trained to understand the term "vegan" and how ingredients in certain meals can be changed to suit the vegan consumer. Restaurants should also follow the necessary practises to ensure that vegan meals are prepared separately without mixing cutlery or ingredients, and ensure that vegan ingredients are of the highest quality and meals are presented with a high standard.

6.5 Recommendations for future research

Most of the international studies have compared the nutritional intake of individuals following a vegan diet and an omnivorous diet matched with age, BMI and race group. Therefore, there is a need for studies similar to compare the nutritional quality of different diets in South Africa. Blood analysis could be conducted to determine if the nutritional quality is improved between vegans who consume nutritional supplements and those who do not. Studies can also be conducted with vegans from South Africa compared to those from another country, to compare the motives, meals and dietary patterns as well as views on the lifestyle as a whole. Further studies using Black South Africans can be done to understand their opinions surrounding veganism, especially when consuming animals is a major part of traditional ceremonies and are seen as a form of wealth. Studies can also be conducted in lower socio-economic and food insecure settings in South Africa were the majority of plant-based food is already consumed, not necessarily out of choice, and to investigate whether these groups reach their nutritional requirements.

Longitudinal studies should be conducted to examine developing trends and the sustainability of a vegan diet in South Africa. Vegans who follow different memberships or societies, including those who do not follow any social groups should be used for further research. Studies should have at least 3 days of 24-hour recalls with clear instructions via telephonic or

face to face interviews with the researcher or field workers. This will assist with improving findings regarding the nutritional quality of the diet.

The opinions of omnivorous respondents on the vegan diet including their opinions on plant-based milk alternatives and meat substitutes, should also be investigated to determine any stigma attached and possible resistance to following a vegan diet or reducing meat in the diet. Vegans and vegetarians perceptions on substitutes' should be investigated and focus groups conducted regarding how they would like their food flavour to be improved. A study on cost analysis following both the omnivorous and vegan diet, prices of meat and milk substitutes and dining in restaurants will assist with knowing which of the diets is more cost effective.

Currently, the number of members on the South African Vegan Society (SAVS) Facebook group has risen to 11 237 since the beginning of this study (April 2020). According to the director of the SAVS, veganism should not be seen as a lifestyle choice or "arbitrary" diet, it involves showing the most basic respect towards animals instead of treating them as "property" and without feelings. Individuals need to be aware of the original intention behind veganism and that is about reducing the harm and exploitation done to animals. Therefore, the transition into veganism is quite a "radical" decision.

It would be interesting to investigate how the majority of South Africans feel about this lifestyle particularly when consuming meat is part of their culture and heritage. This should take into account that South Africa celebrates a national public holiday (Heritage day on the 24th September) to honour the heritage of the country, which involves social gatherings with braaing of meat and other forms entertainment. Many tourists visit the country due to its diversity and culture as well indulging in traditional South African cuisine, including exotic meat options such as various types of game, biltong and droe-wors which is an attraction for tourists visiting the country.

Currently, more and more South Africans are experimenting with international food trends and changing their way of life for the betterment of health and the environment. South Africans are part of a true shift of global consciousness and even though veganism is followed by a minority of the population, it has the potential to grow and develop interest among more individuals in the future. In so saying, the popular phrase, "we are what we eat" provides a keen insight that only we, as individuals, can decide what is best for our health and well-being.

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APPENDIX A: Questionnaire

SECTION A: DEMOGRAPHIC CHRACTERISTICS

1. Are you a South African citizen currently living in South Africa?

Yes	No

2. Indicate the province in South Africa you reside in.

Eastern Cape	
Gauteng	
Western Cape	
KwaZulu-Natal	
Limpopo	
Mpumalanga	
Northern Cape	
North West	
Free State	

3. Do you follow a STRICT vegan diet?

Yes	No

4. For how long have you been following a Vegan diet?

< 6 months	
6 months - <1 year	
1 - <3 years	
3 - <5 years	
5 - <7 years	
7 - <9 years	
9 - 10 years	
>10 years	

