

**DIET AND LIPID PROFILE OF VEGETARIANS AND NON-
VEGETARIANS IN SOME SELECTED COMMUNITIES IN ACCRA**

BY

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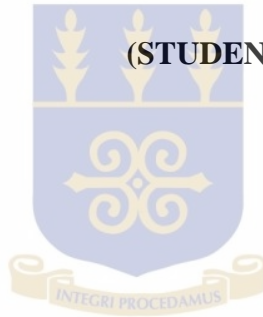
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DECLARATION / SIGNATURE

I, Cedell Naa Oblikai Tetteh, hereby declare that this dissertation is the result of my own diligent research work under the supervision of Dr. George Asare (Maj. Rtd) and Dr. Matilda Asante of the School of Allied Health Sciences, University of Ghana. All references cited in this work have been fully acknowledged.

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ABSTRACT

Background: Vegetarianism is the practice of abstaining mainly from the consumption of meat, poultry, seafood and flesh of any animal while depending mainly on foods of plant origin. Vegetarian diets are typically low in fat, particularly saturated fat and high in dietary fibre, vegetables, whole grains and legumes. Plasma total cholesterol and low density lipoproteins (LDL) cholesterol levels of vegetarians are consistently lower than non- vegetarians. Although vegetarians do not eat meat there may be other sources of saturated fat in the form of unhealthy fat and oils in their diet which may affect their lipid profile. There is paucity of data on dietary composition of vegetarians in Ghana.

Objectives: The main aim of the study was to compare diet and serum lipid profile of vegetarians and non -vegetarians in Accra.

Methodology: A case – control study was carried out involving 54 vegetarians and 59 age and gender matched non-vegetarians. Blood pressure and anthropometric measurement (weight, height, visceral fat and body fat) was measured for all the participants. A structured questionnaire was used to obtain socio- demographic data of the participants. Dietary intake was assessed using a 24-hour recall and food frequency questionnaire. Overnight fasting venous blood samples were collected for analysis of serum lipid profile.

Results: The mean age of vegetarians and non-vegetarians was 54.24 ± 13.86 and 53.9 ± 11.2 years, respectively. No significant differences were found regarding nutritional status based on Body Mass Index (BMI). Diastolic blood pressure was significantly higher in vegetarians compared to non-vegetarians ($p = 0.011$). With the exception of HDL- C, serum triglycerides, total cholesterol and

LDL cholesterol were not significantly different between vegetarians and non-vegetarians ($p = 0.012$). Most of the protein intakes of the vegetarians (77.8%) were below the recommended daily intake. Majority of the vegetarians had lower intakes of vitamin B₁₂ and B₆ (85.2% and 83.3% respectively) than the recommended nutrient intake. Also the mean intake of folate was significantly different between vegetarians than the non-vegetarians ($p= 0.002$).

Conclusion: There was no significant difference in BMI between the two dietary groups. The study was not able to clearly establish whether vegetarian diet improves the lipid status of an individual. With the exception of protein, there were no significant differences in the macro nutrients intake between the vegetarians and non- vegetarians ($p = 0.001$).

Keywords: Vegetarian, Non-vegetarian, Lipid profile and Diet



DEDICATION

In loving memory of my late grandmothers, Agnes Tetteh and Esther Laryea who wished to see me become a dietitian. Unfortunately, they passed away during the first year of my programme and never witnessed the realisation of their dreams.



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LIST OF ABBREVIATIONS

ADA	-	American Dietetics Association
BMI	-	Body Mass Index
BP	-	Blood Pressure
CVD	-	Cardiovascular Disease
HDL- C	-	High- density lipoproteins-Cholesterol
LDL- C	-	Low – density lipoproteins -Cholesterol
MUFA	-	Mono – unsaturated fatty acids
NV	-	Non- vegetarians
PUFA	-	Poly unsaturated fatty acids
RDI	-	Recommended daily intake
SFA	-	Saturated fatty acids
T-C	-	Total- cholesterol
TG	-	Triglycerides
V	-	Vegetarians
VLDL-C	-	Very low-density lipoproteins cholesterol

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Vegetarianism dates back to a time before recorded history. Many anthropologists believe that early humans ate mainly plant foods, being more like gatherers than hunters (Spencer, 2000). According to them, the natural diet of man consists of fruits, nuts and grains, and not meat (Spencer, 2000). This view is supported by the fact that the human digestive system resembles that of other plant eaters rather than meat eaters (Schnitzer, 2005). Vegetarianism involves the practice of following a diet that includes fruits, vegetables, cereals and grains, nuts and seeds with or without dairy products or eggs (Nivedita *et al.*, 2012). A vegetarian does not eat meat, including poultry, fish, crustaceans and shell fish and may also abstain from products of animal sources such as animal -derived rennet and gelatin (Marsh *et al.*, 2011). Vegetarians are categorized by the type of animal foods restricted in their diet. There is a wide debate as to whether it is better to be a vegetarian or non - vegetarian. Most people are of the view that non-vegetarian foods are the only source for getting all the nutrients that can make them strong, healthy and active. There are a number of reasons why people go on a non- vegetarian diet. The reason for choosing a vegetarian diet goes beyond health and well-being and it includes among others religious, economical, and social concerns (Leitzmann, 2005). Improved health is one of the many reasons people choose to adopt a vegetarian diet and there is now a wealth of evidence to support the health benefits of a vegetarian diet (Marsh *et al.*, 2011).

Vegetarians usually consume more fruits and vegetables than non-vegetarians and because of their restricted consumption of animal sources of foods, they have lower intake of saturated fatty acids and increased intake of fibre and various kinds of antioxidants, compared to those of non-vegetarian origin (Rauma and Mykann 2000). This type of diet helps improve antioxidant status lowers oxidative stress and reduces blood lipid levels (Garcia *et al.*, 2008). Vegetarians generally have a lower body mass index (BMI) and tend to be more health - conscious than non-vegetarians (Bedford and Barr, 2005), possibly because of their reduced total energy consumption, although increased exercise may also play a role (American Dietetic Association, 2007).

Furthermore, a number of studies have shown increased longevity among vegetarians (Singh *et al.*, 2003). It is likely that these benefits result from both reduced consumption of potentially harmful dietary components, including saturated fat, cholesterol, animal protein (red meat) and an increased consumption of beneficial dietary components of fruits, vegetables, whole grains, legumes, and nuts which are rich in dietary fibre, antioxidants and phytochemicals (Sebate, 2003). In fact, the nutritional and health consequences of vegetarians are neither necessarily all good nor all bad. The ultimate balance that vegetarians diet strike with respect to health depends on the extent to which they are integrated with current knowledge of nutritional science in dietary planning (Dwyer, 1991).

The major risk involved in vegetarian diets is “deficiency diseases” or malnutrition, secondary to the presence of some other associated cause that is neglected or untreated (Dwyer, 1991). The risks of deficiency also rise during

certain times of life including pregnancy and lactation, infancy, early childhood and the rapid period of growth in adolescence when nutrient needs are particularly high (Dwyer, 1991).

Serum lipids are important determinants of cardiovascular risks behaviour associated with urbanization, and increased saturated fat consumption, as well as decreased physical activity have all been well cited and are associated with adverse changes in the lipid profile (Marlow *et al.*, 2009). Elevated levels of cholesterol, triglycerides and low density lipoproteins (LDL) - cholesterol are documented as risk factors of arterogenesis (Richter *et al.*, 2004).

The vegetarian diet has been found to be associated with some degree of protection against hypertension and higher blood lipids (Richter *et al.*, 2004). However, most of these studies have been conducted in Caucasians and it remains unclear as to how much protection against hypertension and other risk factors for cardiovascular diseases is afforded by vegetarian diet in African Americans (Nivedita *et al.*, 2012). Studies have not yet been conducted to find whether Ghanaian vegetarians generally have lower plasma low density lipoprotein cholesterol like other vegetarians in certain parts of the world. There is also lack of information on diet quality of vegetarians in Ghana and this is worth investigating.

1.2 Problem Statement

There are indications that vegetarianism is increasing in Ghana and this is evidenced in the springing up of vegetarian restaurants. A vegetarian diet is associated with many health benefits because of its high content of fibre, folic acid, vitamins C, vitamin E, magnesium, phytochemicals and a fat content that is more unsaturated (Davey *et al.*, 2003). Although vegetarians do not eat meat there may be other sources of saturated fat in the form of unhealthy fats and oils in their diet which may affect their lipid profile. The American Dietetic Association (ADA) states that appropriately planned vegetarian diets are healthful and nutritionally adequate (ADA, 2007). There is paucity of data on dietary composition of vegetarians in Ghana. This makes it difficult for dietitians to approve this diet for individuals who want to practice vegetarian diet as part of a lipid lowering diet.

1.3 Significance of the Study

The findings of this study may provide useful information on diet quality of vegetarians in Ghana. The results of the study may reveal whether the lower intake of cholesterol, saturated fat and increase in cereals, fruits and vegetables will contribute to lower blood lipid concentrations in vegetarians. In addition, information obtained from the study may provide an in-depth nutritional knowledge on the risks and benefits that are associated with vegetarianism. This information will be useful for dietitians, nutrition-related professionals, the Vegetarian Association of Ghana and the general public. The study will also provide data on the lipid profile of vegetarians in Ghana. Serum lipids are one of the main determinants of cardiovascular diseases (CVD). In conducting this

study, specific constituent of the vegetarian diet which affords protection against CVD will be known.

1.4 Hypotheses

1. There is no significant difference in the dietary intake and lipid profile of vegetarians and non- vegetarians.
2. There is no significant difference between the Body Mass Index (BMI), blood pressure (BP), visceral fat, and body fat among vegetarians and non- vegetarians.

1.5 Aims and Objectives

1.5.1 Aim

The main aim of the study was to compare diet and serum lipid profile of vegetarians and non- vegetarians in selected communities in Accra.

1.5.2 Specific Objectives

The specific objectives of the study were:

1. To access sociodemographic and lifestyle behaviours of vegetarians and non – vegetarians.
2. To examine the effects of dietary pattern and nutrient intake of vegetarians and non- vegetarians on lipid profile.
3. To compare BMI, BP, visceral fat and percentage body fat of vegetarians and non vegetarians.

4. To determine the association between nutrient intake (Saturated Fatty Acids, Polyunsaturated Fatty Acids and Monounsaturated Fatty Acids) and lipid profile of vegetarians and non-vegetarians.
5. To measure biomarkers of lipid profile (total cholesterol, high -density lipoproteins, low density- lipoproteins and triglycerides) of vegetarians and non-vegetarians.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

The term "vegetarian" was created by the British Vegetarian Society in the mid-1800. The Latin root of the word refers to the source of life (Spencer, 2000). However, vegetarianism itself dates back to a time before recorded history. Many anthropologists believe that most early humans are primarily plant foods, being more like gatherers than hunters. This view is supported by the fact that the human digestive system resembles that of other plant-eaters rather than that of meat-eaters (Schnitzer, 2005).

2.2 Early Times of Vegetarianism

Vegetarianism was not very popular in the U.S. until 1971, when Frances Moore Lappé's bestseller *Diet for a Small Planet* was published. Lappé devoted half of her book to the idea of "protein complementing" – for example how to serve beans and rice together for the protein to be “complete”. Many "would-be" vegetarians were discouraged about changing their diets because of the careful planning they thought was required in preparing a well balanced diet ([www.edu.pe.ca/sourishing/pages/Cmp6-03/Beth/homepage/historyofvegetarianism htm](http://www.edu.pe.ca/sourishing/pages/Cmp6-03/Beth/homepage/historyofvegetarianism.htm)).

Those legends were all destroyed by John Robbins' 1987 book "*Diet for a New America*". He demonstrated how dangerous meat-based diets are, and how healthy and safe vegetarian diet is. Robbins' book restarted the vegetarian

movement in the U.S., as it instigated the vegan movement, and helped introduce the term "vegan" into the American vocabulary.

In the early 90's, the American Dietetic Association published a position paper endorsing vegetarian diets, and support for vegetarian diets started to be seen throughout the medical community. Today, recognition of vegetarians by medical authorities and the general public is of significant importance despite some discrimination they sometimes encounter in their lives (Spencer, 2000).

2.3 Reasons for Adopting a Vegetarian Diet

The reason for choosing a vegetarian diet often goes beyond health and well-being. It includes among others economical, cosmetic and social influence (Leitzmann, 2005). Melina and Davies (2003) reported that the main four primary reasons for people choosing a vegetarian diet include:

1. To support personal health and healing.
2. To promote reverence for life.
3. To protect the environment, and
4. To uphold religious and philosophical principles

2.3.1 Support Personal Health and Healing

Health is the most commonly cited reason for becoming vegetarian. Most people now recognize that vegetarian diets are not only a healthy choice but are likely to protect against diseases (Leitzmann, 2005). The potential health advantage of vegetarian diet includes a healthy body weight and reduced chronic diseases such as hypertension, obesity and certain cancers. There is good evidence that a

vegetarian diet and life-styles have positive effects on weight, blood pressure and coronary artery disease (Nivedita *et al.*, 2011).

2.3.2 Protect the Environment

Choosing a vegetarian diet can help protect the environment, prevent global warming, rain forest destruction and pollution, while saving water and other precious resources (Marlow *et al.*, 2009). Vegetarians believe that vegetarianism has a positive effect on the environment and argue that the massive products for human consumption can lead to land degradation, water and air pollution and even change the climate (Baroni *et al.*, 2007).

In 2000, the World Health Organization (WHO) reported that one out of every three people suffered from malnutrition as a result of rapid population growth and diminished land, water and energy resources. Therefore in response to the increasing public concerns about our impact on the earth an Italian study that evaluated the environmental impact on non- vegetarians and vegetarians/vegans diet and concluded that meat-based diets, strain the environment mostly through water pollution compared to the plant- based diets (Baroni *et al.*,2007).

2.3.3 Uphold Religious or Philosophical Principles

Some individuals choose a vegetarian diet in keeping with their religion or the philosophy of a movement. Major world religions that promote vegetarian or vegan diet as part of their basic teachings include Buddhism, Jainism, Hinduism, Hare Krishna and the Seventh Day Adventist (Christian religious group). In addition, many religions that do not explicitly promote plant- based diets have

sub groups that promote vegetarian lifestyles. Good examples are the Christian Vegetarian Association and Muslim Vegan /Vegetarian Society (Melina and Davies, 2003).

2.4 Types of Vegetarian

There are four main types of vegetarians: lacto-vegetarian, ovo-vegetarian, lacto-ovo -vegetarian, and vegan (Marsh *et al.*, 2011). Other types of vegetarian diet are pescatarian, semi vegetarian and fruitarians (Robinson and Hackett, 1995).

2.4.1 Types of Vegetarian Diets

Lacto-vegetarian: - Consumes dairy products but not meat, eggs, poultry and sea food (Marsh *et al.*, 2011).

Lacto-ovo-vegetarian: - Consumes dairy products and eggs but not meat, poultry or seafood (Marsh *et al.*, 2011).

Ovo-vegetarian: - Consumes eggs but avoids dairy products, meat, poultry, fish, and other seafood.

