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RELATIONSHIP BETWEEN DIETARY FIBRE INTAKE AND BLOOD PRESSURE, LIPID PROFILE AND ANTHROPOMETRIC MEASUREMENTS OF HYPERTENSIVE PATIENTS

This dissertation is submitted to the University of Ghana, Legon

in partial fulfilment of the requirement for the award of MSc. Dietetics Degree

By

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DECLARATION

I, Edinam Aku Numadzi, hereby declare that this dissertation is the result of my own research carried out in the Department of Dietetics, School of Biomedical and Allied Health Sciences, University of Ghana, under the supervision of Dr. Matilda Asante and Professor George Awuku Asare. All references cited in this work have been fully acknowledged.

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ABSTRACT

Background

Hypertension also known as high blood pressure is an issue of global health concern. Globally, hypertension is estimated to cause about 12.8% of total deaths. Dietary fibre is an important component of a healthy diet and has received much attention in recent times due to the vital functions it plays in the human body. Studies have shown that dietary fibre helps in body weight regulation, lipid reduction, improved glucose metabolism, and blood pressure control.

Aim

This study sought to determine the relationship between dietary fibre intake and blood pressure, lipid profile and anthropometric measurements of hypertensive patients.

Methodology

A cross-sectional study was conducted among 190 purposively sampled hypertensive patients. Participants (190) were recruited and interviewed using a structured questionnaire to assess lifestyle factors, demographic and socio-economic information. A quantitative Food Frequency Questionnaire was used to assess dietary fibre intake of the patients. Dietary fibre intake was estimated using the nutrient analysis software Microdiet (version 3.0, Downlee Systems, UK). Blood pressure and anthropometric measurements were also taken. Lipid profile values were obtained from the participant's folder. Data was analyzed with the Statistical Package for Social Sciences (SPSS 23.0). Categorical variables were presented using frequency distribution tables, graphs and bar charts. Independent t-test was used to compare variables among gender. The relationship between dietary fibre intake, BMI, blood pressure, visceral fat and lipid profile values was determined using Pearson's correlation.

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Results

Mean dietary fibre intake of participants was 15.4 ±7.1 g. The major sources of dietary fibre were cereals and grains. Mean BMI (29.4 ± 5.6 kg/m^2) and visceral fat (11.0±3.9) were above normal reference range for both male and female participants. Mean lipid profile values (TC-5.1 ± 1.2 mmol/L, TG-1.4 ± 0.6 mmol/L, HDL-C-1.4 ± 0.5 mmol/L and LDL-C-3.1 ± 1.1 mmol/L) of the participants were within normal range. There was no significant association between dietary fibre and blood pressure, dietary fibre and BMI and dietary fibre and visceral fat ($p>0.05$). However, there was a negative correlation, though not significant, between dietary fibre intake and TG ($p > 0.05$, $r = -0.09$) and dietary fibre and HDL-C ($p>0.05$, $r = -0.85$).

Conclusion

Dietary fibre intake among the hypertensive patients was below the recommended daily intake. Education on adequate dietary fibre intake among these patients must be enhanced by healthcare personnel especially dietitians. Associations between dietary fibre, blood pressure, body mass index, visceral fat and lipid profile were not significant.

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DEDICATION

This work is dedicated to my family and friends who have supported me immensely throughout this journey with prayers and moral support.

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I would like to thank God Almighty for seeing me through this journey. His protection and provision throughout this time has been tremendous and awesome.

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TABLE OF CONTENTS

DECLARATION ……II
ABSTRACT……....IV
DEDICATION……VI
ACKNOWLEDGEMENT……..VII
LIST OF FIGURES……....i
LIST OF TABLES.....ii
LIST OF ABBREVIATIONS……..iii
GLOSSARY……..v
CHAPTER 1……..1
1.0 INTRODUCTION……..1
1.2 Problem Statement…….....4
1.3 Justification.....4
1.4 Aim……...5
1.5 Hypotheses…….....5
CHAPTER 2……6
2.0 LITERATURE REVIEW……...6
2.1 Hypertension…….....6
2.2 Dietary Fibre……...12
2.3 Dietary Fibre And Cardiovascular Diseases…….....18
2.4 Dietary Fibre And Lipid Profile…….....20
2.5 Dietary Fibre And Obesity……22
2.6 Dietary Fibre And Visceral Fat…….....23
CHAPTER 3……24
3.0 METHODOLOGY……24
3.1 Study Design…….....24
3.3 Study Population……....24
3.4 Sample Size Calculation…….....25
3.5 Sampling technique…….....25
3.6 Procedure for data collection…….....26
3.7 Data Management…….....29
3.8 Ethics…….....29

University of Ghana http://ugspace.ug.edu.gh

3.9 Data analysis…….29
CHAPTER 4……..30
4.0 RESULTS……30
4.1 Socio-demographic data of participants……....30
4.4 Consumption of high fibre foods…….....36
4.5 Major food sources of fibre…….....37
4.6 Frequency of consumption of foods…….....38
4.7 Lipid Profile of participants……...43
4.8 Correlation between mean fibre intake, blood pressure, anthropometry and lipid profile……...45
5. CHAPTER FIVE……46
5.0 DISCUSSION……...……...46
5.1. Background characteristics…… 46
5.2 Anthropometric measurements and blood pressure of the participants.....48
5.3 Frequency and major sources of dietary fibre…….....50
5.4 Nutrient and dietary fibre intake…….....51
5.5 Lipid Profile of hypertensive patients……53
5.6 Dietary fibre, blood pressure and anthropometry……..54
5.7 Dietary fibre and lipid profile…….....55
CONCLUSION……..57
RECOMMENDATIONS……...57
LIMITATIONS……..57
REFERENCES……...58
APPENDIX 1……69
APPENDIX II……72

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LIST OF FIGURES

Figure.1.1 Chemical structure of cellulose…….12

Figure 1.2 Chemical structure of pectin…….13

Figure 4.4 Consumption of high fibre foods by participants……..36

University of Ghana http://ugspace.ug.edu.gh

LIST OF TABLES

Table 2.1Various components and recommendations of DASH diet……11

Table 2.2 Dietary fibre requirements……..16

Table 2.3 Fibre content of some foods……...17

Table 4.1 Distribution of socio-demographic data of participants…….31

Table 4.2 Physical activity and medical history of participants…….32

Table 4.3 Blood pressure and anthropometric measurements of participants……33

Table 4.4 Energy and nutrient intake of participants…….34

Table 4.5 Dietary fibre intake among age groups……..35

Table 4.6 Major sources of fibre with mean percentage contributions……..37

Table 4.7a Cereals and grains…….39

Table 4.7b Roots, tubers and baked products…….40

Table 4.7c Legumes, nuts and seeds……...41

Table 4.7d Fruits and vegetables…….43

Table 4.8 Lipid profile values of hypertensive patients……..44

Table 4.9 Correlation between dietary fibre, blood pressure, anthropometry and lipid profile..45

Table A.2 Detailed correlation table between dietary fibre, blood pressure, Body Mass Index, visceral fat and lipid profile…….77

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LIST OF ABBREVIATIONS

AACC- American Association of Cereal Chemists

ACC- American College of Cardiology

AHA- American Heart Association

BCA- Body Composition Analyzer

BMI- Body Mass Index

CAD- Coronary Artery Disease

CVD- Cardiovascular Disease

DASH- Dietary Approaches to Stop Hypertension

GHO- Global Health Observatory

GSS- Ghana Statistical Service

HDL-C- High Density Lipoprotein cholesterol

HM- Hypertension medication

LLM- Lipid lowering medication

LDL-C- Low Density Lipoprotein cholesterol

NCDs- Non communicable diseases

NSP- Non-starch Polysaccharides

OMNIHeart- Optimal Macronutrient Intake Trial for Heart Health

OPD- Outpatients Department

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RO- Resistant Oligosaccharides

RS- Resistant Starches

SCFAs- Short Chain Fatty Acids

TC- Total Cholesterol

TG- Triglycerides

VF- Visceral fat

WHO- World Health Organization

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GLOSSARY

Banku- cooked ball of fermented corn and cassava dough

Kenkey- cooked ball of fermented corn dough

Fufu- pounded boiled cassava and plantain

Jollof- Meal prepared from stewed rice

Tombrown- porridge prepared from roasted corn flour

Tuo zaafi- meal prepared with refined corn flour

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CHAPTER 1

1.0 INTRODUCTION

Hypertension also known as high blood pressure is an issue of global health concern. It is defined by the American College of Cardiology (ACC) and American Heart Association (AHA), (2017) as blood pressure above 130/80 mmHg (Whelton et al., 2018). It is associated with high morbidity and mortality rates which affects public health and socio-economic conditions worldwide. The prevalence of hypertension in Africa is reported to be the highest and has been estimated at 46% among adults, aged 25 years and above. The lowest prevalence exists in America with a rate of 35.1% (WHO, 2013). In Ghana, 38% of women between the ages of 45-49 years and 34% of men aged 50-59 years are hypertensive (Ghana Statistical Service (GSS), 2015). According to an annual report by the World Health Organization (WHO), outpatient (OPD) cases of hypertension in Ghana increased from 799,028 in 2011 to 830,620 in 2014 and are recorded as the most occurring among non-communicable diseases (NCDs) (WHO, 2013).

Hypertension has been noted as a risk factor for cardiovascular diseases (CVDs) (Wu et al., 2015). It has also been shown to contribute to the incidence of metabolic syndrome and also associated with complications of kidney disease in Ghana (Ato et al., 2013). In Africa, industrial urbanization is one of the leading risk factors of hypertension in recent times, lack of physical activity and a diet poor in fruit and vegetable intake, as well as high intake of sodium, saturated fat and carbohydrate-rich diets that lead to obesity are risk factors (Ibrahim & Damasceno, 2012). A study in Italy found that hypertensive men had comparably more fat in the abdominal visceral region than normotensive men (Sironi et al., 2004).