5. Please indicate your gender.

Male	Female

6. Please indicate your race group.

Black	White	Coloured	Indian	Other: Please Indicate -

7. Please indicate your current relationship status.

Single	Married	Divorced or Separated	Widowed

8. Into which age category do you fall?

<18 years	18- 29 years	30- 39 years	40- 49 years	50-59 years	60+ years

9. Please indicate your highest academic level.

Some School	Matric	Certificate	Diploma	Degree	Post-graduate Degree	Other

10. What is your TOTAL current <u>monthly</u> income?

I do not have an income		R 6 401 – R 12 800	
Up to R400		R 12 801 – R 25 600	
R 401 – R 800		R 25 601 – R 51 200	
R 801 – R 1 600		R 51 201 – R 102 400	
R1 601 – R 3 200		R 102 401 – R204 800	
R 3 201 – R 6 400		R204 801 or more	

11. Do you smoke?

Yes	No

12. Do you consume alcoholic beverages?

Yes	No

12.1 **<u>If YES to question 12</u>,** how often, on average, do you consume alcoholic beverages in a week?

Less than once a week	Once a week	Two times a week	Three times a week	Four times a week	Five times a week	More than five times a week

13. Do you consume any mineral or vitamin supplement?

Yes	No

13.1 **If YES to question 13,** specify the mineral or vitamin supplement that you consume.

_____

14. Do you participate in any physical activity?

Yes	No

14.1 **If YES to question 14,** indicate the frequency with which you participate in each type of physical activity shown below.

Activity	**Never**	**Once a week**	**Twice a week**	**Three times a week**	**Four times a week**	**Five times a week**	**Six times a week**	**Everyday**	**More than once a day, Please specify the number of times a day**
14.1.1 Low Intensity: Casual walking or bike riding, yoga, stretching, walking up the stairs									
14.1.2 Moderate Intensity: Weight training, jogging, cycling, swimming, brisk walking, aerobics									
14.1.3 High intensity: Circuit training, vigorous forms of weight training, running, cardio workouts									

14.2 **If YES to question 14**, for how long do you participate in physical activity, ON AVERAGE, in a day?

Less than 30 minutes	30 minutes - <1 hour	1 - <2 hours	2 - <3 hours	At least 3 hours

SECTION B: MOTIVES TOWARDS FOLLOWING A VEGAN DIET

1. Indicate your agreement that the following factors motivated or influenced you into following a vegan diet

Factors	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree
1.1 Ethical concern for animals (e.g. preventing cruelty; animal rights and welfare)						
1.2 To improve health						
1.3 Protecting the environment						
1.4 Family tradition and/or friends following the diet						
1.5 Influence of social media						
1.6 Personal well-being						
1.7 To reduce the carbon footprint/impact on the environment						
1.8 The effect of animal product consumption on climate change						
1.9 Religious beliefs (e.g. Jains, Buddhists)						
1.10 To prevent diseases and illnesses						
1.11 Taste preferences						
1.12 Social justice (e.g. world hunger could be reduced by feeding nutritious grains to the underprivileged instead of to farm animals)						
1.13 Protect endangered species						
1.14 Save water						
1.15 Prevent pollution						
1.16 Protect factory and farm workers from unsafe conditions						

2. Since you began following a vegan diet, has your motivation behind your choice changed?

Yes	No

3. Indicate your agreement that the following assisted you in your transition into veganism

	Strongly disagree	Disagree	Slightly disagree	Slightly agree	Agree	Strongly agree

3.1 Social media and/or the Internet						
3.2 Family and/or friends						
3.3 Vegan groups						
3.4 Vegan cook books/magazines /newspapers						
3.5 Vegan shops						
3.6 Health stores						
3.7 Becoming vegetarian first – prior to becoming a vegan						
3.8 Experimenting with replacing dairy and meat products with plant- based alternatives						
3.9 Reading ingredient lists on products						
3.10 Experimenting with vegan recipes						
3.11 Visiting a vegan restaurant						
3.12 Following a 30 day vegan challenge						
3.13 Visiting a Dietitian						