Vegans: - They exclude all animal flesh and products, derived ingredients and additives. They avoid animal products not only in their diet but also in every aspect of their life (Robinson and Hackett, 1995). Many vegans may also avoid honey (Marsh *et al.*, 2011).

Semi Vegetarian: - Occasionally eats meat, poultry and fish (Robinson and Hackett, 1995).

Pescatarian: - Consumes fish and possibly other seafood but excludes red meat and poultry (Robinson and Hackett, 1995).

Fruitarian: - This type of vegetarian mainly eats raw fruits, vegetables, nuts, seeds, sprouted pulses and grains (Robinson and Hackett, 1995).

2.5 Nutritional Implications of the Vegetarian Diet

Some nutrients can be more difficult to obtain from a vegetarian diet, but careful planning and in some cases the use of fortified foods or supplements can ensure that individual nutritional needs are met while maximizing the health benefits of the vegetarian and vegan diet.

The American Dietetic Association reported in their position statement that well planned vegetarian diets, including vegan diets are nutritionally adequate and are appropriate for individuals during all stages of life (Craig and Mandel 2009). Vegetarians who do not adequately plan their diet and do not replace vital sources of proteins, vitamins and minerals may be putting themselves and their families at risk (Thomas and Bishop, 2007). In addition to iron and zinc, unplanned vegan diets are often low in kilocalories, calcium, vitamin B₁₂ and vitamin D unless supplementary sources of these vitamins are provided, since plant foods contain no known sources of these vitamins (Dwyer, 1991).

2.6.0 Comparison in Energy and Nutrients Intake of Vegetarians and Non-Vegetarians

2.6.1 Energy

Vegetarians tend to have a similar energy intake to non-vegetarians (Draper *et al.*, 1993) but the energy intake of vegans tends to be lower (Davey *et al.*, 2003) in men. In order to prevent the catabolism of dietary protein to provide energy, it is

important to ensure sufficient energy intake for growth by including more of energy dense foods such as nuts, dried fruits, soya cheese, vegetable oils and margarines. There is evidenced that a lower energy diet can modulate blood lipids and reduce atherosclerosis and coronary deaths (Kelly *et al.*, 2004).

2.6.2 Protein

Although the adequacy of proteins in vegetarian diets is sometimes questioned, vegetarian diets usually exceed protein requirements, although they may provide less protein than a non- vegetarian diet (Craig and Mandel, 2009). The main nutritional differences between plant and animal protein source diets is the higher and more bioavailable micronutrient content of the latter. It was once thought that certain combinations of plants foods had to be eaten at the same meal to ensure sufficient essential amino acids. Strict protein combining is not necessary, but adequate energy food intake eaten including a variety of plant foods such as legumes, whole grains, nuts seeds, soy products and vegetables are essential in providing dietary protein (Young and Pellet, 1994; America Dietetics Association, 2007).

2.6.3 Fats and Essential Fatty Acids

The diet of semi - vegetarian and lacto- ovo vegetarians have been found to contain similar quantities of total fat (Draper *et al.*, 1993) and essential fatty acids to the non-vegetarian diet (Davis and Kris-Etherton, 2003). The EPIC Oxford Study (Davey *et al.*, 2003) found that total fat intake of vegetarians compared with non-vegetarians was significantly lower in vegans than the non-vegetarians. Vegans diets have been shown to be lower in saturated fatty acids (SFA) and

higher in polyunsaturated fatty acids (PUFA) than vegetarian diets, and both types of diets tend to be lower in saturated fat than diet containing meat. There is however the potential for vegan or vegetarian diets to be high in saturated fat if oils such as coconut and palm oil are used regularly (Thomas and Bishop, 2007).

Omega-3 fatty acids play an important role in health and diseases, particularly with respect to cardiovascular health and also inflammatory diseases (Yashodhora *et al.*, 2009). Because fish and seafood are the main sources of long chain omega-3 fatty acids, obtaining an adequate intake of omega-3 fatty acids on a vegetarian diet will be difficult (Marsh *et al.*, 2011). Vegetarians obtain omega-3 fatty acids predominantly from the omega-3 fatty acid α -linolenic acid (ALA), but there is debate over the efficiency of conversion of ALA to the longer-chain docosahexaenoic acid (DHA) and eicosapentaenoic acid: EPA (Davis and Kris-Etherton, 2003). For the vegetarian, it has been suggested that a ratio range 2:1 to 4:1 of omega-6 to omega-3 would maximize conversion (Davis and Kris-Etherton, 2003) and reduce any thrombotic tendency that might increase their generally low risk of CVD (Ball and Bartlett, 1999). Omega 3 fatty acids lower triglycerides levels by inhibiting VLDL synthesis (Mahan *et al.*, 2012).

There is some evidence to suggest that the requirement for omega-3 fatty acids in vegetarians is higher because of the inefficient conversion of ALA to EPA and DHA and the lack of direct sources of these fatty acids (Key *et al.*, 2006). To optimize Omega-3 fatty acid status in vegetarians, it is best to avoid saturated and trans fat in favour of monounsaturated fats rather than Omega-6 fats. The richest sources of ALA include chia seeds, linseeds and flaxseed oil. Walnuts and soy

products also provide a good source of ALA, with smaller amounts presents in green leafy vegetables (Marsh *et al.*, 2011).

2.6.4 Carbohydrates

Vegetarian diets can be high in carbohydrates and vegans have the higher carbohydrate intakes providing 50-65% of total energy intake (Davey *et al.*, 2003). Total sugar content is similar to that of a meat - containing diet (Draper *et al.*, 1993) although the intake of sugars from fruit may be high in vegetarians and vegans.

2.6.5 Vitamins

Vitamins intake of vegetarians are generally adequate, but vegans may have lower than recommended intakes of vitamin B₁₂ and vitamin D (Draper *et al.*, 1993).

2.6.5.1 Vitamin D

Vitamin D is best known for its role in bone health. Very little calcium is absorbed when vitamin D levels are low. A relatively new era of research is its role in the prevention of diseases such as cancer, heart disease, strokes, arthritis, multiple sclerosis and even depression (Holick *et al.*, 2008). The main source of vitamin D is exposure to the sun. The skin can produce what is needed, however the amount produced depends on many factors, including the time of day, skin pigmentation, use of sunscreens, age and length of exposure (Craig and Mandel, 2009).

Vitamin D is found naturally in only a few foods such as oily fish (cod liver oil), wild mushrooms and eggs. Because only a few products contain Vitamin D, it is often added to some dairy products and other fortified foods. Although lacto- ovo vegetarians obtain some vitamin D from eggs and dairy products, most of their intakes come from fortified foods. Vegans rely only on fortified foods to obtain adequate dietary intake (Marsh *et al.*, 2011).

Studies have shown that vegetarians and particularly vegans have a lower intake of vitamin D compared to non- vegetarians (Outila *et al.*, 2000; Holick *et al.*, 2008). The Adventist Health Study found no relationship between serum vitamin D concentration and vegetarian status, suggesting that factors other than diet have a greater influence on vitamin D levels (Chan *et al.*, 2009). If sun exposure and intake of foods fortified with vitamin D is inadequate to meet the requirements, vitamin D supplements are recommended (Craig and Mandel, 2009).

2.6.5.2 Vitamin B₁₂ (Cobalamin)

Vitamin B₁₂ is found only in animal products, so a deficiency of this vitamin is a potential concern for anyone following a vegan or vegetarian diet. Some studies have found that serum levels of vitamin B₁₂ are generally lower in vegetarians, especially vegans, decreasing with increasing duration of following the vegetarian diet (Allen, 2009; Gilsing and Crowe 2010). Vitamin B₁₂ is unique among the vitamins in that it is synthesized by bacteria, fungi and certain algae and from microbial actions in animals.

Although plant foods, including mushrooms, tempah, miso and sea vegetables are often reported to provide some source of vitamin B₁₂, these are not reliable sources of this vitamin. These foods contain an inactive form of B₁₂, which interferes with the normal absorption and metabolism of the active form in the body and will not prevent a deficiency (Watanbe, 2007). A reliable source of biologically active vitamin B₁₂ is recommended on a regular basis, either from fortified foods or supplements. It is recommended that all vegans should supplement their diet with vitamin B₁₂ and this is especially important for women who are pregnant or breastfeeding to prevent deficiency in their babies (Dror and Allen, 2008).

2.6.6 Calcium

An adequate calcium intake is needed as part of a balanced diet throughout life to help reduce the risk of osteoporosis (Weaver *et al.*, 1999). Research has found that calcium intake is generally similar between lacto-ovo vegetarians and non-vegetarians, (Weaver *et al.*, 1999) although vegans typically have lower intake (Davey *et al.*, 2003; Appleby, 2007). However, the lower fat intake of vegetarians may aid calcium bioavailability, which has been shown to be inversely related to fatty acid chain length and fatty phytate, and as a result foods such as spinach or cabbage may not be a good source of calcium despite their high calcium content (Davey *et al.*, 2003). For lacto-ovo vegetarians, dairy products provide plenty of calcium. Vegans can obtain their calcium from fortified soy milk and yoghurt, tofu or other plant foods rich in calcium. Plant foods that have high calcium bioavailability include low oxalate green vegetables such as broccoli and okra,

which have more bioavailability of 50- 60% compared with 32% from cow milk (Weaver *et al.*, 1999).

2.6.7 Iron

There are two types of iron found in food. Heme iron found only in animal foods such as meat, poultry and fish and non- heme iron present in animal food including eggs and plant foods such as legumes, whole grains, nuts, seeds as well as dark green leafy vegetables. Non-heme iron is not as well absorbed by the body but its absorption is increased significantly in the presence of vitamin C (Cook, 1990). Vegetarian diets can contain as much or more iron (non- heme) than mixed diets, primarily from whole grain bread and cereals including fortified cereals (Davey *et al.*, 2003). Surprisingly, iron deficiency is not less common in vegetarians although iron stores (as shown by ferritin levels) are often lower (Ball and Barlett, 1999; Messina *et al.*, 2004).

2.6.8 Zinc

Vegetarians and vegans of all ages generally have a dietary intake of zinc similar to or higher than that of non-vegetarians (Draper *et al.*, 1993). Most vegetarians have adequate blood levels although children and infants may be at risk due to their higher requirements (Gibson *et al.*, 2006). Zinc is similar to iron in that the richest sources are found in animal foods. Absorption of zinc is reduced by phytate found in wheat bran, whole grains and legumes. However, processing food by leavening (yeast in breads), soaking, fermenting or sprouting can reduce phytate levels and make zinc more readily available (Gibson *et al.*, 2006). Again, like iron, commonly eaten plant foods such as nuts, seeds and whole grains are

high in zinc and may be the reason for the apparent satisfactory status in vegetarians (Marsh *et al.*, 2011).

2.7 Overall Health and Longevity of Vegetarians

Although vegetarians generally have a lower BMI and tend to be more health conscious than non-vegetarians (Bedford and Barr, 2005), a number of studies have shown increased longevity among vegetarians (Fraser, 2009; Singh *et al.*, 2003). It is likely that these benefits result from both reduced consumption of potentially harmful dietary components including saturated fat, cholesterol, red meat and increased consumption of beneficial dietary components including fruit, vegetables, whole grains, legumes and nuts which are rich in dietary antioxidants and phytochemicals (Sebate, 2003). Research has linked higher intake of red meat and processed meat with an increased risk of obesity, type II diabetes (Dam *et al.*, 2004) and some type of cancers (Bazzano *et al.*, 2001). Low meat intake on the other hand has been associated with greater longevity (Tonstand *et al.*, 2009). Vegetarians are generally more healthy people, as they tend to practice healthy, active, lifestyles and refrain from smoking (Singh *et al.* 2003). A vegetarian diet coupled with regular exercise and abstinence from smoking; seem to be cheap, physiological and safe approach for the prevention and possibly management of modern lifestyle diseases (Mahan *et al.*, 2012).

2.8.0 Blood Lipids and Lipoproteins

Because lipid is not water soluble, blood lipids (cholesterol, triglycerides and phospholipids) are transported in the blood bound to proteins (Mahan *et al.*, 2012). These complex particles called lipoproteins vary in composition, size

and density. Lipoproteins measured in clinical practice (chylomicrons, very low density lipoproteins [VLDLs] LDLs and HDLs) consist of varying amounts of triglyceride, cholesterol, phospholipid and protein. Each class of lipoproteins actually represents a continuum of particles (Mahan *et al.*, 2012). The protein portion of the lipoprotein is called *apolipoprotein* (Nelms *et al.*, 2011). The physiologic role of lipoproteins includes transporting lipids to cells for energy, storage, or use as a substrate for synthesis of other compounds such as prostaglandins and leukotrienes (Mahan *et al.*, 2012). In epidemiologic studies high-fat diets of people in Mediterranean countries have been associated with low blood cholesterol levels and CHD incidence (Trichopoulou *et al.*, 2003). Among the Mediterraneans, the main fat source is olive oil, which is high in monounsaturated fatty acids (MUFAs). This observation led to many studies on the benefits of high- MUFA diets. Mediterranean- type step I diet was shown to reduce recurrent CVD by 50- 70% (De Logeril, 1999). This diet emphasises fruits, root vegetables, green leafy vegetables, cereals, fish, and foods high in alpha linolenic acid, vegetable oil products and other products made with non hydrogenated oils, nuts and seed. (Kris- Etherton *et al.*, 2001). Although higher – fat (low in SFAs with MUFAs as the predominant fat) can lower blood cholesterol, they should be used with caution because of the caloric density of high-fat diets. The results of a clinical trial have shown new atherosclerotic lesions in men who consume higher fat diet (Mahan *et al.*, 2012).

2.8.1 Lipids Metabolism

Lipids such as cholesterol and triglycerides are essential substrates for many body processes. Cholesterol is a structural component of cell membranes and nerve

sheaths and is required for the synthesis of steroid and adrenocortical hormones and bile salts. Triglyceride is required as an energy source, its constituent fatty acids and glycerol either being immediately metabolized or reconstituted into triglycerides and stored to meet future energy needs (Thomas and Bishop, 2007).

Lipid metabolism is the process by which the initially large lipid- filled, low-density complexes transporting either diet-derived or endogenously synthesized lipids undergo gradual conversion to smaller, more dense particles rich in protein and phospholipids prior to their utilization or excretion. The body synthesizes at least as much cholesterol as is obtained from the diet every day (Thomas and Bishop, 2007).

2.8.2 Chylomicrons

Chylomicrons are the largest particle that transports dietary fat and cholesterol from the small intestine to the liver and periphery (Mahan *et al.*, 2012). Chylomicrons transport dietary lipids after intestinal absorption (Nelms *et al.*, 2011). The liver metabolizes these chylomicron remnants, but some deliver cholesterol to the arterial wall and thus are considered atherogenic. Consumption of high-fat meals produces more chylomicrons and remnants.

2.8.3 Very Low- Density Lipoproteins (VLDL)

They are synthesized by the liver from chylomicron remnants and comprise mainly of triglycerides (Thomas and Bishop, 2007). The large buoyant VLDL particle is believed to be non-atherogenic (Mahan *et al.*, 2012). Vegetarian diet and low fat diet increase the formation of large VLDL particles. VLDL maintains

a supply of triglycerides for energy production to body tissues in the fasting state (Thomas and Bishop, 2007).