Addo *et al*. (2012) reported a prevalence of 19.3% and 54.6% for both rural and urban Ghana as 19.3% and 54.6% respectively. Furthermore, a hospital study by Sutherland *et al*., (2018) on the

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causes of death in a 37-year review (1979- 2015) revealed that NCDs (60%) were the top cause of death. Among the NCDs, cardiovascular diseases recorded 500 deaths per 1000 between the years 2011 and 2015 making it the leading cause of death in adults followed by cancer. With these stark findings in mind, it is important to note that hypertension is a major risk factor for CVDs such as stroke and ischemic heart disease which are part of the top ten causes of death in the country.

Diet plays a critical role in the prevention and incidence of hypertension. Some studies have associated a decreased risk of hypertension with increased consumption of dietary fibre (Lie et al., 2018; Wei et al., 2017). Dietary fibre from foods such as fruits, vegetables, whole grains and cereals has been reported to have a protective effect from cardiovascular diseases (McRae, 2017).

The American Association of Cereal Chemists International defines dietary fibre as the edible parts of plants or analogous carbohydrates such as cellulose, pectin, and lignin that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation (American Association of Cereal Chemists, 2001). Dietary fibre can be divided into soluble and insoluble in terms of their physical and chemical properties. Soluble fibre can also be subdivided into viscous (gel forming) and non-viscous (El-Salhy, Ystad, Mazzawi, & Gundersen, 2017). The insoluble fibre can be found in fruits, vegetables, whole grains, legumes, and cereals. Soluble fibre includes pectin, gums, certain hemicelluloses, and storage polysaccharides (Jha, Singh, & Prakash, 2017).

Soluble fibre can absorb or bind to lipids present in foods in the gastrointestinal tract which subsequently reduces serum lipids. Soluble fibre also has the ability to swell and become viscous when ingested which increases satiety and thus reduces food intake leading to a lower risk of

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obesity (Gropper, Smith, & Groff, 2009). Other health benefits of dietary fibre include prevention of constipation, management of gastrointestinal diseases such as inflammatory bowel disease (IBD) and ulcerative colitis etc.

The 2015 Dietary guidelines for Americans recommend a dietary fibre intake of 25 g/day for females between the ages of 31–50 and 30 g/day for males of the same age. Also, the Institute of Medicine recommends that adults consume >14 g fibre/1000 kcal (Lie *et al*., 2018). The recommended dietary fibre intake for Ghanaian adults is 25g daily (Ministry of Health, 2009).

Hypertensive patients usually present with poor glycemic control and unfavourable lipid profiles compared with the general population (LaRosa & Kostis, 2013). Diets used in the management of hypertension, such as the DASH and OMNIHeart diets, have been shown to improve blood pressure and blood lipids (Duman, 2013). A study which involved restricted feeding of a high fibre diet which included oats, barley, soy and nuts indicated reductions in low-density lipoprotein cholesterol (LDL-c) (Wong, Comelli, Kendall, Sievenpiper, & Noronha, 2017). An inverse association was also shown between fibre intake, body weight and body fat in cross-sectional observational studies (Parikh et al., 2012). A longitudinal study also found an inverse association between fibre intake and body mass index as well as visceral fat (Slavin, 2005).

There is paucity of published studies of dietary fibre intake of hypertensive patients in Ghana.

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1.1 PROBLEM STATEMENT

Hypertension was reported as the leading cause of cardiovascular mortality in 2013 (World Health Organization, 2013). Worldwide, it has also been estimated that one-third of adults will have hypertension by 2025 (Bhagani, Kapil, & Lobo, 2018). In Africa, a rate above 40% has been recorded for both men and women (WHO, 2013). Hypertension is known to increase risk of cardiovascular diseases making it a public global health concern.

A systematic review and meta-analysis confirmed the association of increased consumption of dietary fibre with low systolic and diastolic blood pressure as well as body weight and lipid profile regulation (Threaplton *et al*., 2013). About 20-30g of dietary fibre per day has been recommended in lowering blood lipids and reducing risk of chronic diseases for which obesity is also a risk factor (Huang *et al*., 2017; British Nutrition Foundation, 2018).

However, there is paucity of data on dietary fibre intake of hypertensive patients in Ghana and any possible relationship with anthropometry and lipid profile is unknown. Also, most of the studies carried out on hypertensive patients in Ghana such as the Ghana Demographic study focused on general dietary patterns of participants (Ghana Statistical Service (GSS), 2015). Hence, data on dietary fibre intake among hypertensive patients as well its effect on blood pressure, serum lipids and weight regulation is undocumented making this study very imperative.

1.3 JUSTIFICATION

The findings of this study will provide information on the sources and intake of dietary fibre of hypertensive patients. It would also provide information on the relationship between dietary fibre intake, blood pressure, BMI and lipid profile values. This study will not only add to literature on hypertension in Ghana but will be useful in planning nutrition education programs and nutrition health policies to reduce the prevalence and mortality associated with hypertension in Ghana.

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It will also be a source of evidence-based data for dietitians and other health care practitioners to support medical nutrition therapy for hypertensive patients.

1.4 AIM

The aim of the study is to determine the relationship between dietary fibre intake and blood pressure, lipid profile and anthropometric measurements of hypertensive patients.

1.4.1 Specific Objectives

The specific objectives for this study were:

1. To estimate mean dietary fibre intake of the patients
2. To determine the major sources of dietary fibre in the diet of patients.
3. To assess blood pressure, anthropometry and lipid profile values of hypertensive patients.
4. To determine the relationships between fibre intake, blood pressure, BMI, visceral fat and lipid profile of patients.

1.5 Hypotheses

H_θ There is no relationship between dietary fibre intake and anthropometric measurements.

H_θ There is no relationship between dietary fibre intake and lipid profile indices.

H_θ There is no relationship between dietary fibre and blood pressure.

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CHAPTER 2

2.0 LITERATURE REVIEW

2.1 HYPERTENSION

Hypertension is a non-communicable disease associated with high morbidity and mortality. It is considered as a silent threat to the health of people worldwide affecting up to one third of the world's population (Gyamfi, Obirikorang, Acheampong, Owusu, et al., 2018). Therefore, it is important that blood pressure levels are examined and checked on regular basis (Duman, 2013).

2.1.1 Types of hypertension

There are two main types of hypertension namely primary or essential hypertension and secondary hypertension. Primary or essential hypertension is the most common form of hypertension which has no known primary cause. It is usually associated with factors such as diet, genes, lifestyle and stress (Kumar, 2014).

Secondary hypertension is a less common type of hypertension due to a specific condition. Hypertension may result as a complication from conditions such as sleep apnea, tumors and kidney failure. Other types of hypertension include isolated hypertension, resistant hypertension and malignant hypertension (Illiades, 2009). Isolated systolic hypertension occurs when the systolic pressure rises above 140 mmHg, while diastolic blood pressure is within the normal range. Malignant hypertension occurs when blood pressure rises very quickly. This requires prompt medical attention. Symptoms include numbness in the arms and legs, blurred vision, confusion, chest pain, and headache. Resistant hypertension occurs when blood pressure is still high even though patient is on treatment (Arakelyan & Sahakyan, 2019).

2.1.2 Classification of hypertension

Hypertension is defined into 4 stages namely: normal, elevated, stage 1 and stage 2. However, the term pre-hypertension was introduced as a new class of blood pressure by the 7th Joint

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National Committee on Prevention, Detection, Evaluation and Treatment of Hypertension (Chobanian et al., 2003). The committee proposed that a systolic BP between 120 and 139 mmHg and/or diastolic BP between 80 and 89 mmHg is indicative of a pre-hypertensive state. People with pre-hypertension have higher chance of developing hypertension and increased risk of major cardiovascular events independent of other risk factors later in life. Stage 1 hypertension is defined as systolic BP of 130 to139 mm Hg or diastolic BP 80 to 89 mm Hg. Stage 2 hypertension is defined as systolic BP >140 mm Hg or diastolic BP >90 mm Hg (Shoulders & Powell, 2019).

2.1.3 Prevalence of hypertension

Cardiovascular diseases accounts for approximately 17 million deaths globally. Out of these deaths, complications of hypertension account for 9.4 million deaths worldwide every year.

The prevalence of hypertension is highest in the African Region at 46% of adults aged 25 and above, while the lowest prevalence at 35% is found in the Americas (WHO, 2013).

A study by WHO-SAGE compared the prevalence of populations over 50 years of age from countries such as China, Ghana, Russia, Mexico, India and South Africa. The highest rate was observed in South Africa which was at a startling rate of 77% due to poor lifestyle choices (Lloyd-sherlock, Beard, Minicuci, Ebrahim, & Chatterji, 2014). Similarly, Gómez-Olivé et al. (2017) observed this same trend in their study where South Africa recorded a significantly higher rate of 54.1% among the countries under investigation. The lowest prevalence of hypertension was among men (19.2%) and women (11.0%) in rural Nanoro, Burkina Faso.

In that same study in rural Navrongo, a prevalence of 24.1% was reported for men and 24.8% for women. According to the Ghana Demographic Health Survey (2014), the prevalence of hypertension among women was highest in Greater Accra (17%) and lowest in Upper West

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(5%). For men, a prevalence of 18.1% and 6.2% was reported in Ashanti and Northern region respectively (Ghana Statistical Service (GSS), 2015). The increasing prevalence of hypertension is attributed to population growth, ageing and behavioural risk factors, such as unhealthy diet, harmful use of alcohol, lack of physical activity, excess weight and exposure to persistent stress (WHO, 2013).

2.1.4 Risk factors of hypertension

Risk factors for hypertension can either be of genetic, behavioural or environmental origin. These could be further grouped into modifiable and non modifiable risk factors (Ibrahim & Damasceno, 2012).

Generally, non modifiable risk factors of hypertension include age, ethnicity and gender. For example, in terms of ethnicity, a study reported that the prevalence of hypertension is twice greater in black people than in white people (Ibrahim & Damasceno, 2012). Similar results have also confirmed that people of black African origin had a higher risk of hypertension compared to white people (Bryson, Ross, Boyko, & Young, 2006; Chaturvedi et al., 2004).