SECTION C: CHALLENGES ASSOCIATED WITH VEGANISM

1. Which word best describes your transition to veganism?

Very easy	Easy	Moderately easy	Moderately difficult	Difficult	Very difficult

2. Which of the following emotions best describes the beginning of your transition?

Fear	Excitement and enthusiasm	Confusion	Contentment

3. Do you experience any financial challenges following veganism?

Yes	No

4. Where do you purchase MOST of your vegan food items? (Select ONE option only)

Online	Health food store	Supermarket

5. Indicate your agreement that you have experienced the following challenges during the time of transition

	Strongly disagree	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**
5.1 Communicating the decision to family and friends						
5.2 Associating yourself with meat-eaters in a social setting						
5.3 Gathering information on veganism						
5.4 Avoiding meat and meat products						
5.5 Planning a suitable vegan diet						
5.6 Finding vegan stores						
5.7 Finding vegan meal options in restaurants						

6. Indicate your agreement that the following practices helped you to overcome the challenges you experienced

	Strongly disagree	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**
6.1 Research on the Internet						
6.2 Talking to /educating friends and family about veganism						
6.3 Visiting a DietitianDietitian						
6.4 Reading vegan books and other literature						
6.5 Joining a vegan group on social media or attending meetings						

7. Indicate your agreement with the following statements:

Statements	**Strongly disagree**	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**
7.1 Vegan recipes are easily accessible						
7.2 There is an adequate range of vegan products at your nearest supermarket or retail store						
7.3 It costs more to follow a vegan diet than a diet which includes animal products.						

SECTION D: NUTRITIONAL QUALITY OF FOOD IN A VEGAN DIET

1. Indicate your agreement with the following statements:

Statements	**Strongly disagree**	**Disagree**	**Slightly disagree**	**Slightly agree**	**Agree**	**Strongly agree**

1.1 A vegan diet is nutritionally complete and adequate for a healthy lifestyle						
1.2 Meat alternatives are healthier than meat products						
1.3 Milk alternatives provide adequate calcium for the body						
1.4 Vegan food is bland and requires many added ingredients in order to be appetizing						
1.5 Vegan food does not provide a feeling of satiety						

2. How often do you visit a restaurant and order a vegan meal?

Less than once a month	Once a month	Several times a month	Once a week	Several times a week

24-HOUR RECALL

Please complete a 24-hour recall indicating all food, beverages and condiments you have consumed in the last 24 hours also include the time and place that the meal had been eaten at and the portion size. **The example below will help assist you**.

Time	**Place**	**Meal**	**Food item/ beverage**	**Preparation details**	**Amount**
8.00am	Home	Breakfast	Oats	Cooked	½ cup
			Almond milk		¼ cup
			Sugar, white		2 teaspoons
			Tea, Rooibos	Mixed with boiling water	¾ cup
			Almond milk		¼ cup
			Sugar, white		2 teaspoons
10.00am	Work	Snack	Apple	Raw	1 medium
			Strawberry soya yoghurt		100ml tub
			Fruit juice		125ml
13.00pm	Work	Lunch	Roll, brown		1 roll
			Sausage, soya	Fried whole	1 medium
			Sauce, tomato		2 teaspoons
			Margarine		1 teaspoon
			Coke, can		330ml can

15.00pm	Work	Snack	Popcorn	Microwave	1 cup
			Coffee, black		3 teaspoons
			Sugar, white		2 teaspoons
18.00pm	Home	Supper	Pasta, egg free		1/2 cup
			Spinach	Cooked added to pasta	½ cup
			Oil, olive	To cook spinach	2 teaspoons
			Garlic, cloves	Added to spinach	2 cloves
			Chili, flakes		1 teaspoon
			Fruit juice		125ml
20.00	Home	Snack	Tea, Rooibos	Mixed with boiling water	¾ cup
			Almond milk		¼ cup
			Sugar, white		2 teaspoons

Time	Place	Meal	Preparation details	Amount

FOOD FREQUENCY QUESTIONNAIRE

From the food item list below, please indicate by selecting **how much** of the item you use per meal or snack and **how often** you consume meals or snacks containing this particular food item.