2.8.4 Low - Density Lipoproteins Cholesterol (LDL- C)

LDL-C is the primary cholesterol carried in the blood, formed by the breakdown of VLDL (Mahan *et al.*, 2012). As the triglycerides are removed by body cells, the remaining cholesterol is concentrated within LDL for transfer to the peripheral tissues. About 60% of the total circulating cholesterol is contained within the LDL - C (Thomas and Bishop, 2007). Low- density lipoproteins cholesterol has been linked to atherosclerosis, cardiovascular heart disease (CHD), and stroke (Mahan *et al.*, 2012). A decrease of 1 mg/dL in LDL - C results in about a 1- 2% decrease in the relative risk of CHD. According to the American Heart Association (2012), for persons who are without disease, LDL-C levels are classified as optimal, (≤ 100 mg/dL) near optimal, (≤ 129 mg/dL), borderline risk, (130 to 159 mg/dL), high risk (160 to 189 mg/dL) and very high risk (≥ 190 mg/dL). Factors that increase LDL- C include aging genetics diet, obesity, nephritic syndrome and some steroid and antihypertensive drugs (Mahan *et al.*, 2012).

Dietary fibres especially soluble fibres such as guar, gum, pectin, and oat gum have been shown to lower cholesterol levels, primarily by lowering LDL-C and triglyceride levels without consistent effect on HDL-C (Taku *et al.*, 2007). Because vegetarians especially vegans may have fibre intake two to three times more than those of non -vegetarians (Sack, 2006) fibre intake may contribute to vegetarians favourable lipid profile. In a study of the metabolic effect of dietary

lipids involved in feeding a lacto-ovo-vegetarian diet and non-vegetarian diet, the findings of the study indicated that lacto-ovo vegetarian diet resulted in lower total and LDL-cholesterol levels but no change in total HDL levels than the non-vegetarian diet (Cooper *et al.*, 1982). Another study compared plasma lipids of dedicated vegans with those of lacto vegetarians; the findings revealed a greater than 20% higher total and LDL-cholesterol level and 7% higher HDL-cholesterol existed in lacto-vegetarians (Sack, 2006). The study concluded that fatty dairy products affect LDL-C more than HDL-C.

Soy protein has been shown to reduce LDL-C levels. A meta-analysis of 30 studies demonstrated a small but significant reduction in both total and LDL-cholesterol, with the consumption of 25 g of soy protein daily (Harland and Haffner, 2008).

2.8.5 High-Density Lipoproteins Cholesterol (HDL-C)

High-density lipoproteins particles contain more proteins than any of the other lipoproteins (Mahan *et al.*, 2012). The main apolipoprotein in HDL-C is the anti-inflammatory, antioxidant protein that also helps to remove cholesterol from the arterial wall to the liver (Barter and Rye, 2006). HDL-C is associated with cholesterol removal. High concentrations are beneficial and inversely related to Cardiovascular Heart Disease (CHD). Many population studies have shown that HDL-C is a strong, negative independent predictor of CHD incidence and mortality in men and women (Rizzo *et al.*, 2010). Because of the inverse relationship between HDL-C and CHD risk, a high HDL cholesterol level (>60 mg/dL) is now considered a negative risk factor and low HDL cholesterol level

(<40 mg/dL) is considered to be a positive risk factor for CHD and stroke (NCEP, 2002).

Major factors that increase HDL- C levels are exogenous estrogen, intensive exercise, and loss of excess body fat and moderate consumption of alcohol (Mahan *et al.*, 2012). The vegetarian diet, when it comes to its relationship with HDL- C, level is more than just eliminating meat and meat products. Eliminating saturated fats and trans fat such as those found in butters and margarine will help raise the HDL-C level. Including monounsaturated and polyunsaturated fat in your diet on the other hand, will raise your HDL- C levels (Lee *et al.*, 2000). These good fats are found in legumes, nuts and oils such as canola and olive oils. The combination of raw and lightly cooked fruit and vegetables, whole grains, fibres and good fat will work to raise HDL - C levels without negatively affecting LDL- C (Jenkins *et al.*, 2002). It is for this reason that the lay public often refers HDL-C as “good” cholesterol. However, the cholesterol is neither good nor bad; it is the lipoprotein complex rather than the cholesterol being transported that is associated with CHD and stroke.

2.8.6 Total Blood Cholesterol (TC)

A total cholesterol measurement captures cholesterol contained in all lipoprotein fractions. 60 - 70% is carried on LDL, 20- 30% on HDL, and 10- 15% on VLDL (Mahan *et al.*, 2012). Clinical studies have consistently shown that a high serum cholesterol level and specifically high LDL - C is one of the key causes of CHD, stroke and mortality. Populations that consumed diet high in saturated fatty acids (SFAs) had increased blood cholesterol levels (Mahan *et al.*, 2012). Total

cholesterol however fluctuates over the course of days or weeks; therefore a diagnosis of hypercholesterolemia should not be based on a single measurement. It is recommended that several separate lipid measurements be made before diagnosis is confirmed and drug therapy started (JBS2, 2005). Numerous factors affect serum cholesterol levels, including age, diet high in fat, and genetics (Mahan *et al.*, 2012). Fasting total cholesterol levels are classified as normal (<200 mg/dL), borderline high (200 to 239 mg/dL), and high (>240 mg/dL) (Grundy *et al.*, 2004).

2.8.7 Total Triglycerides (TG)

The triglyceride - rich lipoproteins include chylomicrons, VLDLs and any remnants or intermediary products formed in metabolism (Mahan *et al.*, 2012). According to the National Cholesterol Education Programme (2002), fasting triglycerides levels are classified as normal (<150 mg/dL); borderline high (150 - 199 mg/dL); high (200 - 499 mg/dL) and very high (>500 mg/dL). There is evidence of a significant and independent association between serum triglycerides concentrations and the incidence of major coronary events (Assman *et al.*, 1996; Mahan *et al.*, 2012). A meta-analysis for controlling HDL - C suggested that for every 1 mmol /L rise in serum triglyceride concentration, the relative risk of CHD increased by 14% in men and 37% in women (Hokanson and Austin, 1996). Studies have concluded that individuals on vegetarian diet have lower lipid blood levels especially LDL- C and triglycerides as compared to individuals who consume meat (Mancila – Carvahho and Crew, 1990; Key, 1999). High consumption of rapidly absorbed refined carbohydrates can exacerbate

hypertriglyceridaemia, and all patients with raised triglycerides should be encouraged to choose low glycaemic index foods (Kumar *et al.*, 2012).

2.9 Dyslipidaemia

This previously was known as hyperlipidaemia and refers to the presence of abnormal blood concentration of lipid cholesterol and triglycerides (Thomas and Bishop, 2007). Typically, dyslipidemia is a condition in which LDL- C levels are elevated and HDL - C levels are low (Nelms *et al.*, 2011). Dyslipidaemia is usually symptomless and hence often remains undiagnosed. Specific signs and symptoms usually only occur if the elevation of the lipid level is particularly severe. Several forms of hyperlipidaemia have strong genetic components (Ottstad, 2006). Studies have identified some defects in genes that produce hepatic lipase, the liver enzyme involved in the triglycerides removal from the bloodstream (Cieveira, 2004).

Lipid profile is a blood test done to assess the status of fat metabolism in the body and is important in the heart diseases (Nivedita *et al.*, 2012). Alterations in the lipid profile have also been associated with age (Richter *et al.*, 2004). Estrogen is the major protective hormone in women and that protection is altered by menopause. Estrogen favourably affects the lipid profile. The incidence of abnormal lipid levels is higher in men, but after menopause this becomes more prevalent in women. Dietary and life-style factors may influence the age dependency of lipid profile (Dholpuria *et al.*, 2007).

2.10 Diet and Lifestyle Influences on Blood Lipids

2.10.1 Fats and Oils

Levels of cholesterol in blood can be reduced by substituting SFA with either MUFA or PUFA (Gardner and Kraemer, 1995; Poppitt *et al.*, 2002). Substituting saturated fat with unsaturated alternatives may also make lipid lowering diet more palatable and improve compliance. Tropical oils such as palm kernel and coconut oil are relatively high in saturated fats and should be used sparingly (Dreher, 1996). In view of this, US dietary recommendations, suggested that SFA should be reduced to 7-8%, MUFA should be increased to 13-15% and PUFA raised to 7-10% of daily energy with the total fat contributing to not more than 30% of all calories consumed (Kris Etherton, 1999; Grundy and Cleaman 1999).

2.10.2 Trans-Fatty Acids (t-FAs)

Trans-fatty acids are produced by hydrogenation of vegetable and marine oils to produce hardened fats such as margarines, cooking fats and shortenings. They have similar effects as saturated fats. These fatty acids should be limited, because they raise LDL cholesterol (Davey *et al.*, 2003). Metabolic studies have demonstrated that t-FAs render the plasma lipid profile even more atherogenic than saturated fatty acids, by not only elevating LDL – C to similar levels but also decreasing HDL – C levels (Judd *et al.*, 1994).

2.10.3 Dietary Cholesterol

Cholesterol in the blood and tissues is derived from two sources, diet and endogenous synthesis (Reddy and Katan, 2004). The influence of dietary cholesterol on blood cholesterol is relatively small because the liver synthesizes

cholesterol, and increased dietary intake tends to be offset by decreased endogenous production (Hopkins, 1992). Only extreme levels of intake, for example, a typically high consumption of eggs, shell fish, liver, dairy fat and meat are likely to have a significant elevating effect (Thomas and Bishop, 2007). The United States National Cholesterol Education Programme (2002) currently recommends an intake of less than 200 mg/day.

2.10.4 Omega-3 (n-3) Fatty Acids

Fish oils rich in n-3 fatty acids have been shown to reduce both fasting and postprandial blood triglycerides levels (Roche and Gibney, 2000; Castro *et al.*, 2005). Effective amounts range between therapeutic doses of 3-5 g/day in supplemental form and cardio protective intake of 1 g/day (Kris-Etherton *et al.*, 2003). The effect of fish oils on blood cholesterol is more equivocal. Some studies have found that supplemental doses elevate LDL cholesterol and reduce HDL cholesterol (British Nutrition Foundation, 1999). Some functional foods enriched with n-3 fatty acids have been found to increase total, LDL and HDL cholesterol (Castro *et al.*, 2005), whereas others appear to have no effect (British Nutrition Foundation, 1999).

2.10.5 Carbohydrate

Although carbohydrate has no direct effect on blood cholesterol levels, an increase in the proportion of energy derived from carbohydrate is usually encouraged as a means of keeping the proportion of saturated fat low (Nivedita *et al.*, 2011). A high carbohydrate diet appears to reduce HDL – C levels and increase the fraction of small dense LDL- C, both of which may impact adversely

on vascular disease (Reddy and Katan, 2004). Carbohydrate diets with high-glycaemic index might adversely impact on glucose control, with associated changes in plasma lipids (Willet *et al.*, 2000; Jenkins *et al.*, 2002). High consumption of rapidly absorbed refined carbohydrates can exacerbate hypertriglyceridaemia. All patients with raised triglycerides should be encouraged to choose low glycaemic index foods (Thomas and Bishop, 2007).

2.10.6 Soluble Fibre

Soluble fibre reduces total cholesterol and LDL - C (Brown *et al.*, 1999; Castro *et al.*, 2005) whereas insoluble fibre does not (Davey *et al.*, 2003). Soluble fibre in particular is thought to bind bile acids in the intestines and prevent re-absorption into the body, consequently decreasing circulating cholesterol in the blood (Bazzono *et al.*, 2001; Fardet, 2010). Although an increased intake of soluble fibre can be expected to have only limited impact on cholesterol levels, the cardio protective properties of foods rich in soluble fibre, particularly fruits and vegetables, are sufficient justification to advocate their increased consumption by dyslipidaemic patients (Bonnie *et al.*, 2010). Oats, a good source of soluble fibre may also be beneficial in respect of blood lipids (Davey *et al.*, 2003). The inclusion of oats as part of a diet low in saturated fat and a healthy lifestyle can help reduce blood cholesterol (JHCI, 2004).

Non-soy legumes are also a particularly good source of dietary fibre. Non-soy legumes include a variety of beans such as pinto, navy, kidney, lima, and black eye beans. Studies have shown that non-soy legumes consumption has been associated with a decrease in total cholesterol and LDL- C in clinical trials (Kushi

et al., 1999; Bazzano *et al.*, 2001; Anderson *et al.*, 2002). For instance, phytosterols, a component of plant cell membranes have been shown to reduce blood cholesterol levels and are present in small to moderate amounts in many types of non- soy legumes such as chick peas (Rochfert and Panozzo, 2007).

2.10.7 Alcohol

Alcohol raises both total triglyceride and HDL- C levels. The effect of alcohol on triglyceride levels are close dependent and are great in persons with triglyceride levels exceeding 150 mg/dL (Mahan *et al.*, 2012). Wine contains resveratrol, an antifungal compound in grape skins that has been associated with 11- 16% increase in HDL cholesterol (Hansen, 2005). The French may experience lower rates of CVD despite a high fat diet, mainly because of their consumption of red wine: “the French paradox” (Sun *et al.*, 2002). There is evidence that alcohol consumption modulates increase in HDL fractions, and stimulates reverse transportation of lipids (Baer *et al.*, 2002; Vander *et al.*, 2001). Alcohol consumption in excess of three drinks per day is associated with a rise in blood pressure and plasma triglyceride levels (Reddy and Katan, 2004).

2.10.8 Plant Sterols and Stanols

Plants do not contain cholesterol but they do have similar sterols components. There are over 60 different types of plant sterols but the most common is a sitosterol. Humans do not synthesis these sterols as they do for cholesterol, nor are they well absorbed (Nelms *et al.*, 2011). A number of studies have demonstrated that when these plant sterols are esterified to common fatty acids (Stanol ester or sterol ester), they can assist in lowering serum cholesterol and

LDL- C levels (Pinedo *et al.*, 2007; Van -Dam *et al.*, 2008). Consuming 2 g/day of plant sterols or stanols has been shown to reduce LDL – C by about 10% within 2 – 3 weeks (Katan and Grundy, 2003), although there are considerable variations between individuals. A number of products such as fat spreads, yoghurt and milk have been fortified with plant sterols and stanols.

2.10.9 Nuts

Consumption of 50-500 g of nuts five or more times per week as part of a healthy heart diet may significantly decrease total cholesterol and LDL cholesterol in dyslipidemic individuals (Mukuddem – Peterson *et al.*, 2005). Walnuts, macadamia, almonds and cashew nuts have cholesterol –lowering properties, and a beneficial effect on the lipoproteins profile (Abbey *et al.*, 1994). In a controlled randomised crossover study by Anderson *et al.* (2002) in 18 normo-cholesterolaemic men, results of the study indicated that diets rich in walnuts decreased total cholesterol (0.58 mmol/L;12.4%), LDL cholesterol (0.47 mmol/L; 16.3%) and triglycerides (0.11mmol/L; 8.3%). Whether nuts lower blood lipids independent of other factors is yet to be determined. Although HDL - C was lowered by 4.9%, the LDL - C to HDL -C ratio was lowered significantly by 12.0%.