Hypertension is also more common in black Caribbean males and females, and less common in Bangladeshi males and females (Erens et al. 2001). In Ghana, a study by Sanuade et al., (2018) observed a higher prevalence among Ewes (16.2%) and lowest among the Mole Dagbani (9.7%).

Hypertension is known to be more common in older individuals than younger individuals. The relationship between increasing age and rise in systolic blood pressure has been associated with the length of time people are exposed to modifiable risk factors (Gyamfi et al., 2018).

In Africa, significant differences in sex with regards to prevalence of hypertension have shown to be minimal (Sanuade, Boatemaa, & Kushitor, 2018). However, a study by Gómez-Olivé et al.

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(2017) on the regional and sex differences in the prevalence and awareness of hypertension across 6 sites in Sub-Saharan Africa found a significantly higher prevalence in women than men. On the contrary, studies have also showed a significantly higher prevalence in men than women due to differences in hormonal activity early in life (Hulanicka, Lipowicz, Kozieł, & Kowalisko, 2007; Ojeda, Grigore, Robertson, & Alexander, 2007).

Modifiable risk factors of hypertension include diet, physical activity, alcohol, obesity and smoking (Gyamfi, Obirikorang, Acheampong, Danquah, et al., 2018). Increases in the intake of diets rich in sodium, sugar and fats which has led to an increase in the prevalence of obesity, a strong predictor of hypertension (Ibrahim & Damasceno, 2012).

2.1.5 Complications of hypertension

Aside from being known as the silent killer, hypertension affects other vital organs of the body over a period (Nshisso et al., 2012). Constant extreme pressure from blood flow can stiffen arteries thereby reducing the flow of blood and oxygen to the heart. Thus, hypertension may lead to angina (chest pain), heart failure, heart attack and arrhythmia resulting in sudden death. Blood vessels that supply blood and oxygen to the brain can burst or become blocked leading to stroke. Furthermore, hypertension can damage the kidney resulting in kidney failure (WHO, 2013).

2.1.6 Management of hypertension

Hypertension is an under-treated disease due to its asymptomatic nature. Among 50% of patients who do receive treatment, only 10–20% achieve blood pressure goals. Hypertension can be managed through lifestyle changes and medications. Medications such as calcium channel blockers and loop diuretics are available to manage hypertension. Studies have also shown that lifestyle changes that include high physical activity, avoiding alcohol and tobacco along with

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dietary changes can help treat and often delay or prevent hypertension (Shoulders & Powell, 2019). Some proposed dietary modifications to lower blood pressure include reduced salt intake, increased potassium intake, and moderation of alcohol consumption. Over the past decade, expert groups such as the American Heart Association and the National Cancer Institute have recommended the DASH (Dietary Approaches to Stop Hypertension) dietary pattern for both the prevention and management of hypertension (Duman, 2013).

In the time frame between 1996 and 2001, cohort studies in countries such as the USA, Finland and Norway have all reported that subjects consuming relatively huge amounts of whole grain cereals have significantly lower rates of coronary heart disease (CHD). Increased intake of fibre from cereal sources was associated with a reduced risk of CHD in the Nurses' Health Study. It was further noted to be inversely associated with the risk of hypertension in the Health Professionals Follow-up Study (Wu et al., 2015).

2.1.7 The DASH diet

The DASH diet is a diet regimen used in the management of hypertension. It encourages the intake of twice the daily amount of fruits, vegetables, low-fat dairy products, and complex carbohydrates. This type of diet is lower in fat, cholesterol, and sodium, however, contains large amounts of fibre, potassium (K), magnesium (Mg), and calcium (Ca). It is therefore recommended as a nutritional strategy for lowering blood pressure, overweight and obesity (National Heart, Lung and Blood Institute, 2015). Table 2.1.7 shows the various components and their recommended intake of the DASH diet.

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Table 2.1Various components and recommended intake of DASH diet

Nutrients per day	2,300 mg	1500 mg
Calories (kcal)	2027	2078
Total fat (g)	64	68
Saturated fat (g)	13	16
Cholesterol (mg)	114	129
Sodium (mg)	2035	1560
Calcium (mg)	1370	1334
Potassium (mg)	535	542
Magnesium (mg)	4715	4721
Fibre (g)	34	34

Source: (National Heart, Lung and Blood Institute, 2015)

A clinical trial study by Sacks et al. (2001) compared the effectiveness of variants of the DASH diet (fruits and vegetables diet and low fat fruit and vegetable diet) with a 'typical' diet in the United States in lowering blood pressure. Results showed that both intervention diets reduced blood pressure but the DASH diet was more effective in significantly reducing systolic and diastolic blood pressures for both hypertensive and normotensive participants. The DASH diet was also demonstrated to be effective as nutritional therapy in individuals with stage I isolated systolic hypertension with 78% of the persons on the DASH diet reducing their systolic blood pressure to less than 140 mmHg, in comparison to 24% in the control group (Moore, Conlin, Ard, & Svetkey, 2001).

A clinical trial in the United States showed that the DASH diet with sodium restriction in 459 adults provided comparable reductions in blood pressure. The DASH diet reduced both systolic and diastolic blood pressure by 5.5 and 3.0 mmHg more respectively compared to the control diet (Appel et al., 1997). Research has also showed that the DASH diet might also help improve

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lipid profile, control blood glucose and prevent cardiovascular diseases (Duman, 2013; Reddy & Katan, 2004; Ljubicic et al., 2017).

2.2 DIETARY FIBRE

The term 'dietary fibre' was first conceived by Eben Hipsley in 1953. It is referred to as edible plant parts, similar to carbohydrates that cannot be digested or absorbed in the small intestines and as such undergo partial or complete fermentation in the large intestine to produce short chain fatty acids (SCFAs) such as acetate, butyrate and propionate (Prasad, Gurav, Zhu, & Martin, 2017). The chemical bonds present in dietary fibre cannot be digested by enzymes in the gastrointestinal tract of humans. The amounts of short chain fatty acids produced in the lumen of the large intestine are approximately in the ratio 60:20:20 respectively (Ljubicic et al., 2017). Liu et al. (2002) also described dietary fibre as a group of plant-based non-starch polysaccharides (NSP) and lignins that are resistant to human digestion.

It includes non-starch polysaccharides from sources such as fruits, vegetables, cereals and tubers, resistant oligosaccharides (RO) and resistant starch (RS). Figure 1.1 shows the structure of cellulose.

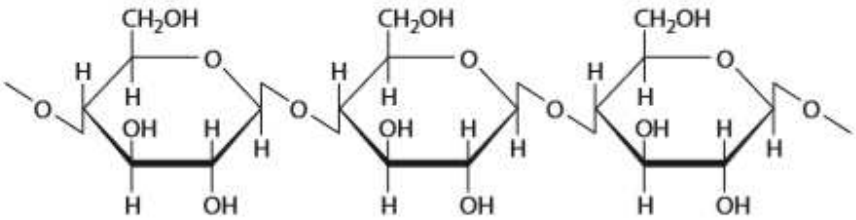

Fig.1.1 Chemical structure of cellulose

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2.2.1 Types of dietary fibre

Dietary fibres are a large group of diverse polysaccharides that are mainly derived from plant cell walls. The length of the monomer is used to classify dietary fibres as short-chain or long-chain carbohydrates. Some long-chain dietary fibres such as pectin, guar gum, and inulin are soluble and extremely fermentable (Gropper et al., 2009). However, other long-chain dietary fibres, such as cellulose and methylcellulose are insoluble and non fermentable (Reddy & Katan, 2002). Fig. 1.2 shows the structure of pectin.

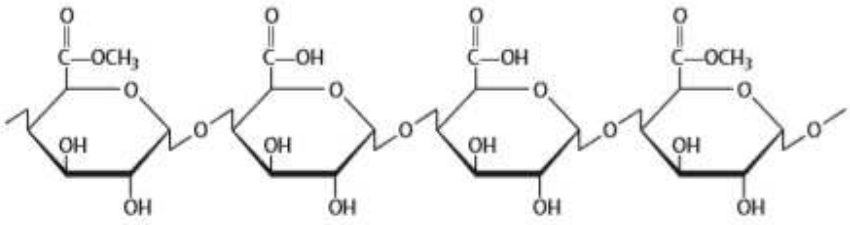

Fig 1.2 Chemical structure of pectin

With regards to solubility in water, dietary fibre can be grouped into insoluble dietary fibre (e.g. cellulose or lignin) and soluble dietary fibre (e.g. pectin) (Lin et al., 2019).

Soluble dietary fibres are broken down by microorganisms present in the gastrointestinal tract. The insoluble part of dietary fibre is undigested and thus mostly serves as a major component of fecal matter. Therefore, high intake of insoluble dietary fibre helps prevent constipation by facilitating proper bowel movement (Prasad et al., 2017).

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2.2.2 Health benefits

Dietary fibres are pre-biotics and thus support the growth of some specific constituents of gut microbiota that promote cardiovascular health (Delzenne et al., 2019).

Dietary fibre can also affect the digestive process of lipids due to viscous fibre which possesses the ability to alter the microstructure of emulsions formed during digestion (Lin et al., 2019). Intake of food sources of soluble fibre can reduce serum cholesterol to normal concentrations which protects against cardiovascular diseases. Adequate intake of insoluble and non-fermentable fibre has been recognized as important in the treatment of several gastrointestinal disorders such as diverticulosis, irritable bowel syndrome, and constipation (Ljubicic et al., 2017).

A generous dietary fibre intake is associated with weight loss or management. High-fibre foods lower the hunger associated with caloric (energy) restriction as well as concurrently extending transit time and hence reducing nutrient absorption and metabolism. The bulk provided by fibre increases satiety with little intake (Slavin, 2013).

Dietary fibre has also been associated with delayed postprandial plasma glucose uptake making it useful in the regulation of blood sugars of patients with diabetes (Li et al., 2019). A study by Flint et al., (2009) revealed an association between cereal fibre and reduced blood pressure in adults.