	How much of this food item do you use per meal/snack?		How often do you use meals/snacks containing this food item?

Milk substitutes	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Almond milk										
Soy milk										
Rice milk										
Cashew milk										
Macadamia milk										
Coconut milk										
Hemp milk										
Oat milk										
Flax milk										
Quinoa milk										
Homemade soy milk										

Bread loaves	< 1 slice	1 -2 slices	> 2 slices		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
White bread										
Brown bread										
Whole-wheat bread										
Rye bread										
Sour dough bread										
French bread										
Other:										

Other Breads:	<½ small item	½ - 1 small item	> 1 small item		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Pita										
Tortilla										
Cornbread										
Waffles										
Muffin – bran/oat										
English muffin										
Rolls – white										
Rolls – brown										
Rolls – whole-wheat/seeded										

Pasta	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Pasta – plain, egg										
Pasta – plain, eggless										
Pure rice pasta										

Maize and rice pasta										
Red lentil pasta										
Chickpea pasta										
Corn and quinoa pasta										
Green pea pasta										
Organic brown rice pasta										
Wholegrain pasta										
Buckwheat pasta										
Organic spelt pasta										
Rice and corn pasta										
Organic black rice noodles										
Brown rice noodles										
Organic lasagna sheets										

Cooked grains	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Rice – white										
Rice – brown										
Sushi rice										
White/brown Basmati rice										
Organic wild rice										
Organic black rice										
Flax meal										
Brown rice koji										
White/ red / black quinoa										
Polenta										
Buckwheat										
Teff grain										
Organic wheat kernels										
Millet										
Puffed rice										
Bulgar wheat										
Pearled barley										
Couscous										
Amaranth										
Barley flakes										
Rolled oats										
Oat bran										
Oatmeal										
Maize meal										
Cornmeal										
Sorghum										

Ready-to-eat cereals	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Oat bran flakes										
Rice Krispies, Milo Cereal										
Special K										

Cornflakes										
Weetbix										
All Bran flakes										
Cheerios										
Muesli										

Vegan Meats	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Gluten (Seitan)										
Textured vegetable protein (from dry)										
Soya products										
Tofu – silken/soft										
Tofu- firm										

Egg/Cheese substitutes	< 1 slice cheese, <1 tsp egg	1 - 2 slices cheese, 1 - 2 tsp egg	>2 slices cheese, >2 tsp egg		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Vegan cheese										
Egg replacer										
Other:										

Mixed foods	<1 slice	1-3 slices	>3 slices		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Vegan pizza										
Vegan lasagna										

Peas and Beans	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Kidney beans										
Butter beans										
Sugar beans										
Black beans										
Navy beans										
Green soybean										
Mature soybean										

Peas and Beans	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
White beans										
Black-eye beans										

Lima beans										
Pinto beans										
Butter beans										
Adzuki beans										
Cannellini beans										
Haricot beans										
Brown lentils										
Red split lentils										
Mung beans										
Split green peas										
Chick peas										

Bean products:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Refried beans										
Baked beans										

Nuts	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Walnuts										
Cashew nuts										
Almonds										
Peanuts										
Pistachio nuts										
Soy nuts										
Pecan nuts										
Brazil nuts										
Coconut										

Seeds/Nut Butters:	< ½ tsp	½ - 1 tsp	>1 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Pumpkin seeds										
Sunflower seeds										
Sesame seeds										
Flax seeds										
Cashew butter										
Hazelnut butter										
Macadamia nut butter										