2.10.10 Soy Protein

Vegetable proteins are useful for the treatment of hyperlipideamia. A soy- bean protein diet lowered the serum cholesterol to a greater degree than a low-cholesterol, low- saturated fat diet containing an equivalent amount of proteins of animal origin (Goldberg *et al.*, 1994). Substantial decreases were observed in

both serum cholesterol (21% after 3 weeks) and triglycerides, in patients with type IIa and IIb hyperlipoproteinaemia, including some with familial hypercholesterolemia (Sacks *et al.*, 2006). Only very large intake of soy protein (at least half of a person's daily protein intake) may decrease LDL – C by few percent when it replaces animal protein (Taku *et al.*, 2007). The mechanisms of the hypocholesteromic effect of soy protein are unknown. It has been suggested that the beneficial effect of soy protein may be as a result of the amino-acid pattern and peptide structure of the soy protein (McVeigh *et al.*, 2006).

2.11 Physical Activity

Regular physical activity appears to have beneficial effects on lipoproteins metabolism which are not due solely to any associated weight loss (Thomas and Bishop, 2007). Aerobic activity of at least 8 minutes a week has been shown to result in an increase in HDL – C and decrease in fasting triglyceride levels (Hardman, 1999; Altens *et al.*, 2006). In vegetarians, physical exercise reduced LDL- cholesterol apo B levels, and increased significantly HDL- cholesterol levels (Delgado *et al.*, 2000). To modify lipid protein metabolism, regular and frequent exercise is recommended which can be of moderate intensity in energy expenditures (Harland, 2008).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Introduction

This chapter gives an account of the research design, the study sites, target population, samples and sampling technique that were employed in this study. Procedures for data collection, analyses of the data and ethical issues are also described in this chapter.

3.2 Study Design

A case – control design was used for the study. A case control was adopted in the study because the nature of the research topic requires comparison of subjects who have a particular condition (cases) with subjects who do not have that condition, but otherwise similar to the cases (controls).

3.3 Study Sites

The study was carried out at the premises of Jamal Ruhani Satsang (a vegetarian religious body) at Weija, a suburb of Accra. Controls were recruited from the Martyrs of Uganda Catholic Church, Mamprobi.

3.4 Study Participants

The study population comprised vegetarians (vegans and lacto vegetarians and non- vegetarians. The vegetarians (cases) were all members of Jamal Ruhani Satsang. The non- vegetarians (controls) were parishners of the Martyrs of

Uganda Catholic Church and individuals living around the church premises. The subjects were made up of males and females between the ages of 25 - 75 years.

3.5 Inclusion and Exclusion Criteria

3.5.1 Inclusion Criteria: Subjects who have been vegans and lacto-vegetarians for more than two years were included in the study. The control group was made up of apparently healthy non- vegetarians. The control group was matched by age and gender to the cases.

3.5.2 Exclusion Criteria: Individuals who have been vegans and lacto-vegetarians for less than two years were excluded from the study. Subjects who were on cholesterol lowering medication were also excluded, to minimize the introduction of errors in the study. These drugs reduce cholesterol bio synthesis in the liver by inhibiting the enzyme HmG Co - A reductase. Also, all subjects outside the age range of 25-75 years were excluded from the study.

3.6 Sample Size Determination

A sample size of 50 was determined based on the population of the Vegetarians Association of Ghana, Accra (about 300 members). An absolute precision of 5% and a confidence interval of 95%, in accordance with the strategic function of Epi Info Statistical Software were used. Allowance was given for a non-participation rate of 10% and non-response rate of 20%.

$$\begin{aligned} N &= \frac{(z)^2 (P) (1-p)}{E^2} \\ &= \frac{1.96^2 (0.05 \times 0.95)}{0.06} \\ &= 50 \end{aligned}$$

Where N is estimated sample size

E is desired margin of error

Z is the critical Z score on the desired level of confidence (95%)

P is the prevalence of vegetarians in Ghana. A sample of 50 for cases and 50 for controls (100) was obtained.

3.7 Research Method

The research methods that were employed in this study included interviews using structured questionnaires, anthropometric measurements and biochemical measurements.

3.8 Sampling Technique

The sampling methods employed for this study were purposive sampling and convenience sampling. Purposive sampling was used to select the vegetarians. Convenience sampling was used to select the non vegetarians. Purposive sampling is a non probability sampling method by which the researcher selects the samples for the study based on his or her own judgment. Purposive sampling is normally used for case control studies when the sample being investigated is quite small, especially when compared with the probability sampling techniques such as simple and random samplings.

3.9 Pre Testing of Questionnaire

In order to familiarise with the research environment and ensure accuracy in the acquisition of data, the questionnaires were pre-tested on one of the meeting days of the Jamal Ruhani Satsang to eliminate issues of ambiguities.

3.10 Data Collection

Subjects who gave consent and met the inclusion criteria were recruited into the study. Data was collected between March, 2013 and April, 2013. Anthropometric measurements and blood samples were collected on a single visit at the various centres. Participants were interviewed in a private area by the researcher using structured questionnaire to assess demographic factors, medical history and dietary patterns of the participants. Interviews were administered in the English language and any local Ghanaian language which was spoken and understood by the participants.

3.11 Anthropometric Measurements

Body weight and height were measured to the nearest 0.1 kg and 0.5 cm, respectively, with the subjects standing in upright positions and without any foot wear. Height was measured with a Seca Stadiometer (Model, SEC-213). Body weight, visceral fat and percentage body fat of the participants were measured with an Omron Bioimpedance analyzer (Omron Healthcare, Incorporated, model HBF-514C) the participants being in light clothing and without shoes. The body mass index (BMI) was computed as the ratio of weight (kg) divided by height in meters squared (m^2) and this was used to classify obesity based on the World Health Organization's (WHO, 1998) criteria.

3.12 Blood Pressure Measurement

Blood pressure (BP) was measured with an Omron Blood Pressure Monitor (model BP 785) following a 5 – minute seated rest. In a relaxed position, the cuff of the blood pressure monitor was placed around the upper arm 1-2 cm above the elbow. Two resting BP measurements were taken (spaced 3 minutes apart) for each subject and the average of the two BP readings were recorded and used in the statistical analyses.

3.13.0 Dietary Assessment

3.13.1 24-Hour Recall

A two day 24- hour recall which included one weekend was used to assess nutrient intake of the participants. Participants were interviewed to describe all food and beverages consumed over a 24-hour period.

3.13.2 Food Frequency Questionnaires

A modified food frequency questionnaire (Asare, J.2011) was administered to assess habitual diet intake of the study participants. The food frequency questionnaire included food items or specific food groups that were consumed over a reference period. The participants food consumption patterns were assessed by multiple responses in which respondents were asked to estimate how often a particular food or beverage was consumed. Categories ranging from ‘never’, ‘weekly’, ‘monthly’ were included in the questionnaire and the participants chose one of these options. The dietary information was collected and analyzed using ESHA FPRO nutrient analysis software.

3.14 Blood Sample Collection and Transportation

After an overnight fast (8 – 12hrs), 3 ml of venous blood samples were drawn into serum separator tubes (from the antecubital space of the forearm) by a qualified phlebotomist. Fasting blood samples of at least 12 hours were used for a full lipids profile (JBS2, 2005). Blood samples were collected between the hours of 6 am and 9 am. The tubes containing the blood samples were placed on dry ice and quickly transported to the laboratory where they were centrifuged at 3000 rpm for 5 minutes. The remaining serum was separated in eppendorf tubes and stored at -20°C until ready for analyses. For HDL analyses, a precipitant was used to separate the HDL in sample into a supernatant. The supernatant was then aliquoted and stored until use.

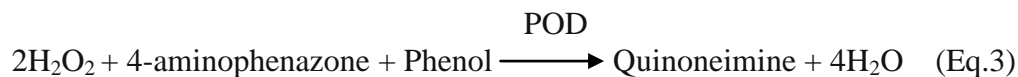
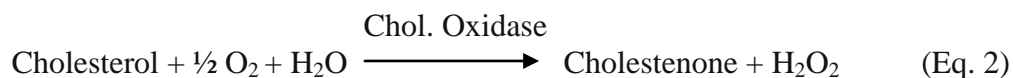
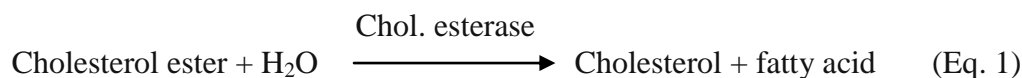
3.15 Biochemical Analyses

All blood samples were analysed at the Chemical Pathology Unit of the School of Allied Health Sciences, Korle-Bu, Accra.

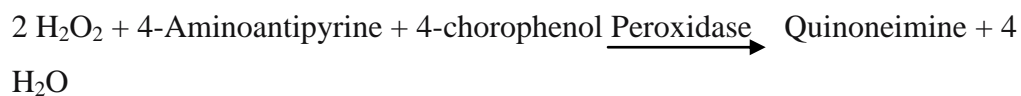
3.16 Lipid Profile

3.16.1 Cholesterol -Test principle

Cholesterol was determined after enzymatic oxidation in the presence of cholesterol oxidase into cholestenone and hydrogen peroxide. The hydrogen peroxide produced reacted under the catalytic action of peroxidase (POD) with phenol and 4-aminophenazone to form a pink coloured product quinoneimine which was measured at 500 nm. The intensity of the colour produced was directly proportional to the cholesterol concentration.

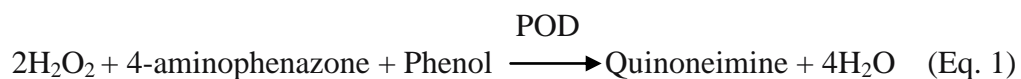
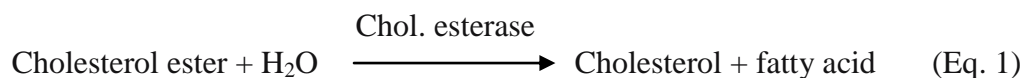


3.16.2 Triglyceride -Test principle



3.16.3 HDL- Cholesterol

Very low density lipoproteins (VLDL) and low density lipoproteins (LDL) in the sample were precipitated with phosphotungstate and magnesium ions. The supernatant contained high density lipoproteins (HDL). The HDL Cholesterol was then spectrophotometrically measured by means of a coupled reaction described below at 500 nm.



3.16.4 LDL-Cholesterol

LDL- Cholesterol was estimated based on the Friedewald equation:

$$\text{LDL} = \text{Total Cholesterol} - [(\text{Triglycerides} / 2.2) - \text{HDL Cholesterol}]$$

(Friedewald *et al.*, 1972)

3.16.5 VLDL

VLDL was calculated as the concentration of Triglycerides/2.2

(Friedewald *et al.*, 1972)

3.16.6 Assay Procedure

All samples were allowed to thaw at room temperature. Samples were run on an A25 Biosystems autoanalyzer; (Spain, Madrid). Quality control samples obtained from Biosystems were run to ensure accuracy of results. Test samples were run in duplicates.

3.17 Data Analyses

Data was entered into Statistical Package for Social Sciences (SPSS version 20.0) for all analyses. Two-way analysis of variance (ANOVA) was used to test for the differences in continuous variables among the two groups. Chi square test was used to determine the association between categorical variables. Logistic regression was used to determine the strength of the relationship between dependent variables and independent variables. Independent t-test was used to compare mean levels of lipids among vegetarians and non-vegetarians. All tests were computed as two-tail and p-values less than 0.05 were considered significant. Quantitative data was summarized as proportions, percentages, means and standard deviation. The term quantitative data is used to describe a set of information that can be counted or expressed numerically. Summary of results were displayed in graphs, tables and narrative forms.

3.18 Ethical Issues

The study was given approval by the Ethics and Protocol Review Committee of the School of Allied Health Sciences (**SAHS-ET./10362833/AA/8A/2012-2013 Appendix 1**). Introductory letters were sent to the Martyrs of Uganda Catholic Church, Mamprobi and Jamal Ruhani Satsang, Weija, to seek permission prior to the commencement of data collection. Participants recruited into the study were provided with information about the study and signed the consent form. Blood samples were collected by a qualified phlebotomist. All data collected was kept confidential and anonymity was ensured. Information gathered from the participants was kept in a file in a locked cabinet and later transferred into a password protected computer.

CHAPTER FOUR

RESULTS

4.0 Introduction

This study sought to compare diet and serum lipids in vegetarians and non-vegetarians. The results of the study are presented below in accordance with the objectives of the study in the form of tables and charts.

4.1 Socio-demographic Characteristics of Participants

The study sampled 113 participants, out of which 59 (52.2%) were non-vegetarians and 54 (47.8%) were vegetarians. The mean age of the participants was 54.06 ± 12.5 years. The mean age of vegetarians was 54.24 ± 13.86 years and non-vegetarians were 53.9 ± 11.2 years, (Table 4.1). The study participants were made up of more males (69.5%) than females (30.5%) in the non-vegetarian group. In the vegetarian group, majority of the participants (68.5%) were males, while the rest (31.5%) were females. In both vegetarians and non-vegetarians the ratio of males to females was 2:1. There was no significant difference in the proportion of males and females in both groups ($p = 0.006$). Majority of the vegetarians and non-vegetarians were married (47.5% and 53.7%, respectively). A higher proportion of the vegetarians (27.8%) compared to non-vegetarians (8.5%) had tertiary education. Almost all the vegetarians (93.2%) and non-vegetarians (90.7%) were Christians. More than half of both the vegetarians and non-vegetarians were employed (57.4% and 69.5% and respectively). About a

quarter (27.8%) of the vegetarians were retired personnel, while 15.3% of the non-vegetarians were unemployed (Table 4.1).