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2.2.3 Dietary fibre intake

According to WHO guidelines, individuals are advised to consume 400g or have 5 portions of fruits and vegetables to meet their daily dietary fibre requirements (WHO, 2013). Previous studies among African-American women showed that they had lower intakes of dietary fibre than other racial and ethnic group (King, Mainous, & Lambourne, 2012; Kong et al., 2014). A cross-sectional study investigating dietary fibre intake by age, sex, and race reported that non-Hispanic, black females consumed less fibre per day (12.7g/day) compared with European-American women (15.7g/day) as well as non-Hispanic, African-American males (15.0g/day)(Storey & Anderson, 2014). In another cross-sectional study which examined the dietary quality of African-American and Hispanic families in the Special Supplemental Nutrition Program for Women, Infants, and Children, African-American mothers consumed a median fibre intake of 8.8g/day compared to 14.5g/day in Hispanic mothers (Kong et al., 2014).

It is reported that dietary fibre intake in Asians is twice greater than Europeans. It is also reported that Mediterranean countries have high intakes of dietary fibre as well (Gunashekar et al., 2017)

In Ghana, results from a study showed a dietary fibre intake of 6.7 ± 2.2 g/1000kcal compared to 8.3±3.1 g/1000kcal for diasporic Ghanaian adults living in the UK (Gibson, Knight, Asante, Thomas, & Goff, 2015).

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Table 2.2 Dietary fibre requirements

Population group	Age	Total fibre (g)
Men	19-50	38
	>51	31
Women	19-50	25
	>51	21
Children	1-3	19
	4-8	25
Boys	9-13	31
	14-18	38
Girls	9-18	26

(Food and Nutrition Board, 2002)

To ensure adequate intake of fibre, food sources of fibre need to be varied and complementary. Assurance of a good intake of fibre requires daily intake of a variety of high-fibre foods (Gropper et al., 2009). The table below shows the fibre content of some foods.

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Table 2.3 Fibre content of some foods

FOOD	SERVING	FIBRE (g)
Apple with skin	1	3.3
Banana	1	3.1
Orange	1	3.4
Carrots	1 cup	4.8
Kidney beans	1 cup	16.4
Corn	1 cup	2.1
White rice (cooked)	1 cup	0.6
Bread (white)	1 slice	0.6
Peanuts	1 oz	2.3
Almonds	1 oz	3.3
Waakye	100g	3.4
Banku	100g	0.1
Yam	100g	0.5
Kontomire stew	100g	1.4

(Source: www.ars.usda.gov.) and http://huh.harvard.edu) (Eyeson & Ankrah, 1975)

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2.3 DIETARY FIBRE AND CARDIOVASCULAR DISEASES

Studies have reported that dietary fibre reduces the risk of CVDs. A review of meta-analyses by McRae (2017) reported that increased dietary fibre intake reduced the relative risk of CVD incidence and mortality. Across all sites of the study, cardio metabolic risk (metabolic syndrome, inflammation and obesity) was inversely associated with dietary fibre intake, such that the prevalence of metabolic syndrome was 13% for those in the lowest quartile of fibre intake, compared to 9% for those in the highest quartile of fibre intake. Interestingly, twice as many of the participants (38%) in the lowest quartile were obese compared to those in the highest quartile of fibre intake (18%).

A systematic review and meta-analysis study by Threapleton et al., (2013) also provided evidence of increased consumption of dietary fibre especially β-glucan fibre with lower systolic and diastolic blood pressure. These findings were consistent with results from Khan et al., (2018). However, they concluded that viscous soluble fibre supplementation particularly from psyllium had a modest but significant reduction in systolic and diastolic blood pressure.

Another meta-analysis study by Wu et al., (2014) showed that higher fibre intake was associated with decreased incidence of coronary heart disease (CHD). In subgroup analysis, results from studies on different sources of dietary fibre (cereal, fruit and vegetable) intake were analyzed. Results demonstrated a significant association between both higher cereal and fruit fibre intake and decreased CHD incidence ($p= 0.032$, $p= 0.01$ respectively).

However, higher vegetable fibre intake was not significantly associated with CHD incidence. The study also examined the association between soluble and insoluble fibre intake and incidence of CHD. The results indicated that both types of fibre intake were inversely associated with CHD incidence (soluble fibre $r= 0.84$, $p=0.002$), (insoluble fibre, $r= 0.85$, $p= 0.044$). It was

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also discovered that higher fibre intake was significantly associated with decreased mortality of CHD.

Consequently, Sun et al. (2018) in a study on the exploration of the association between dietary fibre intake and hypertension among U.S. adults using 2017 American College of Cardiology/American Heart Association Blood Pressure Guidelines found a nonlinear relationship between total fibre intake and hypertension. The risk of hypertension was reduced by 53% when the total fibre intake increased from 0.07 g/kg/day to 0.35 g/kg/day. However, cereal and vegetable fibre intakes had linear inverse associations with the risk of hypertension.

A study by Maki et al., (2007) analyzed the effects of consuming foods containing oat β-glucan on blood pressure in hypertensive men and women. They followed a randomized, double-blind, controlled clinical trial design and recruited 97 men and women with resting systolic blood pressure values of 130-179 mmHg and/or diastolic blood pressure levels of 85-109 mm Hg. They were randomly assigned to consume foods containing oat β-glucan or control foods for 12 weeks. Blood pressure responses were not significantly different between groups. However, individuals with a body mass index > 31.5 kg/m^2 in the β-glucan group showed decreases in systolic (8.3 mmHg) and diastolic (3.9 mmHg) blood pressures than their control group.

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2.4 DIETARY FIBRE AND LIPID PROFILE

Some studies have showed that excessive adiposity affects lipid profile. Hence, obese or overweight hypertensive patients usually present with abnormal lipid profile values which increases cardiovascular risk (Spannella et al., 2019).

Consumption of foods with low glycaemic index values such as vegetables and legumes improve blood lipid levels with a reduction in total cholesterol (TC), low density lipoprotein cholesterol (LDL-c) and triglycerides (TGs) (Obarzanek et al., 2001). However, some clinical trials have shown inconsistent associations (Sloth et al., 2004; Lin et al., 2012).

A meta-analysis study by McRae (2017) showed that fibres such as β-glucan and psyllium supplementation significantly reduced total serum and LDL cholesterol concentrations.

The mechanism involved in the reduction of total serum cholesterol of dietary fibre was attributed to soluble fibre's ability to bind to cholesterol in the lumen of the small intestine and therefore reduces the absorption of cholesterol. Soluble fibre also increases the fecal excretion of bile acids and this diverts hepatic cholesterol for bile acid production which lowers circulating levels of plasma LDL cholesterol (Raman, Ambalam, & Doble, 2018).

Another study by Mohammadifard et al., (2014) on the inverse association of legumes and dyslipidemia in randomly selected adults in 3 districts in Iran also suggested that the hypolipidemic effect was due to the increase in steroid fecal excretion.

An inverse association between frequency of legume intake and risk of hypertriglyceride, low HDL-C and high LDL-C was observed. In support of their findings, a study by Hermsdoff et al., (2011) also demonstrated that consumption of legume including lentils, chickpeas, peas, or beans (4 servings/week) within a low-calorie diet improved LDL-C and TC values.

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A double-blinded, randomized clinical study examined the effect of inulin in 12 dyslipidemic obese subjects between 19 and 32 years of age. Subjects received 7 g/day of inulin or placebo in the morning. After 4 weeks, a significant reduction in total cholesterol, low-density lipoprotein (LDL) cholesterol, very low-density lipoprotein (VLDL), and triglyceride levels in blood was observed (Balcazar-Munoz, Martinez-Abundis, & Gonzalez-Ortiz, 2003). In the group consuming inulin, serum triglycerides decreased significantly by 40 mg/dL ($P < 0.05$). Studies have been conducted to test effectiveness of dietary fibre in improving blood lipid profiles in healthy individuals. In a randomized, double-blinded, placebo-controlled and parallel design, healthy young individuals consumed 50 g of a rice-based ready-to-eat cereal daily with or without 18% inulin for breakfast. After 12 weeks, the group consuming inulin showed significant decrease in plasma total cholesterol and triglycerides by 7.9 ±5.4% ($P < 0.05$) and 21.2 ± 7.8% ($P < 0.005$), respectively (Brighenti, Casiraghi, Canzi, & Ferrari, 1999).

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2.5 DIETARY FIBRE AND OBESITY

Increased intake of refined foods, industrially processed foods, sugary drinks, red meat and processed meat as well as desserts have been associated with obesity and weight gain. Consequently, increased intake of whole cereals and grains, legumes, nuts, fruits and vegetables have been associated with a lower risk of obesity and weight gain (Malinowska, Mlodzik-Czyzewska, & Chmurzynska, 2020).

Numerous epidemiological studies suggest that a diet high in fibre, especially intake of whole grains or cereal fibre can prevent excessive weight gain. Results from a 12-year dietary data analysis from the Nurses' Health Study revealed that women with the greatest increase in dietary fibre intake gained 1.53kg less on average than females with the smallest increases in dietary fibre intake (Liu et al., 2002).

In that same study, women in the highest quintile of dietary fibre intake had a 49% lower risk of major weight gain than women in the lowest quintile. Results from this study suggested that over the course of the 18-month weight loss maintenance trial, there was a change in the relationship between dietary fibre consumption and BMI over time. At baseline, there was no relationship between dietary fibre consumption and BMI. However, at 6 months, there was a statistically significant negative association between dietary fibre consumption and BMI ($p < 0.05$). This relation remained significant at 18-months and was even stronger than at 6 months. These findings are consistent with the few existing prospective studies investigating associations between fibre intake and weight in African-American women (Buscemi *et al*., 2018).

Evidence of the association between dietary fibre and obesity has also been confirmed by Ben Slama et al., (2011) in a study on dietary fibre in the diets of urban Tunisian women and its association with BMI, waist circumference and blood chemistry. Results from the study showed

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that dietary fibre intake was higher in non-obese women than in obese women. A negative correlation however, was found for mean daily fibre intake and BMI of the study population.