Seeds/Nut Butters:	< ½ tsp	½ - 1 tsp	>1 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day

Almond nut butter										
Peanut butter										
Roasted sunflower/ pumpkin seed butter										
Coconut butter										
Sesame Tahini										

Fats/Oils:	< 1 tsp	1-2 tsp	>2 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Olive oil										
Coconut oil										
Hemp seed oil										
Flax seed oil										
Grapeseed oil										
Almond oil										
Macadamia oil										
Pine nut oil										
Sesame oil										
Sunflower oil										
Soybean oil										
Canola oil										
Ghee (clarified butter)										

Butter and Margarine:	< 1 tsp	1-2 tsp	>2 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Organic Coconut butter										
Dairy-free margarine										

Salad dressings:	< 1 tsp	1-2 tsp	>2 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Hummus										
1000 island style vegan mayonnaise										
Peri- peri vegan mayonnaise										
Other mayonnaise:										
Italian dressing										
French dressing										

Leafy vegetables:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Bok choy										
Collard greens										
Kale										

Spinach- raw										
Spinach – cooked										
Swiss chard										
Romaine lettuce										
Green leaf lettuce										
Iceberg lettuce										
Chinese/ Lapa cabbage										
Cabbage – red										
Cabbage – green										
Mustard greens										

Non- Leafy Vegetables:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Broccoli – raw										
Broccoli – cooked										
Cauliflower – raw										
Cauliflower- cooked										
Green beans										
Green peas										
Zucchini / Baby marrow										
Butternut										
Pumpkin										
Gem squash										
Artichoke										
Asparagus										
Mushrooms										
Carrots – cooked										
Carrots – raw										
Beetroot										
Sweetcorn										
Corn on the cob										
Sweet potato										
Potato – white/red										
Cassava										
Okra										
Olives – black/ green										

Other vegetable condiments:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Tomato sauces, paste & salsa										
Packet vegetable soups or broths										
Carrot juice										
Tomato juice										

Fresh/ Frozen Fruit	< ½ med item, < ½ a cup	½ - 1 med item, ½ - 1 cup	>1 med item, >1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Cantaloupe										
Avocado										
Watermelon										
Mango										
Banana										
Orange										
Apple										
Pear										
Grapes										
Plums										
Cherries										
Blueberries										
Strawberries										
Litchis										
Nectarine										
Peaches										
Persimmons										
Dragon fruit										
Jack fruit										
Papaya										
Figs										
Pineapple										

Dried & Canned Fruit:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Dried raisins										
Dried prunes										
Dried dates										
Dried figs										
Dried apricots										
Dried berries										
Dried pomegranates										
Dried peaches										
Dried mangoes										
Dried mixed fruit										
Pineapple- canned										
Peaches –canned										
Apple sauce										
Fruit juices:	< 1 cup	1-2 cups	>2 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Orange juice – freshly prepared										
Orange juice										
Apple juice										
Grape juice										
Coconut water										

Mixed fruit juice										

Jams/Marmalade/ Sweetened spreads	< 1 tsp	1-2 tsp	>2 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Jam e.g. strawberry, apricot, raspberry and plum, mixed fruit, mixed berry										
Papaya chutney										
Marmalade e.g. citrus fruits, olive, berries, ginger, fig, mixed Fruit										
Organic chocolate spreads										

Beverages:	<1 cup	1-2 cups	>2 cups		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Five roses tea										
Herbal tea										
Green tea										
Flavored tea										
Rooibos tea										
Coffee – decaffeinated/regular										
Coffee substitutes										
Fruit flavored juice										
Fruit cordials										

Other beverages:	< 1 cup	1-2 cups	>2 cups		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Sugar- sweetened soft drinks										
Artificially sweetened diet soft drinks										
Sweetened - Iced tea										
Kombucha										
Beer										
Wine- non-alcoholic										
Wine- Red										
Wine – White										
Liquor/Rum										