Table 4.1 Socio-demographic Characteristics of Vegetarians and Non-vegetarians

Gender	V (n= 54)		NV(n= 59)	
	Frequency	%	frequency	%
Male	37	68.5	41	69.5
Female	17	31.5	18	30.5
Marital status				
Single	14	25.9	17	28.8
Married	29	53.7	28	47.5
Divorced	6	11.1	5	8.5
Widowed	5	9.3	6	10.2
Separated	0	0	3	5.1
Educational level				
No formal education	4	7.4	7	11.9
Basic education	17	31.5	29	49.2
SHS	18	33.3	18	30.5
Tertiary	15	27.8	5	8.5
Religion				
Christian	49	90.7	55	93.2
Muslim	2	3.7	4	6.8
Buddhist	2	3.7	0	0
Hindu	1	1.9	0	0
Employment status				
Employed	31	57.4	41	69.5
Unemployed	4	7.4	9	15.3
Retired	15	27.8	7	11.9
Student	4	7.4	2	3.4

Vegetarians (V) Non- vegetarians (NV)

4.2 Vegetarianism

4.2.1 Length of vegetarian Status

Approximately twenty seven percent of the participants (27.8%) reported that they had been vegetarians between 11-20 years. Twenty two percent of the participants had been vegetarians between 21-30 years and 18.5% between 31-40 years. Fifteen percent also reported that they had been vegetarians for more than 40 years (Figure 4.1)

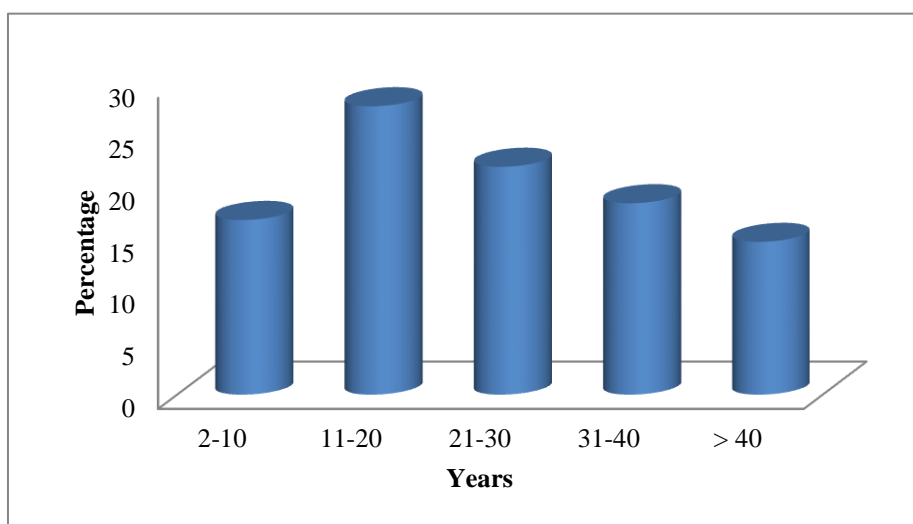


Figure 4.1 Length of years of vegetarianism. The highest number of years was found to be 11-20 years and the lowest was less than 40 years.

4.2.2 Types and Reasons for Becoming a Vegetarian

Eighty-two percent (82%) were lacto-vegetarians while 18% were vegans (Figure 4.2). More than half (53.7%) of the vegetarians reported that they became vegetarians for religious purposes; 27.8% reported that they did so to protect the environment, while 18.5% stated that their reason for becoming vegetarian was to promote health (Figure 4.3).

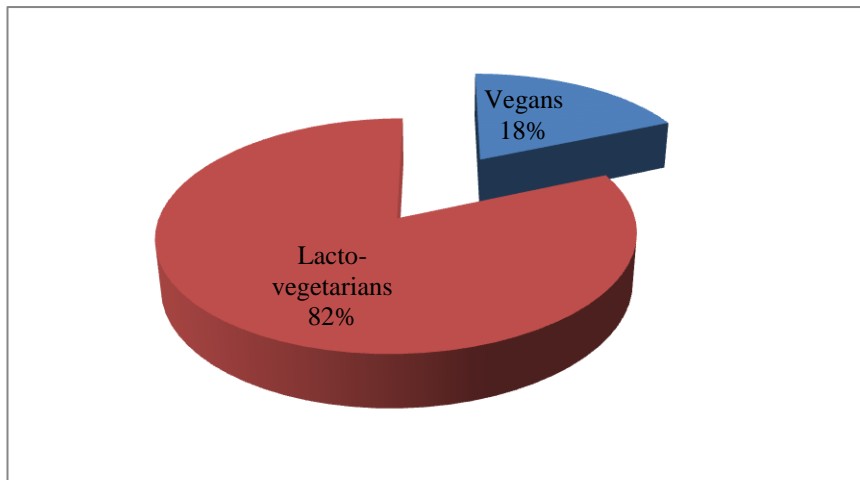


Figure 4.2 Types of vegetarian.

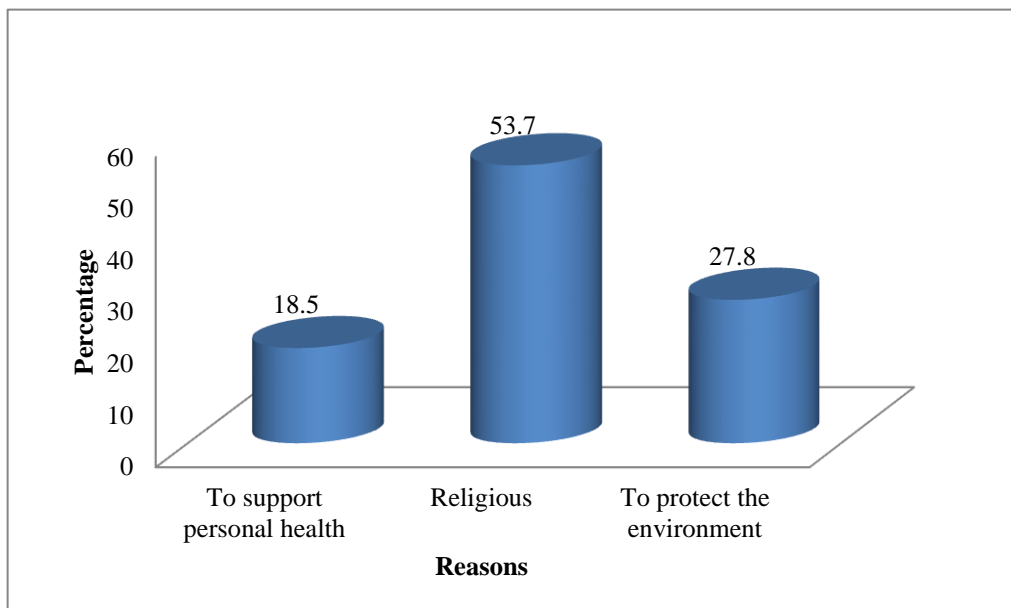


Figure 4.3 Reasons for becoming a vegetarian.

4.3 Dietary and Meal Pattern

More than half (50.8%) of the non-vegetarians stated that they ate three meals a day while 51.9% of the vegetarians reported eating twice daily. Majority of the non-vegetarians (61%) and vegetarians (75.9%) reported that they ate breakfast daily. More than half of the non-vegetarians (54.2%) and 48.1% of the

vegetarians reported that they ate snacks. Soft drinks were the main snack consumed by non -vegetarians (25.4%) while most of the vegetarians (33.3%) snacked on fruits and vegetables (Table 4.2)

Table 4.2 Dietary and Meal Patterns of Participants

Patterns	V n =54		NV n=59	
	Frequency	%	Frequency	%
Number of main meals				
One	1	1.9	1	1.7
Two	28	51.9	28	47.5
Three	25	46.3	30	50.8
Skip breakfast				
Yes	13	24.1	23	39.0
No	41	75.9	36	61.0
Snacks in between meals				
Yes	26	48.1	32	54.2
No	28	51.9	27	45.8
Types of snacks				
Fruits and vegetables	18	33.3	10	16.9
Soft Drinks	4	7.4	15	25.4
Pastries	5	9.3	7	11.9
Frequency of fruits intake				
Daily	41	75.9	27	45.8
Weekly	6	11.1	14	23.7
Monthly	2	3.7	3	5.1
Occasionally	4	7.4	9	15.3
Never	1	1.9	6	10.2
Vegetarians (V)	Non- vegetarians (NV)			

4.4 Health and Medical Condition of Vegetarians and Non- Vegetarians

About 44% of the non-vegetarians and 29.6% of the vegetarians reported that they were hypertensive (Figure 4.4.) Twenty - four percent of the vegetarians reported that they were on herbal medications, while 20.4% of the non-vegetarians reported so. Some of the reported herbal medications included *Moringa oliefera*, ‘agbeve’ herbs, and ‘Kingdom herbs’. (Figure 4.4)

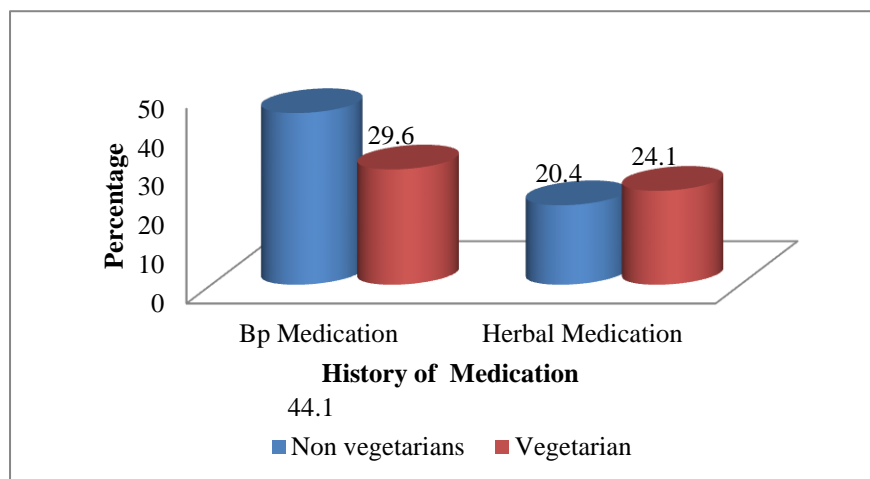


Figure 4.4 History of medication use

4.5 Life Style Behaviours

The findings of the study showed that smoking was uncommon in both groups. Only 1.7% and 1.9% of non- vegetarians and vegetarians reported that they were current smokers and the frequency of smoking was once a week. A few (1.9%) of the vegetarians consumed alcohol while 66.1% of non-vegetarians reported they consumed alcohol. The most frequently consumed alcohol for the non-vegetarians was beer (47.5%) out of which 28.8% consumed it occasionally. Most of the non-vegetarians (37.3%) consume a bottle of beer or a tot of whisky weekly (Table 4.3)

Table 4.3 Life Style Behaviours of Participants

	V(N= 54)		NV (N=59)	
	Frequency	%	Frequency	%
Current smokers	1	1.9	1	1.7
Alcohol drinkers	1	1.9	39	66.1
Type of alcohol				
Wine only	0	0.0	4	6.8
Beer only	1	1.9	28	47.5
Hard liquor	0	0.0	5	7.5
wine, beer	0	0.0	1	1.7
Frequency intake				
Daily	0	0.0	7	11.9
Weekly	1	1.9	7	11.9
Monthly	0	0.0	5	8.5
Occasionally	0	0.0	17	28.8
Quantity of intake				
half medium glass	1	1.9	9	15.3
1 mini Guinness or	0	0.0	22	37.3
1 tot of hard liquor	0	0.0	5	8.5
Others	0	0.0	2	3.4

Vegetarians (V) Non- vegetarians (NV)

4.6 Comparison of Anthropometric Variables of Vegetarians and Non-Vegetarians

There were no significant differences in weight, BMI, visceral fat and systolic blood pressure between vegetarians and non- vegetarians ($p>0.05$). However, there was a significant difference in body fat ($p=0.040$) and diastolic blood pressure ($p=0.011$) between the two groups (Tables 4.4 and 4.5).

Table 4.4 Comparison of Anthropometric and Blood Pressure Measurement between Vegetarians (V) and Non-Vegetarians (NV)

Anthropometric	Groups	N	Mean	SD	P-value	95% C.I.	
Weight	V	54	70.38	12.85	0.160	-1.57	9.39
	NV	59	74.29	16.18			
BMI	V	54	25.54	4.56	0.152	-0.02	3.87
	NV	58	27.46	5.70			
Visceral fat	V	54	8.70	4.42	0.740	-1.21	1.71
	NV	59	8.95	3.41			
Body fat	V	54	25.63	11.60	0.040*	0.20	8.32
	NV	59	29.90	10.19			
Systolic BP	V	54	140.00	24.52	0.100	-17.531	1.57
	NV	59	132.02	26.52			
Diastolic BP	V	54	85.94	13.57	0.011*	-11.816	-
	NV	59	79.27	13.97			

***Significant at 5%**

Table 4.5 Classification of Risk of High Blood Pressure of vegetarians and Non- vegetarians

	V	NV	Z-value	P-value
	N (%)	N (%)		
Systolic BP mmHg				
Optimal <120	32 (54.2)	21 (35.6)	-1.327	0.184
Normal <130	11 (18.6)	12 (20.3)	0.102	0.918
High Normal <130-139	4 (6.8)	6 (10.2)	0.185	0.852
High Grade 1 140-159	8 (13.6)	7 (11.9)	-0.098	0.947
High Grade 2 160-179	0 (0.0)	5 (8.5)	4.234	0.001*
High Grade 3 >180	4 (6.8)	8 (13.6)	0.350	0.726
Diastolic mmHg				
Optimal Bp <80	15 (27.8)	33 (55.9)	1.795	0.073
Normal Bp <85	34 (63.0)	20 (33.9)	-2.067	0.038
High Normal 85-89	5 (9.3)	6 (10.2)	0.063	0.950
High Grade 1 90-99	14 (25.9)	16 (27.1)	0.074	0.948
High Grade2 100-109	14 (25.9)	18 (30.5)	0.868	0.775
High Grade 3 >110	13 (24.1)	11 (18.6)	-0.326	0.744

***Significant at 5%**

Reference: Classification of blood pressure levels, British Hypertension Society Guidelines, William *et al.*, 2004.

4.7 Lipid Profile of Vegetarians and Non-vegetarians

There were no significant differences in the mean levels of triglycerides, total cholesterol, and LDL and VLDL concentrations between the two groups. However, there was a significant difference between the mean HDL concentrations of vegetarians and non- vegetarians, ($p= 0.012$) (Tables 4.6 and 4.7).

Table 4.6 Comparison of Lipid Profile between Vegetarians (V) and Non-Vegetarians (NV)

Lipid parameters	Groups	N	Mean	S.D.	P-value	95% C.I.	
TG	V	54	1.29	0.52	0.119	-0.35	0.04
	NV	59	1.13	0.52			
TC	V	54	5.54	1.17	0.479	-0.28	0.60
	NV	59	5.70	1.20			
LDL	V	54	3.45	1.15	0.524	-0.59	0.65
	NV	59	3.31	1.24			
HDL	V	54	1.55	0.48	0.012*	0.09	0.67
	NV	59	1.92	0.96			
VLDL	V	54	0.59	0.24	0.116	-0.16	0.01
	NV	59	0.51	0.24			

***Significant at 5%**

Table 4.7 Classification of Lipid Parameters of Vegetarians (V) and Non-vegetarians (NV)

	V (N=54)	NV (N=59)	P-value
Total Cholesterol (mmol/L)			
Optimal Level <5.2	19 (35.2)	22 (37.3)	0.889
Borderline 5.2-6.2	20 (37.0)	20 (33.9)	0.834
High Risk >6.2	15 (27.8)	17 (28.8)	0.950
HDL (mmol/L)			
Optimal Level ≥ 1.6	15 (27.8)	33 (55.9)	0.071
Borderline 1.03-1.5	34 (63.0)	20 (33.9)	0.039*
High Risk <1.03	5 (9.3)	6 (10.2)	0.960
LDL mmol/L			
Optimal Level <2.6	14 (25.9)	16 (27.1)	0.941
Near optimum 2.6-3.3	14 (25.9)	18 (30.5)	0.775
Borderline 3.4-4.1	13 (24.1)	11 (18.6)	0.744
High Risk 4.1- 4.9	9 (16.7)	6 (10.2)	0.735
Very High Risk >5.0	4 (7.4)	8 (13.6)	0.346
Triglycerides (mmol/L)			
Optimal Level <1.7	43 (79.6)	53 (89.8)	0.751
Borderline 1.7-2.2	10 (18.5)	3 (5.1)	0.161
High Risk 2.3-5.6	1 (1.9)	3 (5.1)	0.891
Very High Risk	0 (0.0)	0 (0.0)	NA

NA = Not Applicable *Significant at 5%

Reference: European society guidelines for the management of dyslipidaemia, Reiner *et al.*, 2011

4.8 Daily Nutrient Intake of Vegetarians and Non-Vegetarians

No significant differences were found between mean levels of energy, carbohydrate, total fat, cholesterol, saturated fat, monounsaturated fat and dietary fibre between vegetarians and non-vegetarians. However, significant differences were found in mean levels of protein ($p=0.001$) and polyunsaturated fat intake ($p=0.001$) (table 4.8). With regards to micronutrients there were no significant difference between the mean levels of vitamin C, vitamin E, iron, and calcium. Mean levels of folate ($p=0.002$) and potassium ($p=0.001$) between the two were significantly different as indicated in Table 4.9.