2.6 DIETARY FIBRE AND VISCERAL FAT

Evidence from studies also supports the association between increased dietary fibre intake and visceral fat. A two-year follow up study in Latino children between the ages of 7-11 revealed that an increase in dietary fibre by 3g per 1000kcal was associated with a 4% reduction in visceral fat while a reduction by the same amount was associated with an increase in visceral fat by 21% (Davis et al., (2009). This was also true for a study by Parikh et al., (2012), after they investigated for associations between dietary fibre intake, inflammatory-related biomarkers and central adiposity in adolescents. The study showed that greater dietary fibre consumption was associated with lower visceral adiposity in adolescents.

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CHAPTER 3

3.0 METHODOLOGY

3.1 Study Design

A hospital-based cross sectional study was conducted among hypertensive patients.

3.2 Study Site

The study was carried out at the Dietetic Department of the University Hospital, Legon. The University Hospital was established in 1957 purposely to provide healthcare services for the university staff, staff dependents and students but was open to the general public since 1977. It provides primary, secondary and specialist services in 13 clinical areas which include paediatrics, surgery, obstetrics and gynaecology. It has a 130-bed capacity and an outpatient population of 8000. It is situated in the Ayawaso West Wuogon district (Sutherland, Ansa, Baiden, Quaye, & Amoabeng, 2018).

3.3 Study Population

Participants of the study were hypertensive patients who were reporting to the Dietetics department at the University Hospital.

3.3.1 Inclusion and Exclusion criteria

Hypertensive patients who did not provide consent to participate in the study were excluded.

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3.4 Sample Size Calculation

Using a margin of error of 5% at 95% confidence interval and mean fibre intake among a West African population of 5.6g (Ijarotimi & Keshinro, 2008) and standard deviation of 0.35, a sample size of 190 was computed.

$$n=\left(\frac{Z_{\alpha/2} \text{ x standard deviation (SD)}}{\text{MOE}}\right)^2$$, (Glen, 2018)

where $Z_{\alpha/2}$ is the critical value of the normal distribution at α/2 and MOE= margin of error

$Z_{\alpha/2}$= 1.96

MOE = 0.05

$$n=\left(\frac{1.96 \text{ x } 0.35}{0.05}\right)^2$$

n = 188.24 rounded up to 190

3.5 Sampling technique

The total enumeration technique was employed in this study. This technique involves selecting all eligible participants at the study site. Daily visits were paid to the study site and with the assistance of the dietitian at the Dietetics department, eligible patients were identified. The details of the study were explained to them and their written consent obtained before they were recruited into the study. They were interviewed and physical measurements taken. Recruitment continued until the total number of patients needed was obtained.

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3.6 Procedure for data collection

3.6.1 Socio-demographic and dietary data

Dietary fibre intake of hypertensive patients was assessed using a 31-item quantitative food frequency questionnaire (QFFQ) (Healey et al., 2016). Foods of Ghanaian origin were added to the original questionnaire. The QFFQ listed foods in 7 groups namely; cereals and grains, roots and tubers, breads, legumes, nuts and seeds, baked products, fruits and vegetables. The food frequency questionnaire was validated and pre-tested at the University hospital using 19 participants (10% of calculated sample size). Food models and household handy measures were used to assist in the estimation of portion sizes of usual food intake. Portion sizes were then converted into grams using a food handy measures conversion compilation. The questionnaires were interviewer-administered. A sample of the QFFQ can be found in appendix 1.

3.6.2 Anthropometric data

3.6.2.1 Weight

Weight was measured following standard procedures using a calibrated Body Composition monitor (Omron HBF-516C, USA). The participants were asked to remove footwear, heavy clothing and objects inside of pockets of clothing before standing on the scale. Weight was then recorded to the nearest kilogram. Trained personnel were used to take the measurements to ensure reliability of results.

3.6.2.2 Height

Height was measured using a stadiometer (Seca 213, Germany). Participants were asked to stand erect on the floor board of the stadiometer with their back to the vertical backboard of the stadiometer. The weight of the participant was distributed on both feet. The heels of the feet were placed together with both heels touching the base of the vertical board. The buttocks, scapulae, and head were positioned to make contact with the vertical backboard. The participant was asked

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to inhale deeply and to stand fully erect without changing the position of the heels. The head was maintained in the Frankfort Horizontal Plane position and the horizontal bar of the stadiometer was lowered to the top of the head with enough pressure to compress the hair. Hair ornaments, buns etc. were removed to obtain an accurate measurement. The reading was recorded to the nearest 0.1 cm.

3.6.2.3 Body Mass Index (BMI)

Body Mass Index was determined using a calibrated Body Composition Monitor (Omron HBF-516C, USA). A simple range of values defined as underweight (<18.5 kg/m^2), normal weight (18.5-24.5kg/m^2), overweight (25-29.9 kg/m^2), obese class 1(30– 34.4kg/m^2), obese class 2 (35-39.9 kg/m^2) and obese class 3 (≥ 40 kg/m^2) was used in this study based on the WHO criteria for adults (WHO, 2012).

3.6.2.4 Visceral Fat

Visceral fat of participants was assessed using the Body Composition Monitor (Omron HBF-516C, USA). Classification of visceral fat was obtained from the manual of the Body Composition Monitor and defined as normal (1- 9), high (10 – 15) and very high (>15).

3.6.3 Blood pressure

Blood pressure was measured using a calibrated upper arm BP monitor (Omron M2 Basic, USA). Participants were asked to relax sitting in a chair (feet on floor, back supported) for more than 5 minutes before measurement. Participants were asked to be silent during the rest period or during the measurement. All clothing covering the location of cuff placement was removed before measurement. The participant's arm was supported by resting it on a desk after which the middle of the cuff was positioned on the participant's upper arm at the level of the right atrium (the midpoint of the sternum). Two separate measurements were taken with an interval of 1–2

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minutes. The SBP and DBP were then recorded and the average of the two readings were used for analysis (Whelton et al., 2017).

3.6.4 Lipid Profile

Total cholesterol (TG), total triglycerides (TG), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C) values were obtained from the patient's folder. These values were determined using the Selective Junior auto analyzer at the hospital laboratory. Test values that were done within 3 months at the time of data collection were used. Lipid profile components were classified as shown below and measured in millimole per litre (mmol/L).

Parameter	**Low**	**Normal**	**High**
Total cholesterol	below 3.0mmol/L	3.0-5.2mmol/L	above 5.2mmol/L
Total triglyceride	below 0.01mmol/L	0.01-1.7mmol/L	above 1.7mmol/L
HDL-C	below 1.03mmol/L	1.03-1.55mmol/L	1.55mmol/L
LDL-C	below 2.5mmol/L	2.5-3.5mmol/L	above 3.5mmol/L

(Source- University Hospital Health Information System (HIS), 2019).

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3.7 Data Management

All questionnaires were kept under lock and were accessible to only the research team during the period of collecting data. Data were entered on a password protected laptop and accessible to only the research team. Patient confidentiality was assured in all reports from the study.

3.8 Ethics

The study conformed to the Helsinki Declaration on Human Experimentation of 1975, revised in 1985 and 1989. The proposal was submitted to the University of Ghana, College of Health Sciences Ethics and Protocol Review Committee for ethics approval before the study was carried out (Ref No. EPRC/APRIL/2019). Permission was also sought from the University Hospital, Legon. Consent was finally sought from patients before being recruited into the study.

3.9 Data analysis

Dietary fibre intake and consumption of high fibre foods of patients was determined using Microdiet (version 3.0, Downlee Systems, UK) after portion sizes were converted into grams and divided by 7 to obtain daily dietary fibre intake. Data obtained was analyzed using SPSS version 23.0. Differences in means between male and females were tested using the independent sample T-test. Pearson's Chi Square was used to test for associations between categorical variables. Pearson's correlation was used to determine relationship between dietary fibre, anthropometry and lipid fibre. Significance was set at a $p \leq 0.05$.

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CHAPTER 4

4.0 RESULTS

4.1 Socio-demographic data of participants

Table 4.1 shows the socio-demographic characteristics of the participants. A total of one hundred and ninety (190) participants were recruited for the study. Out of this number, 43.7% were males and 56.3% were females. The mean age of participants was 57.1±12.3 years. The modal age range for the study was 53-59 years (28.42%) followed by the 60-66 years (25.26%). Majority of the participants were Christians (93.2%) and married (74.2%). Table 4.2 also shows physical activity level and medical history of participants. General physical activity level of participants was low. Majority of participants were on hypertensive medication only.

4.2 Blood pressure and anthropometric indices of participants

Table 4.3 shows the blood pressure and anthropometric measurements of participants. The mean BMI of the participants in the study was 29.5±5.6kg/m^2. About 18% of the patients had a normal BMI and 41.1% were obese. The mean BMI for males was significantly lower (p=0.001) compared to females. The mean visceral fat was 11±3.9. The mean visceral fat was significantly higher (p= 0.013) in males than females.