Snacks:	< 1 packet (<125g)	1 packet (125g)	>1 packet (>125g)		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Packet chips – tortilla/corn										
Chips – potato										
Vegetable crisps										
Fruit crisps										
Coconut chips										
Pretzel (hard)										

Salted peanuts										
Rice / oat cakes										
Oyster mushroom biltong										
Vegan Droëwors										

Biscuits:	< 1 item	1-2 items	>2 items		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Biscuits (wheat free) e.g. choc chip, vanilla										
Buttermilk/ bran rusks										
Muesli rusks										
Grain-free crackers										
Biscotti										

Bars and candy:	< 1 item	1 -2 items	>2 items		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Granola bar										
Trail mix bar										
Peanut clusters										
Organic fruit gums										
Organic white/ brown chocolate bars										
Organic dark chocolate bar										

Desserts:	< ½ cup	½ - 1 cup	>1 cup		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Soy ice cream										
Coconut cream										
Non-dairy yoghurt										
Non-dairy cream										
Non- dairy custard										

Pies/ Puddings:	< 1 slice	1 -2 slices	> 2 slices		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day
Vegan cheesecake										
Egg-less cake										
Fruit pie										

Sweeteners:	< 1 tsp	1-2 tsp	>2 tsp		Never	Less than once a month	at least once a month	at least once a week	Once a day	more than once a day

Sugar, white										
Sugar, brown										
Coconut sugar										
Raw bee honey										
Molasses										
Agave										
Stevia										
Real maple syrup										
Coconut syrup										
Organic rice syrup										
Organic date syrup										
Jaggery powder										
Non- nutritive sweeteners e.g. Xylitol, Sucralose, Saccharin, Aspartame, Acelfame K										

THANK YOU FOR YOUR TIME

APPENDIX B: Household food measurements

Bread:

1 slice **2 slices** **3 slices**

Mashed Potato:

1/4 cup **½ cup** **1 cup**

Potato and Chickpea salad:

¼ cup **½ cup** **1 cup**

Muesli with mixed fruit:

¼ cup **½ cup** **1 cup**

Samp with beans:

1/4 cup **½ cup** **1 cup**

Pasta:

¼ cup **½ cup** **1 cup**

Baked beans:

¼ cup **½ cup** **1 cup**

Pizza:

1 slice **2 slices** **3 slices**

Salad:

¼ cup **½ cup** **1 cup**

Vegetable stew:

½ cup **1 cup** **2 cup**

Juice/Cooldrink:

¼ glass **½ glass** **1 glass**

Plant-based Milk:

¼ glass **½ glass** **1 glass**

Medium Fruit:

1 medium apple **1 medium orange** **1 medium nectarine**

Commercial Popcorn:

¼ cup **½ cup** **1 cup**

Cooked Rice:

1 rice ladle spoon **2 rice ladle spoons** **3 rice ladle spoons**

Commercial Vegan Crackers:

2 crackers **3 crackers** **4 crackers**

Peanuts and Raisins:

1 tablespoon **2 tablespoons** **3 tablespoons**

Bran Muffin:

½ Muffin **1 Muffin**

Nut Butter:

1 teaspoon

1 tablespoon

Vegan Margarine:

1/4 teaspoon

½ teaspoon

1 teaspoon

Tomato Sauce:

1 teaspoon

1 tablespoon

Oil:

1 teaspoon

1 tablespoon

Salad dressing:

1 teaspoon

1 tablespoon

Banana and Oat Milk Smoothie:

1/4 glass **½ glass** **1 glass**

Roti:

1/2 medium roti **1 medium roti** **2 medium roti's**

Paneer:

2 cubes **3 cubes** **4 cubes**

Cake:

1 Slice **2 Slices** **3 Slices**

Oven-baked Potato Chips:

½ cup **1 cup**

Mixed Fruit Salad:

¼ bowl **½ bowl** **1 bowl**

Samoosa's:

1 medium samoosa **2 medium samoosa's** **3 medium samoosa'**

Chocolate pieces:

1 piece

2 pieces

3 pieces

Vegetable crisps:

1/4 cup **½ cup** **1 cup**

Drinking Oats:

½ cup **1 cup**

Ice-cream:

1 scoop **2 scoops** **3 scoops**

Mixed boiled vegetable:

¼ cup **½ cup** **1 cup**

Vegan Feta Cheese:

½ block **1 block**

Vegan Cheese:

¼ cup **½ cup** **1 cup**

Soya Products:

1 soya sausage (47.5g), 1 soya burger (85g)

Quinoa:

½ cup **1 cup**

Couscous:

½ cup **1 cup**

Wholegrain Wheat Biscuits:

1 biscuit **2 biscuits** **3 biscuits**

Sauerkraut:

1 tsp **2 tsp** **3 tsp**

Flaxseed:

¼ cup **½ cup** **1 cup**

Hummus:

1 tsp **2 tsp** **3 tsp**

Cashew Nuts:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Almonds:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Macadamia Nuts:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Brazil Nuts:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Pecan Nuts:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Mixed Nuts:

1 Tablespoon **2 Tablespoons** **3 Tablespoons**

Dried Fruit:

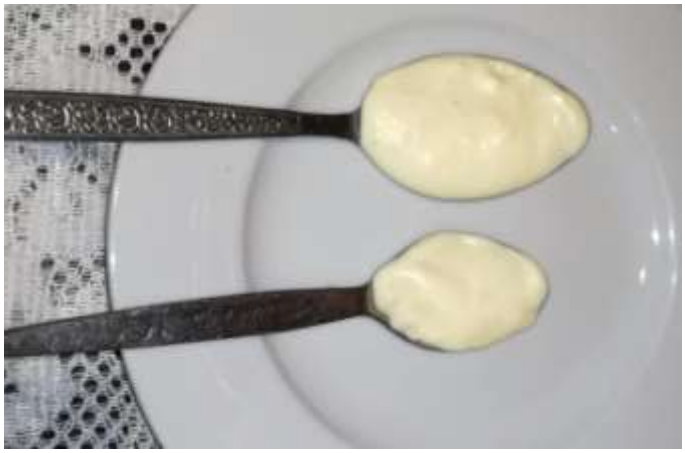
½ cup **1 cup**

Tahini:

1 teaspoon

1 tablespoon

Vegan Mayonnaise:



1 tablespoon

1 teaspoon

Vegan Sushi:

1 piece

4 pieces

Alcoholic Beverages:

500ml beer **330ml cider** **1 glass red wine**

Beverages:

500ml bottle **250ml carton** **300ml can**

APPENDIX C: Gatekeepers permission

South African
Vegan Society
PO Box 25903
Trafalgar
4275
South Africa

To: Sansha Kohidh RD (SA)

Dear Sansha,

Thank you for reaching out to us.

This is to confirm that SAVS has reviewed your Master of Science (Dietetics) topic: "*The motives and challenges facing South African vegans and the nutritional diversity of their diet*" and that we're happy for you to use our social media platforms to collect your data by means of an online questionnaire. We request that you let us have a look at your copy before posting.

Please let me know if you need anything

else. Looking forward to it!

Kind regards, Dylan Barsby
M: +44 773 666 9757
E: dylan@vegansociety.org.za

APPENDIX D: Ethical clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

06 February 2019

Ms S Kohidh (211516794)
School of Agriculture, Earth and Environmental Sciences
College of Agriculture, Engineering and Science
sanshak@hotmail.co.za

Protocol: The motives and challenges facing South African vegans and the nutritional diversity of their diet.
Degree: MSc Dietetics **BREC REF: BE712/18**

EXPEDITED APPLICATION: APPROVAL LETTER

A sub-committee of the Biomedical Research Ethics Committee has considered and noted your application received 07 December 2018.