Table 4.8 Comparison of Macronutrients between Vegetarians (V) and Non-Vegetarians (NV)

	Groups	N	Mean	S.D.	P-value	95% C.I.	
Energy (Kcal)	V	54	1414	568			
	NV	59	1619	760	0.111	47.587	456.85
Total Protein (g)	V	54	37.2	12.5			
	NV	59	59.4	31.3	0.001*	13.091	31.16
Total carbohydrate (g)	V	54	214.8	92.9			
	NV	59	259.0	336.8	0.353	-49.69	138.21
Total fat (g)	V	54	53.4	33.7			
	NV	59	69.0	141.3	0.428	-23.41	54.78
Cholesterol (mg)	V	54	4.7	156			
	NV	59	85	164	0.496	-39.24	80.48
Saturated fat (g)	V	54	7.5	15.4			
	NV	59	4.7	5.9	0.190	-7.14	1.43
MUFA (g)	V	54	8.2	9.8			
	NV	59	6.1	11.2	0.300	-6.03	1.88
PUFA (g)	V	54	9.7	8.7			
	NV	59	2.8	4.1	0.001*	-9.40	-4.38
Dietary fibre (g)	V	54	17.1	12.12			
	NV	59	21.0	28.3	0.350	-4.34	12.16

*Significant at 5%

Table 4.9 Comparison of Micronutrients between Vegetarians (V) and Non-Vegetarians (NV)

	Groups	N	Mean	S.D.	P-value	95% C.I.	
Folate (µg)	V	54	88	64	0.002*	-60.76	-14.65
	NV	59	51	58			
Vitamin C (mg)	V	54	77.29	88.14	0.882	-30.70	35.697
	NV	59	79.79	89.72			
Vitamin E (mg)	V	54	3.87	4.79	0.243	-3.52	0.90
	NV	59	2.56	6.80			
Iron (mg)	V	54	20.8	49.8	0.570	-15.09	27.27
	NV	59	26.9	62.5			
Calcium (mg)	V	54	468	250	0.274	225.22	785.68
	NV	59	748	1858			
Potassium (mg)	V	54	835	785	0.001*	185.22	374.68
	NV	59	686	670			
Sodium (mg)	V	54	516	434	0.159	-58.99	355.75
	NV	59	665	646			

***Significant at 5%**

4.8 Recommended Nutrients Intake in Vegetarians and Non- Vegetarians

Protein intake of majority of the vegetarians (77.8%) was below the recommended levels while 22.2% of non- vegetarians had intakes above the recommended daily intake. Majority of the vegetarians had lower intakes of vitamin B₁₂ (85.2%) and B₆ (83.3%) than the recommended nutrient intake. (Tables 4.10 and 4.11)

Table 4.10 Comparison of Recommended Macro Nutrients Intake in Vegetarians (V) and Non-vegetarians (NV)

	V	NV	P-value
	(n=54) %	(n=59) %	
Energy			
< RDI	37 (68.5)	38 (64.4)	0.707
> RDI	17 (31.5)	21 (35.6)	0.790
Protein			
< RDI	42 (77.8)	23 (39.0)	0.002*
> RDI	12 (22.2)	36 (61.0)	0.019*
Carbohydrates			
< RDI	36 (66.7)	38 (64.4)	0.835
> RDI	18 (33.3)	21 (35.6)	0.881
Total Fat			
< RDI	16 (29.6)	23 (39.0)	0.545
> RDI	38 (70.4)	36 (71.0)	0.955
Cholesterol			
<RDI	34 (63.0)	46 (78.0)	0.141
>RDI	20 (37.0)	13 (32.0)	0.768
Saturated Fat			
< RDI	47 (87.0)	56 (94.9)	0.157
> RDI	7 (13.0)	3 (5.11)	0.710
Mono saturated Fat			
< RDI	37 (68.5)	35 (59.3)	0.416
> RDI	17 (31.5)	24 (40.7)	0.547
Poly saturated Fat			
< RDI	14 (25.9)	27 (45.8)	0.215
> RDI	40 (74.1)	32 (54.2)	0.078
Dietary Fibre			
< RDI	48 (88.9)	45 (76.3)	0.107
> RDI	6 (11.1)	14 (23.4)	0.526

*Significant at 5%

Table 4.11 Comparisons of Recommended Micronutrients Intake in Vegetarians and Non-vegetarians

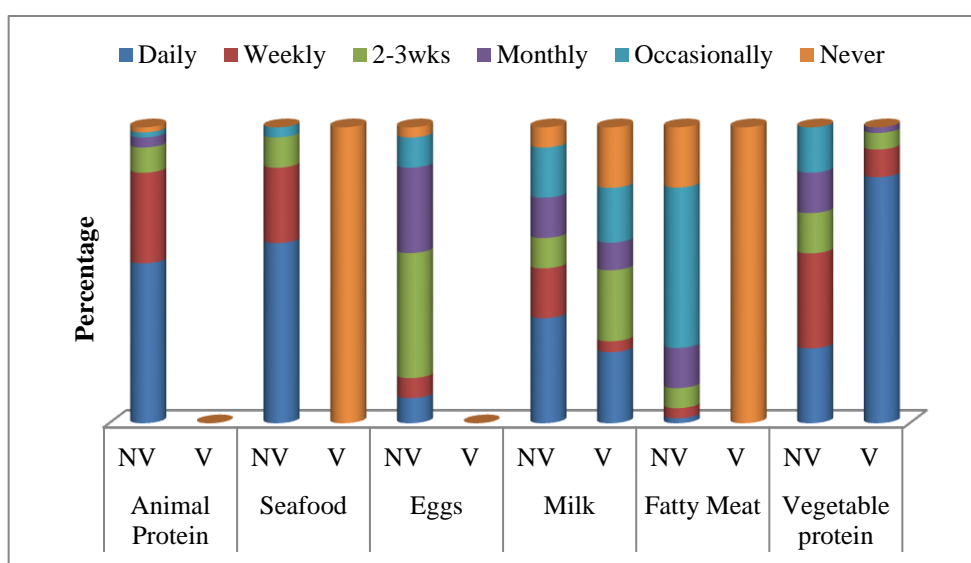
	V (n=54) %	NV (n=59) %	P-value
Vit B₆			
<RDI	46 (85.2)	1 (1.7)	0.011*
>RDI	8 (14.8)	58 (98.3)	***
Vit B₁₂			
<RDI	45 (83.3)	9 (15.3)	0.017*
>RDI	9 (16.7)	50 (84.7)	0.935
Folate			
<RDI	53 (98.1)	52 (84.7)	0.014*
>RDI	1 (1.9)	7 (11.9)	0.762
Vit C			
<RDI	32 (59.3)	34 (57.6)	0.887
>RDI	22 (40.7)	25 (42.4)	0.906
Vit E			
<RDI	33 (61.1)	20 (33.9)	0.055
>RDI	21 (38.9)	39 (66.1)	0.042*
Iron			
<RDI	19 (35.2)	12 (20.3)	0.373
>RDI	35 (64.8)	47 (79.7)	0.131
Mono unsaturated Fat			
<RDI	37 (68.5)	35 (59.3)	0.416
>RDI	17 (31.5)	24 (40.7)	0.547
Calcium			
<RDI	53 (98.1)	8 (13.6)	0.025*
>RDI	1 (1.9)	51 (86.4)	0.737
Potassium			
<RDI	53 (98.1)	55 (93.2)	0.214
>RDI	1 (1.9)	4 (6.8)	0.835
Sodium			
<RDI	54 (100.0)	53 (89.8)	0.013*
>RDI	0 (0.0)	6 (10.2)	***

***not applicable, < less than, > greater than

4.9 Frequency of Consumption of Food

4.9.1 Animal Protein and Vegetable Protein

Non-vegetarians frequently consumed red meat (54.2%) and seafood including fish and shrimps (61%) daily. None of the vegetarians consumed these animal proteins. Milk (full cream, skimmed and semi skimmed milk) was consumed more frequently by the non-vegetarians compared to the vegetarians. (35.6% vs. 24.1%) as shown in figure 4.5. Again majority of the vegetarians (83.3%) consume vegetable protein such as groundnuts, soybeans, “agushie” in the form of stews and soups than the non-vegetarians (25.4%) (Figure 4.5).



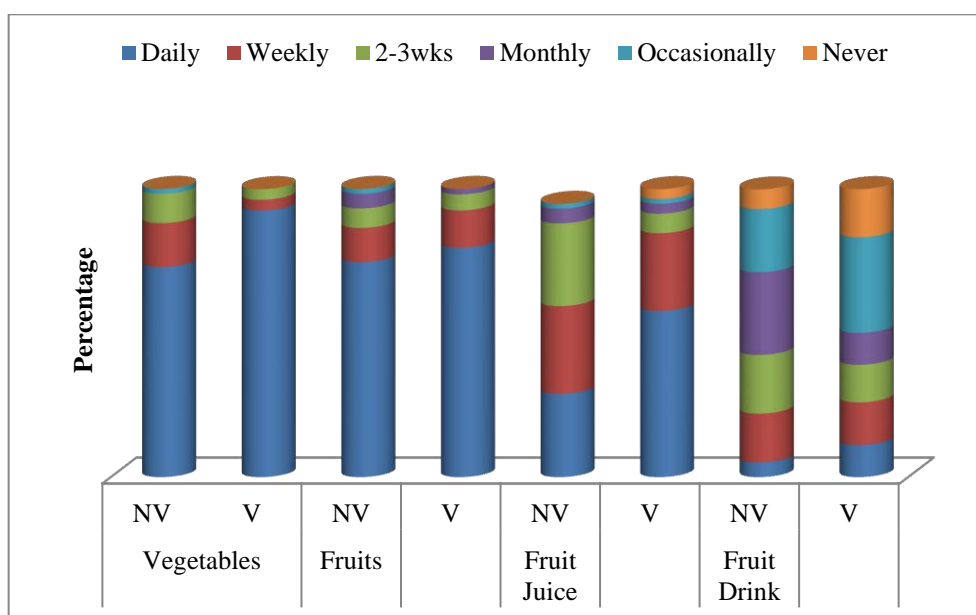
V= Vegetarians

NV= Non-vegetarians

Figure 4.5 shows the intake of comparisons of animal protein and vegetable protein of vegetarians and non-vegetarians.

4.9.2 Fruits, Vegetables, Fruit Juices and Drinks

A higher percentage of the vegetarians (92.6%) consumed more vegetables daily than the non-vegetarians (72.9%). Fruits were consumed more frequently by the vegetarians (79.6%) than non-vegetarians (74.6%). Frequency of fruit juice intake was higher among the vegetarians (57.6%) than the non-vegetarians (28.8%). In both groups fruit drinks were frequently less consumed (Figure 4.6)



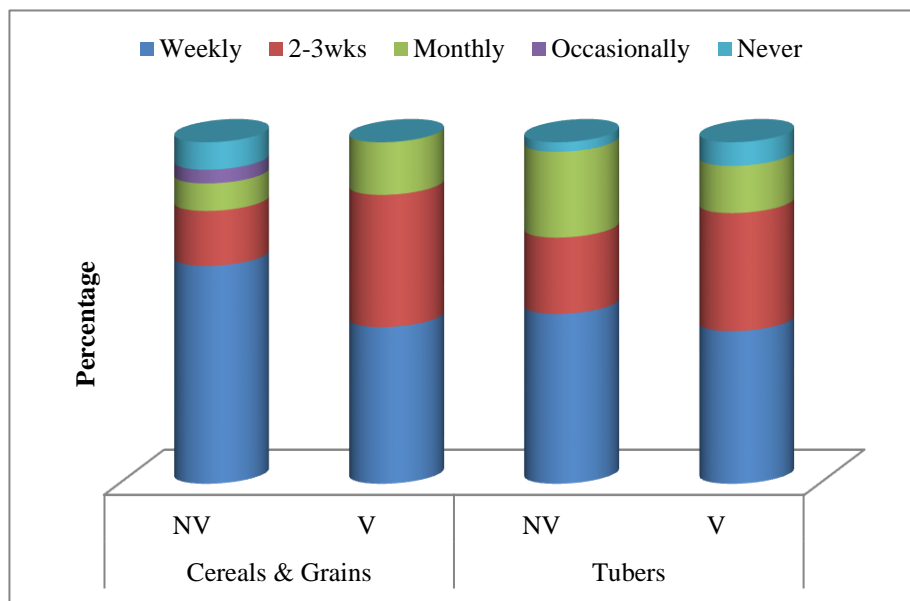
NV= Non-vegetarians V=Vegetarians

Figure 4.6 Intake of fresh fruits and vegetables, fruit juices and drinks between vegetarians and non-vegetarians.

4.9.3 Cereals and Grains

Cereals and grains such as maize, rice and wheat were consumed weekly by a higher proportion of non-vegetarians (27.1%) compared to the vegetarians (11.1%) Again a greater proportion of non-vegetarians had a higher weekly

intake of plantain, and tuber such as, yam and cassava (30.5%) as compared to vegetarians (24.1%) (Figure 4.7)

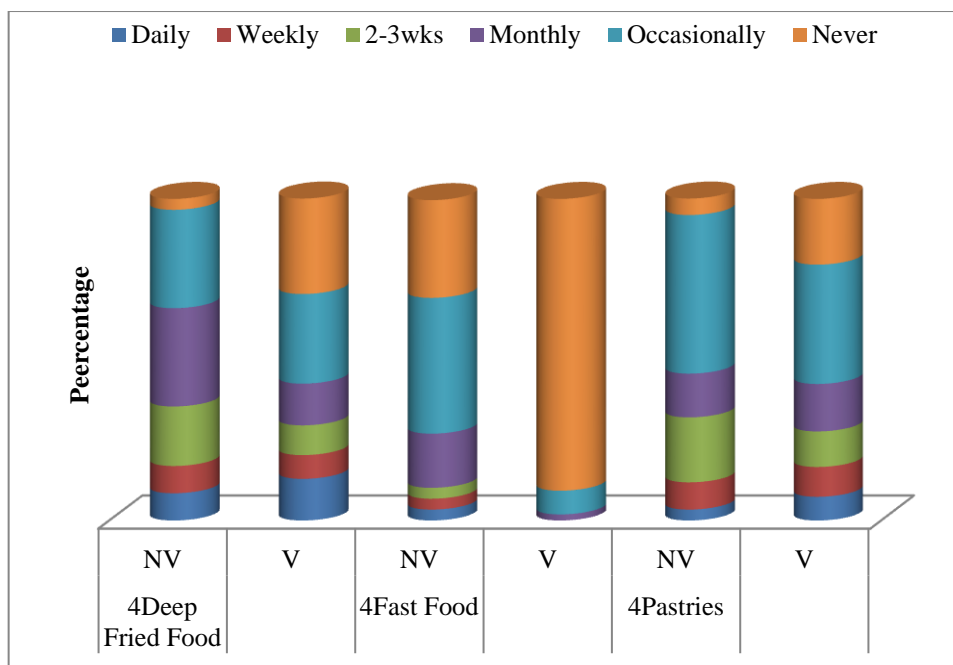


NV= Non-vegetarians N=Vegetarians

Figure 4.7 The intake of cereals and grains and tubers between vegetarians and non-vegetarians.