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Table 4.1 Socio-demographic data of participants

Parameter	Male (n = 83) n (%)	Female (n = 107) n (%)	Total (n = 190) n (%)	P-value
Age (years)				
Mean±SD	56.1 ± 14.4	58.0 ± 10.5	57.1 ± 12.3	0.292
15-24	3 (3.6)	1 (0.9)	4 (2.1)	
25-34	4 (4.8)	2 (1.9)	6 (3.2)	
35-44	11 (13.3)	9 (8.4)	20 (10.5)	
45-54	16 (19.3)	18 (16.8)	34 (17.9)	
55-64	27 (32.5)	51 (47.7)	78 (41.1)	
65-74	15 (18.1)	20 (18.7)	35 (18.4)	
75-84	7 (8.4)	6 (5.6)	13 (6.8)	
Religion				
Christian	77 (92.8)	100 (93.5)	177 (93.1)	0.976
Muslim	5 (6.0)	6 (5.6)	11 (5.8)	
Other	1 (1.2)	1 (0.9)	2 (1.1)	
Marital status				
Single	14 (16.9)	12 (11.2)	26 (13.7)	0.056
Married	63 (75.9)	78 (72.9)	141 (74.2)	
Divorced	3 (3.6)	2 (1.9)	5 (2.6)	
Widowed	3 (3.6)	15 (14.0)	18 (9.5)	
Employment status				
Employed	43 (51.8)	58 (54.2)	101 (53.2)	**0.019**
Unemployed	1 (1.2)	12 (11.2)	13 (6.8)	
Retired	34 (41.0)	35 (32.7)	69 (36.3)	
Student	5 (6.0)	2 (1.9)	7 (3.7)	
Level of education				
Primary	4 (4.8)	12 (11.2)	16 (8.4)	**p<0.001**
JHS	5 (6.0)	25 (23.4)	30 (15.3)	
SHS	27 (32.5)	19 (17.8)	46 (24.2)	
Tertiary	37 (56.6)	41 (38.3)	88 (46.3)	
Vocational	0 (0.0)	88 (56.3)	8 (4.2)	
No formal education	0 (0.0)	2 (1.9)	2 (1.1)	

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Table 4.2 Physical activity and medical history of patients

Parameter	Male (n = 83) n (%)	Female (n =107) n (%)	Total (n = 190) n (%)	P-value
Level of physical activity				
Low	49 (75.4)	71 (85.5)	120 (81.0)	**0.041**
Moderate	16 (24.6)	8 (9.6)	24 (16.2)	
High	0 (0)	4 (4.8)	4 (2.7)	
Medical history				
0-2 years	33 (39.7)	27 (25.2)	60 (31.6)	**0.004**
3-5 years	11 (13.3)	20 (18.7)	31 (16.3)	
6-10 years	8 (9.6)	30 (28.0)	38 (20.0)	
< 10 years	31 (37.4)	30 (28.0)	61 (32.1)	
Medication				
No medication	11 (13.3)	11 (10.3)	22 (11.6)	**0.046**
HM only	45 (54.2)	60 (56.1)	105 (55.3)	
HM and LLM	27 (32.5)	36 (33.6)	63 (33.2)	

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Table 4.3 Blood pressure and anthropometric measurements of participants

Parameter	Male (n=81)	Female(n=105)	Total (n =186)	P-value
Weight (kg)	78.9 ± 14.5	81.1 ± 18.9	80.2 ± 17.1	0.360
Height (m)	1.7 ± 0.06	1.6 ± 0.2	1.6 ± 0.1	**p<0.001**
Blood pressure(mmHg)				
SBP	139.1 ± 18.0	135.4 ± 15.5	136.9 ± 16.7	0.130
DBP	82.6 ± 12.6	81.7 ± 10.6	82.1 ± 11.5	0.580
BMI (kg/m^2)	27.5 ± 4.7	30.9 ± 5.9	29.5 ± 5.6	**p<0.001**
Visceral fat	11.8 ± 4.8	10.4 ± 2.9	11.0 ± 3.9	**0.013**
BMI classification n(%)				
Underweight	2 (2.5)	0 (0.0)	2 (1.1)	
Normal	18 (22.2)	13 (12.4)	31 (16.7)	**0.013**
Overweight	38 (46.9)	36 (34.3)	74 (39.8)	
Obese class 1	16 (19.8)	37 (35.2)	53 (28.5)	
Obese class 2	6 (7.4)	13 (12.4)	19 (10.2)	
Obese class 3	1 (1.2)	6 (5.7)	7 (3.8)	
VF classification n(%)				
Normal	25 (31.3)	36 (34.3)	61 (32.9)	**0.001**
High	38 (47.5)	65 (61.9)	103 (55.7)	
Very high	17 (21.3)	4 (3.8)	21 (11.4)	

Data is presented as means ± SD unless otherwise stated *BMI classification (WHO, 2012) VF classification (BCA manual)

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4.3 Nutrient intake

4.3.1 Mean energy, macro-nutrient and fibre intake

Table 4.4 displays the nutrient mean energy, macronutrient and fibre intake of the participants. The daily mean intake of fibre of the participants was 15.4 ± 7.1 g. Dietary fibre intake among males was slightly higher than females. However, this was not significant. The mean daily nutrient intake of energy, protein, fat and carbohydrate was significantly higher ($p<0.05$) in males than females. Percentage contributions for carbohydrate and protein were 68% and 9.5% respectively.

The age group between 35-44 years had the highest dietary fibre intake of 20.1±9.7 g while the age group between 65-74 years had the lowest intake (14.1 ± 7.2 g). Table 4.5 also shows dietary fibre intake across age groups.

Table 4.4 Energy and nutrient intake of participants

Variable	Male (n=83)	Female (n=107)	Total (n=190)	P-value
Dietary fibre (g)	16.3 ± 7.7	14.6 ± 6.6	15.4 ± 7.1	0.090
Energy (kcal)	2052 ± 860	1780 ± 636	1899 ± 753	**0.017**
Carbohydrate (g)	352.2 ± 152.4	300.6 ± 116.8	323.4 ± 135.7	**0.010**
% energy contribution	68.6	67.5	68.0	
Protein (g)	49.6 ± 22.7	41.6 ± 16.9	45.1 ± 20.0	**0.008**
% energy contribution	9.6	9.3	9.5	
Fat (g)	66.3 ± 37.8	52.3 ± 24.2	58.4 ± 31.6	**0.004**
% energy contribution	29.1	26.4	27.7	

Data is presented as means ±SD unless otherwise stated

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Table 4.5 Dietary fibre intake among age groups

Age group	Dietary fibre intake Mean ± SD	p-value
15-24	17.8 ± 5.9	0.476
25-34	18.6 ± 8.6	
35-44	20.1 ± 9.7	
45-54	14.8 ± 6.7	
55-64	14.7 ± 6.6	
65-74	14.1 ± 7.1	
75-84	14.7 ± 6.5	

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4.4 Consumption of high fibre foods

Figure 4.4 shows the consumption of foods high in dietary fibre among participants. About 64.7% participants consumed mostly cereals and grains. Roots and tubers followed with 18.4% participants consuming them. Foods usually consumed in this category included *fufu*, plantain and potatoes. Baked products, legumes, nuts and seeds were not commonly consumed by participants.

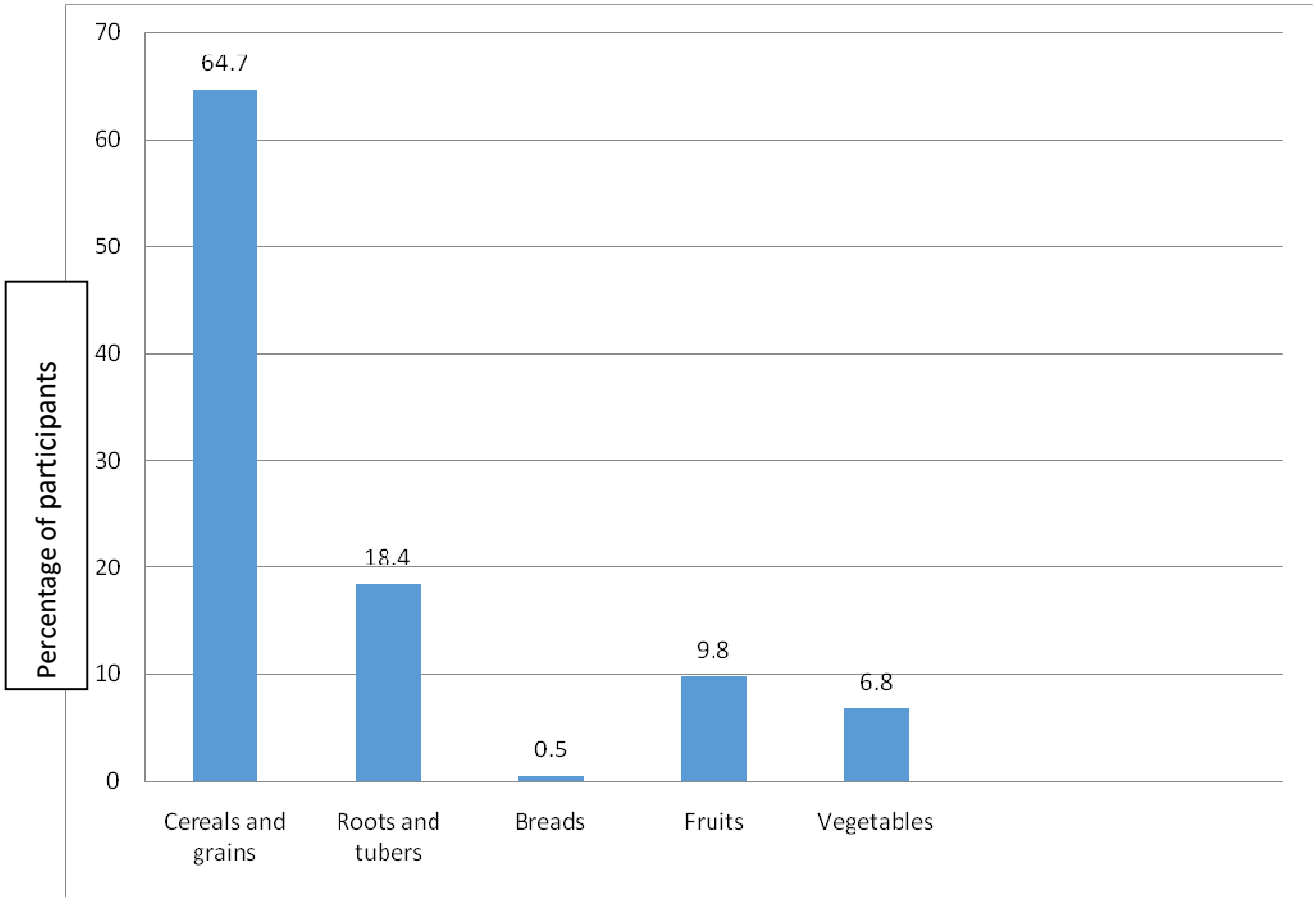

Figure 4.4 Consumption of high fibre foods by participants

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4.5 Major food sources of fibre

The major food sources of fibre among participants were foods in the cereals and grains group. *Tombrown* which was the highest source of fibre contributed 24.52% of overall fibre intake in participants followed by *fufu* which contributed 15.7%. The major source of fibre was analyzed by using information from the percentage contribution data of the Microdiet software for the various foods to obtain an average percentage. Table 4.6 shows the average percentage contribution of foods.