The study was provisionally approved pending appropriate responses to queries raised. Your response received on 25 January 2019 to BREC correspondence dated 24 January 2019 has been noted by a sub-committee of the Biomedical Research Ethics Committee. The conditions have been met and the study is given **full ethics approval** and may begin as from 06 February 2019. Please ensure that site permissions are obtained and forwarded to BREC for approval before commencing research at a site.

This approval is valid for one year from **06 February 2019.** To ensure uninterrupted approval of this study beyond the approval expiry date, an application for recertification must be submitted to BREC on the appropriate BREC form 2-3 months before the expiry date.

Any amendments to this study, unless urgently required to ensure safety of participants, must be approved by BREC prior to implementation.

Your acceptance of this approval denotes your compliance with South African National Research Ethics Guidelines (2015), South African National Good Clinical Practice Guidelines (2006) (if applicable) and with UKZN BREC ethics requirements as contained in the UKZN BREC Terms of Reference and Standard Operating Procedures, all available at http://research.ukzn.ac.za/Research-Ethics/Biomedical-Research-Ethics.aspx.

BREC is registered with the South African National Health Research Ethics Council (REC-290408-009). BREC has US Office for Human Research Protections (OHRP) Federal-wide Assurance (FWA 678).

The sub-committee's decision will be **noted** by a full Committee at its next meeting taking place on **12 February 2019.**

We wish you well with this study. We would appreciate receiving copies of all publications arising out of this study.

Yours sincerely [redacted]

Professor V Rambiritch
Chair: Biomedical Research Ethics Committee

Supervisor: WilesN@ukzn.ac.za

APPENDIX E: Informed consent

Discipline of Dietetics and Human Nutrition

University of KwaZulu- Natal

Pietermaritzburg Campus

06 August 2019

Good day Participant,

My name is Sansha Kohidh and I am currently registered as a Masters Student at the University of KwaZulu-Natal Pietermaritzburg, South Africa. My contact number is 0795652546 and my email address is sanshak@hotmail.co.za

You are being invited to consider participating in a study that involves research study to investigate the motives and challenges facing South African vegans and the nutritional diversity of their diet.

The objectives of the study are as follows:

- To determine the socio-demographic characteristics of vegans
- To determine the factors that influence an individual to become a vegan
- To determine the challenges associated with becoming a vegan and how these challenges were overcome
- To determine the nutritional quality of the foods consumed in a vegan diet

This study involves an online questionnaire that will be available on the South African Vegan Society Facebook page for all South African vegans to voluntarily complete. Each participant should complete the questionnaire once. All information obtained from the questionnaires will be kept confidential.

It is predicted that there are millions of individuals following veganism in different countries around the world. Therefore, sound knowledge is needed to understand the progression into the vegan diet and nutritional quality of the diet. This topic is yet to be explored in South African literature and this research will assist in expanding individuals' knowledge on veganism in South Africa.

This study has been ethically reviewed and approved by the UKZN Biomedical research Ethics Committee (approval number BE712/18).

In the event of any problems or concerns/questions you may contact my research supervisor Dr Nicola Wiles or the Biomedical Research Ethics Committee.

CONTACT DETAILS:

Research Supervisor: Dr Nicola Wiles

Email: wilesn@ukzn.ac.za

Contact: 033 260 5430

Researcher: Sansha Kohidh

Email:sanshak@hotmail.co.za

Contact: 079 5652 546

BIOMEDICAL RESEARCH ETHICS ADMINISTRATION:

Research Office, Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 2604609
Email: BREC@ukzn.ac.za

Participation in this research is voluntary and you may withdraw participation at any point. The event of refusal/withdrawal of participation will not have any negative effect on you. All answers will be kept anonymous and will not be shared with any third party without your signed consent.

In order to maintain confidentiality, all personal data will be used solely for the purpose of the study and will not be disclosed to the public. No names will be used when drawing conclusions and/or writing up results. The results of the study will be submitted for publication in a journal.

Kind Regards,

Sansha Kohidh RD (SA)