4.9.4 Deep Fried Foods, Fast Foods and Pastries

The proportion of participants who never consumed deep fried foods (eg. fried yam and plantain) was higher among vegetarians (29.6%) than non-vegetarians (3.4%). Also, vegetarians who never consume fast foods were significantly higher (90.7%) than the non-vegetarians (30.3%). A few of the participants from both the vegetarians and non-vegetarian group consumed pastries such as vegetable pie and mushroom pies daily (7% vs. 3.4% respectively). However, vegetarians who never consumed pastries of any kind were higher (20.4%) than non-vegetarians (5.1%) as showed in Figure 4.8.



NV = Non-vegetarians V = Vegetarians

Figure 4.8 Intake of deep fried foods, fast foods and pastries between vegetarians and non-vegetarians.

CHAPTER FIVE

DISCUSSION

5.1 Socio – Demographic Characteristics of Participants

As expected, there were no significant differences in the mean age of vegetarians and non- vegetarians due to the fact that participants were matched by age and gender. The mean age of vegetarians (54.2 ± 13.9) and non-vegetarians (53.9 ± 11.2 years) in this current study was similar to the ages of participants in a study that investigated the effects of long term vegetarianism on lipid levels in Korea (Kyung *et al.*, 2012). The mean ages of vegetarians and non-vegetarians in the Korean study was 56.4 and 55.9, respectively. However, there is evidence that vegetarians tend to be older than non-vegetarians (Davey *et al.*, 2003).

The study sampled more males than females in both the vegetarians and non-vegetarians. The 2.1 ratio of males to females in this study is contrary to findings in other studies that have found that vegetarian and vegan diets were frequently chosen by females than males in other countries (Davey *et al.*, 2003). This was attributed to the fact that females are more concerned about their body shape and weight than males, and as a result is more interested in trying different diets to achieve this (Davey *et al.*, 2003).

Vegetarians have been shown to be more educated than the non-vegetarians (Davey *et al.*, 2003). Twenty-eight percent of the vegetarians in this study had attained education to the tertiary level compared to the non-vegetarians (8.5%) in

this study. This finding may thus suggest that generally individuals with higher levels of education tend to take greater responsibility for their health and nutrition whilst those who are less educated are also less knowledgeable about the importance of good nutrition and health.

5.2 Vegetarianism

Studies have shown that persons who follow a vegetarian diet are more content with their dietary regimen and are likely to follow it for a longer period than those who undertake dietary plans for weight reduction purposes (White *et al.*, 1999; Smith *et al.*, 2000). The present study indicates that majority of the vegetarians (85.2%) have been practicing vegetarianism for more than a year and 14.8% for over 40 years. In another study that investigated serum fatty acids and lipid profile of Hong Kong Chinese non-vegetarians and vegetarians, it was suggested that to study the health and nutritional status of vegetarians, they should have been on the diet for at least a period of one year (Lee *et al.*, 2000). This observation may be accounted for by the fact that vegetarianism is not just dietary persuasions, but also reflects a lifestyle (Davey *et al.*, 2003). In a Korean study on cholesterol levels of vegetarians, the authors concluded that the main reason for choosing a vegetarian diet was to maintain good health and prevent diseases (Nivedita *et al.*, 2012; Kyung *et al.*, 2012). In this study however, the main reason for choosing a vegetarian diet was to uphold religious and philosophical principles. Less than a third of participants from this study (18.5%) stated that they followed vegetarianism for personal health purposes.

Additionally, majority of vegetarians (82%) were lacto- vegetarians while 18% were vegans. The reason for high lacto -vegetarians in this study may be attributed to the fact that lacto- vegetarians believe their daily protein requirement can be met through the consumption of dairy products such as milk, butter and cheese, compared to the vegans who do not consume foods of animal origin. However, in another related study conducted in African-Americans, majority of the vegetarians were lacto- ovo vegetarians (85%), while 15% were vegans (Toohey *et al.*, 1998). This implies that it is more preferred to be a lacto-vegetarian or lacto- ovo-vegetarian than a vegan.

5.3 Health and Lifestyle Behaviours

About 44% of non-vegetarians and 29% of vegetarians were hypertensive. This is consistent with findings of other studies in vegetarian populations. Recent studies have reported lower rates of hypertension in vegetarians than non-vegetarians (Tonstadd *et al.*, 2009; Rizzo *et al.*, 2008). It must be emphasized that, although the vegetarian diet appears healthy and may prevent non-communicable diseases, genetic variation and increase in age could also be contributing factors to the incidence of hypertension among the participants of this study.

The teratogenic effect of smoking is well documented. Ghanaians are becoming more health conscious and this could be the reason why only 1.7% of the vegetarians and 1.9% of the non-vegetarians sampled for this study do smoke. Vegetarians normally have regular physical activity and usually abstain from smoking and alcohol consumption than non-vegetarians (Davey *et al.*, 2003;

Hansen, 2005). The results of this study also indicate a healthy lifestyle of the vegetarians. Alcohol consumption was low in the vegetarian population (1.9%) while 66.1% of non - vegetarians stated that they consumed alcohol.

5.4 Body Composition and Blood Pressure

Epidemiological studies often report that vegetarians are thinner than non-vegetarians (Davey *et al.*, 2003; Fraser, 2009). However, this was not observed in the current study. No significant differences were observed in BMI of vegetarians and non-vegetarians. This finding is in agreement with the results of a study in rural Bangladesh, which investigated nutrition and lipid profile in the general population and vegetarians, but did not find any significant differences in the BMI between the two groups (Kumar *et al.*, 2012).

There was however, significant difference in the mean body fat of the vegetarians and non-vegetarians ($p=0.040$). The mean body fat for non-vegetarians was significantly higher ($29.9 \pm 10.19\%$) than for vegetarians ($25.63 \pm 11.60\%$). Another study conducted by Delgado *et al.* (2000) which evaluated the effect of dairy product intake on the plasma lipid profile in vegetarians and non-vegetarians also found that BMI was similar in both groups but percentage body fats mass was lower and lean body mass was higher in the vegetarian group. Lower percentage of body fat of vegetarians may probably be due to an increased consumption of more fibre and less saturated fatty foods. High fibre diets have lower energy density, resulting in less fat accumulation.

Concerning blood pressure parameters, the only statistically significant difference between the two groups was in the diastolic arterial pressure ($p = 0.011$). The vegetarians had a higher mean diastolic pressure 85.94 ± 13.57 mmHg than the non-vegetarians (79.27 ± 3.97 mmHg). However, both groups had mean systolic and diastolic values within the high normal blood pressure range according to Williams' classification (Williams *et al.*, 2004).

Diastolic blood pressure was significantly higher in vegetarians compared to non-vegetarians. Comparison in blood pressure measurements of vegetarians and non-vegetarians have shown varying results. A study conducted in Brazil, which investigated the serum lipid levels of lacto-vegetarians, reported that the vegetarians had lower systolic arterial pressure values than non-vegetarians even while exhibiting similar BMI (Fernande *et al.*, 2011). On the contrary, another study conducted in China which investigated the nutritional status of elderly Chinese vegetarians and non-vegetarians did not find any differences in blood pressure between the two groups (Woo *et al.*, 1998).

However, in the current study, the prevalence of hypertension was significantly higher among the non-vegetarians (44.1%) compared to the vegetarians (29.6%). It is assumed that the disproportionately higher percentage of non-vegetarians using pharmacological therapies to lower BP would clearly attenuate the true blood pressure differences between the two groups. The higher diastolic pressure among the vegetarians is inexplicable. It indicates that the adherence of a vegetarian diet is not necessarily associated with greater protective effect against blood pressure elevation.

5.5 Lipid Profile

Most epidemiological studies on the lipid profile of vegetarians and non-vegetarians concluded that vegetarians had a favourable lipid profile than non-vegetarians (Woo *et al.*, 1998; Kumar *et al.*, 2012). This study hypothesized that there will be no significant difference between lipid profile of vegetarians and non-vegetarians. Results from the present study support the hypothesis. With the exception of HDL, serum triglycerides (TG), total cholesterol and LDL- C were not significantly different between vegetarians and non- vegetarians ($p > 0.05$). Nevertheless, both mean values of TG and LDL-C of both groups were at optimal levels according to the European Society Guidelines for the classification of dyslipidaemia (Reiner *et al.*, 2011). However, the mean TG of the vegetarians (1.29 ± 0.52 mmol/L) was slightly higher than non- vegetarians (1.13 ± 0.52 mmol/L). In reality, vegetarians may consume more carbohydrates in various forms such as fructose which might reflect higher serum triglyceride levels than the non-vegetarians. A rich carbohydrate diet makes greater availability of carbohydrates for synthesis of triglycerides (Jhala *et al.*, 2009). Vegetarians also consume a lot of fruits which contain fructose. Dietary fructose also contributes to TG elevation (Reiner *et al.*, 2011). Lack of significant differences in the serum TG between the two groups is consistent with literature which shows that plasma TG are not affected by alteration in saturated fat, MUFA and PUFA (Cariappa *et al.*, 2005).

The mean value of the total cholesterol (TC) was slightly higher among the non-vegetarians (5.70 ± 1.20 mmol/L) than the vegetarians (5.54 ± 1.17 mmol/L) although both mean values were on the “borderline normal”. In a study

conducted in Brazil, which compared levels of TG, TC and LDL- C, it was concluded that the vegetarian diet was associated with lower levels of TG, TC, and LDL- C than the non- vegetarian diet (Cariappa *et al.*, 2005). In another study conducted in Korea which also compared the lipid profile of vegetarians and non- vegetarians, significantly lower lipid levels were observed among the vegetarians (Kyung *et al.*, 2012). However, the present study is in consonance with a study conducted in India which compared the lipid profile of vegetarians and fish eaters. The authors revealed that there was no significant difference between the lipid profiles of vegetarians and non- vegetarians (Cariappa *et al.*, 2005). Furthermore, the mean LDL – C levels of both groups was not significantly different in this study. Although not significant, an unexpected finding was the lower mean levels of LDL – C (3.31 ± 1.24 mmol/L) in non-vegetarians compared to that in vegetarians (3.45 ± 1.15 mmol/L). The mean LDL- C of non-vegetarians and vegetarians can be interpreted as near optimal and borderline normal respectively according to the European Society Guidelines for the classification of dyslipidaemia (Reiner *et al.*, 2011).

The higher LDL – C mean values may be attributed to the fact that majority of the vegetarians sampled were more of lacto- vegetarians (82%) than vegans (8%). The lacto–vegetarians consume dairy products such as milk, cheese and ‘waagashi’ (cured local milk). Milk fat contains some of the most commonly consumed saturated fatty acids such as lauric and myristic acids that have a more pronounced influence on plasma cholesterol (Nivedita *et al.*, 2012). Another possible explanation of the relatively higher LDL – C of the vegetarians may be due to higher trans- fatty acids (TFA) in their diet. Partially hydrogenated fatty

acids represent the major source of trans-fatty acids found in vegetarian pies which increases TG and LDL cholesterols (Lee *et al.*, 2000).

In a study carried out in Brazil to investigate the relation between dietary and circulating lipids in lacto – vegetarians and vegetarians, it was concluded that there was no significant difference in HDL- C between the two groups (Fernandes *et al.*, 2011). However, in this present study, the HDL- C was statistically significant between the two groups ($p = 0.012$) which is in disagreement with the study by Fernandes *et al.*, conducted in 2011. The non-vegetarians had a higher mean value of HDL-C (1.92 ± 0.96 mmol/L) than the vegetarians (1.55 ± 0.48 mmol/L). Nevertheless, both groups were within the optimal levels of the HDL- C reference range according to the European Society Guidelines for the management of dyslipidaemia (Reiner *et al.*, 2011).

The discrepancies between HDL- C concentrations may be due to several factors. The fact that majority of the non-vegetarians (66.1%) consumed alcohol as against 1.9% of the vegetarians may have contributed to the significantly higher HDL-C. There is evidence that alcohol consumption increases HDL- C fractions and stimulates reverse transportation of lipids (Vander *et al.*, 2001). Alcohol consumption of more than three drinks per day is associated with raised blood pressure and plasma triglycerides (Reddy and Katan, 2004). The type of alcohol consumed may also be taken into consideration when one needs to increase his or her HDL- C in the body. Wine contains resveratrol, an antifungal compound in grapes skins that has been associated with 11% to 16% increase in HDL- C (Hansen A. S 2005). Another explanation for the discrepancies may be attributed

to increased carbohydrate consumption as isocaloric substitution for fat. This is associated with significant decrease in HDL- C (0.1mmol/L for every 10% energy substitution). However, in carbohydrate-rich foods with high fibre content, the reduction of HDL- C is either not observed or is very small (Mensink *et al.*, 2003; Frost *et al.*, 2004). Usually, a higher fructose or sucrose intake is associated with a more pronounced decrease in HDL- C (Frost *et al.*, 2004). The lower HDL- C in vegetarians may have led to the increase in LDL concentrations observed in this population, as HDL – C is believed to be a carrier of excess cholesterol (Brewer,2004)

5.6 Dietary Intake of Participants

With the exception of protein, there were no significant differences in the macro nutrients ($p=0.001$). The vegetarians had a significantly lower intakes of protein (37.2 ± 12.5 g) than non –vegetarians (59.4 ± 31.3 g). Studies have reported that vegetarians generally have lower intake of proteins compared to individuals who eat meat. Despite this, their intakes were still within an adequate intake range (Appleby *et al.*, 1998; Davey *et al.*, 2003). Findings of this study showed that vegetarians had lower intakes of protein which was below the recommended daily intake. This partially agrees with Appleby *et al.* (1998) and Davey *et al.* (2003). Vegetable protein can supply an individual's protein needs when a variety of foods of vegetable origin are consumed and the energy needs are met (Kumar *et al.*, 2012).