Table 4.6 Percentage contributions of major food sources of fibre in the diet of participants

Food item	% contribution
Tombrown	24.5%
Fufu	15.7%
Millet porridge	15.3%
Oats	15.1%
Corn porridge	14.4%
Salad	14.4%
Kenkey	13.2%
Waakye	12.9%
Mango	12.7%
Wheat	12.6%

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4.6 Frequency of consumption of foods

Breakfast cereals such as wheat, cornflakes and millet porridge were not commonly consumed as majority of the participants did not consume them during the week. However, 33.3% of participants consumed oats 2-4 times during the week. Foods such as *kenkey*, *jollof* and *banku* were commonly consumed by participants.

For roots and tubers, about 62.1% of participants consumed *fufu* once a week. Plantain and yam were also consumed 2-4 times a week by 42.1% and 49.5% of the participants respectively.

With regards to legumes, nuts and seeds, foods such as beans or beans stew, groundnut soup and palm nut soup were consumed once a week by majority of participants. Cashew nuts, roasted groundnuts and *koose* were not consumed by most participants.

Generally, participants consumed fruits and vegetables at least once a week. The fruits which were not consumed by majority of participants were pineapple, grapes and apples. Fruits that were consumed included pawpaw, oranges, bananas and watermelon. Vegetables such as cauliflower, squash and broccoli were also consumed by some participants 2-4 times a week. Stews patronized by majority of participants included vegetable stew (cabbage, carrot, green pepper), *kontomire* stew, okro stew/soup and tomato stew. About 59.5% of participants consumed vegetable salad at least once a week. Beetroot and other vegetables were not commonly consumed by most of the participants.

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Frequency of foods consumed by participants

Table 4.7a: Cereals and grains

FOOD ITEM	Not consumed	Consumed once/week	Consumed 2-4x /week	Consumed 5-7x/week	Consumed >7x/week
Oats	77 (40.5)	38 (20.0)	64 (33.7)	10 (5.3)	1 (0.5)
Tombrown	95 (50.0)	50 (26.3)	41 (21.6)	4 (2.1)	0 (0)
Wheat porridge	135 (71)	29 (15.3)	24 (12.6)	2 (1.1)	0 (0)
Corn porridge	87 (45.8)	42 (22.1)	53 (27.9)	8 (4.2)	0 (0)
Millet porridge	99 (52.1)	51 (26.8)	31 (16.3)	9 (4.7)	0 (0)
Kenkey	56 (29.5)	73 (33.2)	50 (34.7)	5 (2.6)	0 (0)
Rice and beans	62 (32.6)	73 (38.4)	50 (26.3)	5 (2.6)	0 (0)
Banku	24 (12.6)	43 (22.6)	105 (55.3)	16 (8.5)	2 (1.0)
Plain rice/jollof	27 (14.2)	34 (17.9)	111 (58.4)	17 (8.9)	1 (0.5)
Brown rice	157 (82.6)	13 (6.8)	14 (7.4)	5 (2.6)	1 (0.5)
Cornflakes	174 (91.6)	11 (5.8)	5 (2.6)	0 (0)	0 (0)
Weetabix	183 (96.3)	4 (2.1)	3 (1.6)	0 (0)	0 (0)
Tuozaafi	106 (55.8)	57 (30.0)	20 (10.5)	6 (3.2)	1 (0.5)

Data is presented as n (%)

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Table 4.7b: Roots, tubers and baked products

Food item	Not consumed	Consumed once/week	Consumed 2-4x /week	Consumed 5-7x/week	Consumed >7x/week
Fufu	35 (18.4)	118 (62.1)	33 (17.4)	4 (2.1)	0 (0)
Kokonte	113 (59.5)	59 (31.1)	14 (7.4)	4 (2.1)	0 (0)
Boiled/fried plantain	37 (19.5)	66 (34.7)	80 (42.1)	6 (3.7)	1 0.5)
Boiled/fried yam	34 (17.9)	58 (30.5)	94 (49.5)	4 (2.1)	0 (0)
Gari/eba	148 (77.9)	26 (13.7)	13 (6.8)	3 (1.6)	0 (0)
Wheat bread	64 (33.7)	14 (7.4)	43 (22.6)	69 (36.3)	0 (0)
White bread	100 (52.6)	19 (10.0)	41 (21.6)	30 (15.8)	0 (0)
Pastries(meat pie, cake, doughnut etc)	115 (60.5)	62 (32.6)	11 (5.8)	2 (1.1)	0 (0)

Data is presented as n (%)

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Table 4.7c: Legumes, nuts and seeds

Food item	Not consumed	Consumed once/week	Consumed 2-4x/week	Consumed 5-7x/week	Consumed >7x/week
Cooked beans/beans stew	55 (28.9)	76 (40.0)	54 (28.4)	5 (2.6)	0 (0)
Roasted groundnut	117 (61.6)	38 (20.0)	29 (15.3)	6 (3.2)	0 (0)
Cashew	180 (94.7)	8 (4.2)	0 (0)	2 (1.1)	0 (0)
Agushie	162 (85.3)	11 (5.8)	17 (8.9)	0 (0)	0 (0)
Groundnut soup	48 (25.3)	92 (48.4)	45 (23.7)	4 (2.1)	1 (0.5)
Palm soup	36 (18.9)	105 (55.3)	45 (23.7)	1 (0.5)	0 (0)
Koose	110 (57.9)	51 (26.8)	25 (13.2)	4 (2.1)	0 (0)

Data is presented as n (%)

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Table 4.7d: Fruits and vegetables

Food item	Not consumed	Consumed 1-2x/week	Consumed 2-4x/week	Consumed 5-7/week	Consumed >7x/week
Pawpaw	72 (37.9)	56 (29.5)	46 (24.2)	16 (8.4)	0 (0)
Orange	66 (34.7)	46 (24.2)	59 (31.1)	19 (10)	0 (0)
Banana	46 (24.2)	59 (31.1)	65 (34.2)	20 (10.5)	0 (0)
Mango	89 (46.8)	56 (29.5)	34 (17.9)	11 (5.8)	0 (0)
Watermelon	55 (28.9)	72 (37.9)	44 (23.2)	19 (10)	0 (0)
Pineapple	115 (60.5)	37 (19.5)	32 (16.8)	6 (3.2)	0 (0)
Grapes	170 (89.5)	19 (10)	1 (0.5)	0 (0)	0 (0)
Apple	118 (82.1)	50 (26.3)	20 (10.5)	2 (1.1)	0 (0)
Fruit juice	141 (74.2)	31 (16.3)	14 (7.4)	4 (2.1)	0 (0)
Others	164 (86.3)	15 (7.9)	7 (3.9)	4 (2.1)	0 (0)
Vegetable stew	57 (30.0)	41 (21.6)	80 (42.1)	12 (6.3)	0 (0)
Kontomire stew	22 (11.6)	47 (24.7)	114 (60)	7 (3.7)	0 (0)
Tomato stew	28 (14.7)	48 (25.3)	93 (48.9)	21 (11.1)	0 (0)
Garden egg stew	40 (21.1)	60 (31.6)	88 (46.3)	2 (1.1)	0 (0)
Okro/ayoyo/ademe	28 (14.7)	57 (30.0)	91 (47.9)	13 (6.8)	1 (0.5)
Salad	77 (40.5)	37 (19.5)	51 (26.8)	24 (12.6)	1 (0.5)
Beetroot	164 (86.3)	10 (5.3)	13 (6.8)	3 (1.6)	0 (0)
Cauliflower	180 (94.7)	6 (3.2)	3 (1.6)	1 (0.5)	0 (0)
Others	175 (92.1)	3 (1.6)	9 (4.7)	2 (1.1)	1 (0.5)

Data is presented as n (%)

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4.7 Lipid Profile of participants

The lipid profile of participants was obtained from their hospital records. Results are shown in Table 4.8. The mean total cholesterol was 5.10±1.24mmol/L. The mean total and HDL cholesterol concentration of male hypertensive patients was significantly lower ($p<0.05$) compared to females. More than half of the patients (54.1%) had normal total cholesterol, triglycerides and HDL concentration. Forty-two percent (42%) of participants had normal LDL-cholesterol concentrations while 34.2% had high LDL-cholesterol concentrations.

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Table 4.8: Lipid profile of hypertensive patients

Parameter (mmol/L)	Male (n=68)	Female (n=89)	Total (n=157)	P-value
TC (mean ± SD)	4.83 ± 1.12	5.33 ± 1.30	5.10 ± 1.24	**0.012**
Normal (3.0-5.2)	38 (55.9)	47 (52.8)	85 (54.1)	0.321
High (>5.2)	27 (39.7)	41 (46.1)	68 (43.3)	
Low (<3.0)	3 (4.4)	1 (1.1)	4 (2.5)	
TG (mean ± SD)	1.31 ± 0.58	1.3 9 ± 0.60	1.35 ± 0.58	0.388
Normal (0.01-1.7)	59 (86.8)	73 (82.0)	132 (84.0)	0.416
High (>1.7)	9 (13.2)	16 (18.0)	25 (16.0)	
HDL-C (mean ± SD)	1.24 ± 0.45	1.44 ± 0.56	1.35 ± 0.52	**0.020**
Normal (1.03-1.55)	43 (65.2)	49 (57.0)	92 (60.5)	**0.025**
High (>1.55)	7 (10.6)	25 (29.0)	32 (21.1)	
Low(<1.03)	16 (24.2)	12 (14.0)	28 (18.4)	
LDL-C(mean ± SD)	2.98 ± 1.03	3.20 ± 1.16	3.1 ± 1.10	0.190
Normal (2.5-3.5)	30 (45.5)	34 (39.5)	64 (42.1)	0.685
High (>3.5)	21 (31.8)	31 (36.0)	52 (34.2)	
Low (<2.5)	15 (22.7)	21 (24.4)	36 (23.7)	

TC-Total cholesterol TG- Triglycerides Data is presented as n (%) unless otherwise stated

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4.8 Correlation between mean fibre intake, blood pressure, anthropometry and lipid profile

There was no significant association between dietary fibre, blood pressure, anthropometry and lipid profile. A negative relationship, though not significant ($p>0.05$), was found between dietary fibre intake, triglycerides and HDL-C. Table 4.9 shows the correlation values between mean dietary fibre intake, blood pressure, visceral fat, BMI and lipid profile. Detailed results are shown in Appendix 2.