Regarding dietary fat and monounsaturated fat, there was no significant difference between the two groups. Surprisingly, the mean values for the

saturated fat was higher in the vegetarians ($7.55 \pm 15.43\text{g}$) than the non vegetarians ($4.70 \pm 5.90 \text{ g}$). This may be due to the fact that those vegetarians who participated in the study consumed a lot of fried foods or palm nut soups which are high in saturated fat. Dietary intake of polyunsaturated fat was significant in the two groups ($p = 0.001$). The vegetarians had a higher mean value of polyunsaturated fat ($9.7 \pm 8.7\text{g}$) than the non-vegetarians ($2.8 \pm 4.1 \text{ g}$). A possible explanation for this is that polyunsaturated fat is mostly derived from plant sources such as soya beans, sunflower and seed weeds. Vegetarians are more likely to consume these foods in large quantities. Increase in polyunsaturated fat intake tends to lower blood cholesterol levels especially LDL-C. (St-Onge *et al.*, 2007). High dietary polyunsaturated fat intake among vegetarians has been reported in similar studies done by Bonnie *et al.* (2010) and Karelis *et al.* (2010). Vegetarians are still at a lower risk of cardiovascular diseases probably because of other favourable dietary features such as lower intake of trans-fatty acids and higher intakes of polyunsaturated fat (Lee *et al.*, 2000).

Again, there was a significant difference in dietary folate between the vegetarians and the non – vegetarians ($p = 0.002$). The vegetarians had a higher mean folate intake ($88 \pm 64.56 \text{ mg}$) than the non-vegetarians ($51 \pm 58 \text{ mg}$). Other studies corroborate this finding (Appleby *et al.*, 1998; Kyung *et al.*, 2012). A plausible explanation is that vegetarians consume more green leafy vegetables and fruits which are rich in folic acids.

This study showed no significant differences in dietary antioxidants (vitamin C and E) between both groups. Nevertheless, 61 % of the vegetarians' vitamin E intake was less than the recommended daily intake. Vitamin E is a powerful antioxidant in the body's lipid phase. It can prevent LDL- C lipid peroxidation caused by free radical reaction (Stephen *et al.*, 1996). The lower daily intake of vitamin E of the vegetarians showed a negative correlation with their serum LDL – C, which is supported by studies done by Castro *et al.* (2005), Lee *et al.* (2000) and Kyung *et al.* (2012). Significant differences in dietary calcium intake of the vegetarians and non – vegetarian were not observed in this study. Nevertheless 98% of the calcium intake of the vegetarians was less than the recommended daily intake compared to the non-vegetarians (13.6%). Other studies have established that vegetarians have a lower intake of calcium than non- vegetarians (Woo *et al.*, 1998 and Kyung *et al.*, 2012). A similar result to the aforementioned studies was observed in this study. As a consequence there is the need for dietary education on how to maximise the absorption of calcium among vegetarians. The lower calcium utilisation in vegetarians is probably due to the higher intake of a soya bean- based diet. Soya beans may adversely affect calcium absorption due to the high oxalic acid content that may interfere with calcium absorption in the body (Davey *et al.*, 2003).

The vegetarians' intake of vitamin B₆ (85%) and vitamin B₁₂ (83%) fell below the recommended daily intake. The intake of vitamin B₁₂ is lower in vegetarians and deficiencies in vitamin B₁₂ have been reported in adult vegetarians especially among vegans (Herrmann and Geisel, 2002, Hermann *et al.*, 2003). The results of this study confirmed the reports of Herrmann and Geisel (2002) and Herrmann *et*

al., (2003). Furthermore, this highlights the need for vegetarians to regularly include a reliable source of vitamin B₁₂ such as fortified foods or supplements in their diet. Vitamin B₁₂ deficiency is usually the result of reduced absorption and / or lack of vitamin B₁₂ in their diet. Although vitamin B₁₂ deficiency is common to both vegetarians and vegans, they often have good intakes of folic acid that may mask the deficiency which can only be diagnosed when sufferers present with neurological symptoms (Thomas and Bishop, 2007).

5.7 Dietary Habits

Sixty percent (60%) of the non-vegetarians consumed more fish daily than red meat (54.2%) in this study. The frequent consumption of fish was encouraging since some fish oils are known to be rich in n-3 fatty acids and have been shown to reduce both fasting and postprandial blood triglyceride levels (Roche and Gibney, 2003; Castro *et al.*, 2005). Surprisingly, only 8.5% of the non-vegetarians consumed egg daily. High consumption of eggs is likely to have a significant elevating effect on blood cholesterol especially LDL- C (Thomas and Bishop, 2007). The higher intake of fish and lower intake of eggs of the non-vegetarians indicates that this group had healthy food choices. Consumption of vegetable protein such as beans and soy beans was higher (83.3%) among the vegetarians than the non-vegetarians (25.4%).

According to the Joint Health Claims Initiative (JHCL, 2004) the inclusion of at least 25 g of soya protein per day as part of a diet low in saturates, can help reduce blood cholesterol levels. However, practical implications of a regular large consumption of soya protein products need to be considered with lifestyle issue.

The safety of high intakes of soya phytoestrogens may be of concern to some individuals. Dietary proteins vary in their nutritional quantity; the digestibility of some plant proteins is lower than most animal sources of proteins (Thomas and Bishop, 2007). The biological value (BV) can also be lower in plant proteins especially with diets based on un-supplemented cereals or starchy roots. However, within a mixed diet, plant protein sources can meet the demands for indispensable amino acids as well as animal source proteins (Mahan *et al.*, 2012). Nevertheless, soya protein has a similar protein quality as animal protein (Young, 1994). The main nutritional difference between a plant source and an animal source protein diet is in the higher and more bioavailable, micronutrient content of the latter (Millward, 2004). This reflects why 78% of the vegetarians did not meet the recommended daily intake of protein, and highlights the need for nutritional education on how to maximize vegetable protein to meet the daily needs for vegetarians in Accra.

5.7.1 Fruits, Vegetables and Fruit Juices

Vegetables such as tomatoes, garden eggs, 'nkontomire' were consumed daily by 92% of the vegetarians, compared to 72% of the non – vegetarians. This was expected, since vegetables form the basis of the vegetarian diet. Daily fruit intake was similar between the vegetarians (79%) and the non – vegetarians (74%). Fruits and vegetables are good sources of folate and soluble fibre. Soluble fibre reduces total LDL cholesterol (Castro *et al.*, 2005). Although an increased intake of soluble fibre can be expected to have only a limited impact on cholesterol levels, the cardio protective properties of foods rich in soluble fibre (particularly fruits and vegetables) are sufficient justification to advocate their increased

consumption by dyslipidaemic patients (Davey *et al.*, 2003). On the other hand, daily fruit juice consumption was higher among the vegetarians (58%) than the non – vegetarians (29%). Fruit juice contains fructose. High fructose intake contributes to TG elevation (Stanhope *et al.*, 2009). Results from this study seem to suggest that fruit juice (even without added sugar) should be consumed in moderation to prevent high TG levels.

5.7.2 Cereals and Grains

The study results showed that more than half of the vegetarians (76%) frequently consumed more cereals and grains than the non-vegetarians (58 %.). Examples of cereals and grains consumed by the participants were maize, rice, millet, and oats. Additionally, these foods provide energy and were major sources of carbohydrates for the participants. Evidence consistently demonstrates a TC – and LDL – C lowering effect of water – soluble fibre from oats, wheat and maize. A daily dose of soluble fibre of 5 – 15 g/day is recommended for LDL – C lowering effect (Rideout *et al.*, 2008).

5.7.3 Deep Fried Foods, Fast Foods and Pastries

Deep fried foods such as fried yam and plantains and fried foods generally, were not commonly consumed by both groups. The results of this study explain the health consciousness of the vegetarians. Fast foods are high in trans-fatty acids. High trans-fatty acids intake have been shown to elevate LDL – C and decrease HDL – C (Richter *et al.*, 2004). Also 49% of the non-vegetarians and 37% of the vegetarians reported a monthly intake of pastries. Common pastries mentioned by the participants included vegetable pies and meat pies. Hardened fats such as

margarines (produced by hydrogenation of vegetable oils) were used in the preparation of pastries. Hardened fats have similar effects as saturated fats. Increased intake of saturated fat increases LDL – C in the blood.

5.8 Limitations of the Study

- i. Failure to include a homogenous vegetarian diet group constituted a limitation to a more uniform data. In this study, vegans and lacto-vegetarians were both included, but analysis was not done separately because of the small numbers.
- ii. Findings of the samples may be generalizable to a similar group in Accra but may not be representative of the total vegetarian population in Ghana.
- iii. The lipid profile of an individual also depends on exercise and physical activities. These factors were not taken into account in the present study. This may be the reason for the lack of significant differences in the lipid profile of vegetarians and non-vegetarians.
- iv. The dietary assessment methods used in this study may have a level of under reporting or over reporting. It is also likely that eating habits were modified to impress the researcher and these might have affected the results.

5.9 Conclusions

The study was not able to clearly establish whether a vegetarian diet improved the serum lipid status of an individual. There was also no significant difference in BMI between vegetarians and non- vegetarians. The prevalence of alcohol consumption for vegetarians (1.9%) was lower than non-vegetarians (66.1%).

Vegetarians had a higher mean diastolic blood pressure than the non-vegetarians in this study. With the exception of protein there were no significant differences in the macro-nutrients intake between the two dietary groups ($p= 0.001$). Only 22% of the vegetarians met the recommended daily intake of protein. Regarding micro-nutrients there was significant difference between the mean folate intake between the two groups ($p= 0.002$). Only 16% of vegetarians met the recommended daily intake of vitamin B₁₂, with only 14% meeting the RDI of vitamin B₆ in this study.

5.10 Recommendations

A larger study of the vegetarian population in Ghana will give a better understanding on the impact of vegetarianism on the lipid profile of Ghanaians

Vegetarians should regularly include a reliable source of vitamin B₁₂ in their diet such as fortified foods or supplements. A variety of plant foods consumed daily can provide all essential amino acids and ensure adequate nitrogen balance.

In counseling sessions, dietitians should not be judgmental of vegetarian diets. As dietitians there is the need to give appropriate information on the pros and cons of vegetarian diets. This will enable the client to make an informed decision.

A healthy diet does not stem merely from eliminating meat and fat, it is of essential importance to stress the benefits of a diversified diet rich in fruits and vegetables, fibre and antioxidants for a desirable lipid profile and safe blood pressure.

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Appendix I

UNIVERSITY OF GHANA

SCHOOL OF ALLIED HEALTH SCIENCES

INFORMED CONSENT FORM

I am Cedell Naa Oblikai Tetteh, conducting a researcher on lipids profile of vegetarians and non-vegetarians. I am a final year student offering MSc. Dietetics with the school of Allied Health Sciences, College of Health Sciences, University of Ghana, Korle Bu. The main focus of this proposed study is to determine the relationship between dietary cholesterol intake and plasma lipids among vegetarians and the general population. About 10ml (2 teaspoons, the amount of blood usually required to test the blood) will be drawn from you to measure lipids in the blood. Your height, weight, and waist circumferences will be measured and be required to answer few questions about yourself.

The information provided will not be harmful to you in any way. You are assured that the information provided will be available only to the scientist conducting the study and will be kept confidential and secure. If the information is published in the scientific journal, you will not be identified by name. This study may contribute to the existing knowledge of vegetarian diet and cholesterol levels. There is no risk involved in the study, except a little discomfort and bruising you will experience at the site of blood drawn. Participating in this study is voluntary, without any cost and you are free to withdraw at any point in time without losing any medical treatment.

The researcher will be available and willing to answer any further questions about the research, now or during the course of the project.

CONSENT

I agree that the research project named above has been explained to my satisfaction and I agree to take part in this study. I understand that I am agreeing by my signature/thumbprint on form to take part in this research project and I understand I will receive a signed copy of this consent form for my records.

NAME OF RESEARCHER: Cedell Naa Oblikai Tetteh

DATE:

SIGNATURE:

TELEPHONE NUMBER: 0243851887

NAME OF PARTICIPANT:

SIGNATURE/THUMBPRINT: DATE:

MOBILE NUMBER:

iii. To protect the environment []

iv. To uphold religious and philosophical principles []

9. Do you have any medical condition? YES [] NO []

9b. If yes please state the condition

10. Are you on cholesterol lowering medication? YES [] NO []

11. Do you take other medication or herbal treatment? YES [] NO []

11b. If yes, please state.....

Life style behaviours

12. Do you smoke? YES [] NO []

12b. If yes how often? Daily [] Weekly [] Monthly []

Occasionally []

13. Do you drink alcohol? YES [] NO []

13b. If yes how often Daily [] Weekly [] Monthly []

Occasionally []

One servings of alcohol: 120ml of wine (½ medium glass of dry wine)

285ml of beer (1/2 large beer bottle, one full mini Guinness)

30ml (1 tot) of spirit, whisky gin, akpeteshi and alcoholic bitters)

60ml of (brandy, vermouth, aperitif)

13c. On average, how many servings of alcohol do you take daily?

.....

ANTHROPOMETRIC AND PHYSICAL MEASUREMENTS

Weightkg

Height.....meters

BMI.....Kg/m²**BLOOD PRESSURE**

Systolic BP..... mm Hg

Diastolic BP.....mm Hg

LIPID PROFILE

LIPIDS

Lab values (mmol/dl)

TRIGLCERIDES

.....

TOTAL CHOLESTEROL

.....

LDL CHOLESTEROL

.....

HDL CHOLESTEROL

.....

24 HOUR RECALL (Section B)

Type of Meal & Time eaten	Food Eaten	Handy Measure	Quantity (g)
Breakfast			
Snack			
Lunch			
Snack			
Supper			
Snack			

Appendix III

**SCHOOL OF ALLIED HEALTH SCIENCES
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA
ACADEMIC AFFAIRS**

**Phone: +233-0302-687974/5
Fax: +233-0302-688291**

**My Ref. No. SAHS/ 10362833
Your Ref. No.**



P. O .Box KB 143
Korle Bu
Accra
Ghana

25th March, 2013.

Ms. Cedell N. O. Tetteh,
Dept. of Dietetics,
SAHS,
Korle Bu.

Dear Ms. Tetteh,

ETHICS CLEARANCE

Ethics Identification Number: SAHS – ET. /10362833/AA/8A/2012-2013.

Following a meeting of the Ethics and Protocol Review Committee of the School of Allied Health Sciences held on Friday 1st February, 2013, I write on behalf of the Committee to approve your research proposal as follows:

TITLE OF RESEARCH PROPOSAL: “Dietary Patterns and Lipid Profile of Vegetarians and Non-Vegetarians in Selected Communities in Accra”

This approval requires that you submit six-monthly review reports of the protocol to the Committee and a final full review to the Committee on completion of the research. The Committee may observe the procedures and records of the research during and after implementation.

Please note that any significant modification of the research must be submitted to the Committee for review and approval before its implementation.

You are required to report all serious adverse events related to this research to the Committee within seven (7) days verbally and fourteen (14) days in writing.

As part of the review process, it is the Committee’s duty to review the ethical aspects of any manuscript that may be produced from this research. You will therefore, be required to furnish the Committee with any manuscript for publication.

Please always quote the ethical identification number in all future correspondence in relation to this protocol.

Thank you.

Yours sincerely,



Dr. (Maj. Rtd.) George Asare
(Chairman, Ethics and Protocol Review Committee)

cc Dean
 Co-ordinator, Dept. of Dietetics
 Senior Assistant Registrar

Appendix IV