Table 4.9 Correlation between dietary fibre, BP, anthropometry and lipid profile

Parameter	Correlation value	P-value
BMI	.042	.572
VF	.021	.772
TC	-.025	.758
TG	-.091	.259
HDL-c	-.015	.858
LDL-c	.056	.497
SBP	.078	.285
DBP	.132	.070

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5. CHAPTER FIVE

5.0 DISCUSSION

5.1. Background characteristics

Out of the 190 participants recruited for the study, a greater proportion of the participants were females. This is consistent with findings from a comparative cross-sectional study on the interplay of adipokines in the pathogenesis of essential hypertension in Ghana where 68.5% of participants were females (Asibey et al., 2018). Another study by Guwatudde et al. (2015) on the burden of hypertension in Sub-Saharan Africa confirmed these results where 64.6% of participants were females. Similar results were also observed in a study done in Astana, Kazakstan by Supiyev et al. (2015) which saw a higher prevalence of hypertension in women than men.

Gender, marital status and religion were in proportions similar to a cross-sectional study done on the burden and correlates of hypertension in rural Ghana by William et al. (2013). For example, majority of participants in that study were married and Christians as observed in this study. This could be due to Christianity being the dominant religion in Ghana (United States Department of State, 2018)

The World Health Organization (2013) notes aging as a risk factor for hypertension as clearly highlighted in this study. Results showed that approximately 59.47% of the participants were within the ages of 55-74 years. Analysis from a study showed that prevalence of hypertension was significantly higher in adults aged 50 years and above compared to adults aged 18 to 29 years (Guwatudde et al., 2015). Hypertension is associated to increasing age due to physiological changes such as arterial and arteriolar stiffness, decreased baroreceptor sensitivity, increased

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responsiveness to sympathetic nervous system stimuli, changes in renal and sodium metabolism and altered renin-aldosterone relationship (Sanuade et al., 2018).

Previous studies carried out on hypertensive patients across different geographical and ethnic barriers have also shown age as a major risk for hypertension (Williams et al., 2013; Colecraft et al., 2018; James, Kamara, Bah, Steel, & Wardle, 2018).

With regards to level of education, a study on the prevalence and predictors of hypertension in Ghanaian men found that participants with secondary or higher level of education were more likely to have hypertension compared to those without formal education (Nyarko et al., 2017). Also, in a cross sectional study on the prevalence, awareness, treatment and control of arterial hypertension in Astana, Kazakhstan, majority of participants had attained tertiary or higher level of education (Supiyev, Kossumov, Utepova, & Nurgozhin, 2015). This trend was observed in this study as well and could be attributed to the nature of the study site as it serves as a primary healthcare facility for staff and students of the University of Ghana.

Majority of the participants in the study had been diagnosed with hypertension for 6 years and above. Most of them were on one type of antihypertensive medication which correlates with a study by James *et al*., (2018) on herbal use among hypertensive patients attending private and public health facilities in Freetown, Liberia where most of participants were also on one type of antihypertensive medication. Most participants (77.89%) were engaged in some form of physical activity such as brisk walking, gardening, aerobics etc. However, the level of physical activity was low which could be due to the average age range of the participants which prevented them from engaging in very strenuous physical activity such as running, weight lifting and skipping.

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5.2 Anthropometric measurements and blood pressure of the participants

Obesity and overweight have been associated with increased risk of hypertension (WHO, 2013). The mean BMI of participants (29.49 kg/m^2) was similar to that of participants (29.99 kg/m^2) in a study by Lee *et al*. (2014) on noncompliance with medication in hypertensives in Ghana. However, this figure was found to be slightly higher than that of participants in that study (26.15±1.44kg/m^2) in South Asia (Kumar, 2014). Ethnicity, geographical location, diet and physical activity are factors that influence body weight and height and could account for these differences.

However, the mean BMI for male and female hypertensive patients corresponds to findings by Supiyev et al (2015). Comparatively, the mean BMI for females was significantly higher than that of males ($p<0.05$) in this study. The Global Health Observatory (GHO) data on mean BMI for adults aged 18 years and above showed that the mean BMI for women (25.2 kg/m^2) was higher than men (23.9 kg/m^2) in Ghana as at 2016 (WHO, 2016). These differences could be attributed to women having more body fat percentage than men. Also, a comparative study on the BMI of healthy men and women in the United States showed a range of 19.5-30 kg/m^2 for men and 18-30 kg/m^2 for women, a finding similar to this study (Ogden et al., 2006).

Furthermore, Benkeser et al. (2012) examined 2814 Ghanaian women to determine associated risk factors for obesity. The authors found that 37.1% of women were obese, 27.8% were overweight, and 3.6% were underweight. A similar trend was seen in this study with majority of women being obese.

Majority of participants (55.7%) had high visceral fat which is similar to findings from other studies (Sironi *et al*., 2004; Guo et al., 2019).

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High visceral fat is a strong risk factor for cardio-metabolic diseases. Some observational studies have reported associations between visceral fat and dietary fibre intake. The intake of fruit, vegetables, legumes and whole grains help reduce visceral fat mass whereas intake of fried foods and fat, alcohol, red and processed meat, sugar-sweetened beverages and refined grains are associated with higher levels of VF mass (Ozato et al., 2014, 2019; Pallister et al., 2017). The low dietary fibre intake of hypertensive patients may contribute to their high visceral fat.

Furthermore, the association between increased dietary fibre intake and visceral fat was also mirrored by a two-year follow up study in Latino children between the ages of 7-11years. Results revealed that an increase in dietary fibre by 3g per 1000kcal was associated with a 4% reduction in visceral fat while a reduction by the same amount was associated with an increase in visceral fat by 21% (Davis *et al*., 2009). This was also seen for a study by Parikh *et al*., (2012), where they investigated for associations between dietary fibre intake, inflammatory-related biomarkers and central adiposity in adolescents. The study showed that greater dietary fibre consumption was associated with lower visceral adiposity in adolescents.

The mean systolic and diastolic blood pressure of participants was in the stage 1 hypertension category. A study by Williams et al. (2013) on the burden and correlates of hypertension in rural Ghana showed similar results for both SBP and DBP. However, higher results were seen a study by Asibey et al. (2018).

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5.3 Frequency and major sources of dietary fibre

The major sources of dietary fibre in the diet of participants were cereals and grains. Cereals and grains were also the highest source of fibre in a study investigating dietary fibre intake among students a in tertiary institution contributing 58.2% of fibre (Adegoke, Fadupin, & Ketiku, 2006). In Sub-Saharan African countries such as Ghana, cereals and grains serve as one of the main staples (Galbete *et al*., 2017; Adegoke *et al*., 2006; Lie *et al*., 2018, Steyn & Mchiza, 2014).

The major food source of dietary fibre was *tombrown* contributing an average of 24.52% of fibre. On the contrary, a study by (Sardinha et al., 2014) on dietary sources of fibre intake in Brazil found beans as the major contributor to dietary fibre for Brazilian households. Differences in culture, preferences, geographical location and economic determinants of food choices may have contributed to this. It was also observed that in this study consumption of beans was in the form of *waakye* (rice and beans). *Kenkey* (fermented maize ball) was also consumed frequently by most participants in that category. *Kenkey* and *waakye* are commonly consumed and easily available food sold by food vendors in the Greater Accra region. They are also relatively cheaper making it affordable for many people in the community (Asante et al., 2015).

Consumption of foods from roots and tubers ranked next after cereals and grains with *fufu* ranking as the frequently consumed food in this category. This reflects the traditional food pattern observed across West African countries especially for both rural and urban settings (Galbete et al., 2017).

Fufu was also the second highest major source of fibre for participants and contributed an average of 15.70% in the total group. *Fufu* is one of Ghana's common staple foods known all across the country as most food joints and eateries are highly patronized especially on weekends (Lie et al., 2018).

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Fruits such as grapes and apples were not commonly consumed by participants. This could be due to the fact that these fruits are generally expensive and less readily available on the market compared to other fruits (Florkowski, 2019). Commonly consumed fruits included oranges, bananas, watermelon and pawpaw. This was also observed in a study by Kpodo et al. (2015) on fruit and vegetable consumption patterns and preferences of students in a Ghanaian polytechnic.

5.4 Nutrient and dietary fibre intake

The mean dietary fibre (15.4g) intake of the participants was below the recommended intake of 25g/day for both males and females (Ministry of Health, 2014). It was also below the recommended dietary intake for the Institute of Medicine guideline. Comparisons of mean intake of dietary fibre (5.2 g) in a similar study in Nigeria (Ijarotimi et al., 2006) however showed that participants in this study had higher intakes.

The low dietary fibre intake of Ghanaian participants could be associated with the high intake of refined foods such as polished rice and white bread. High fibre foods such as unpolished rice (brown rice), fruits and vegetables were not frequently consumed.

These findings confirm reports in a systematic review paper on obesity and the nutrition transition in Sub Saharan Africa by Steyn and Mchiza (2014) for adults in Capetown, South Africa. The review showed that dietary fibre intake had decreased from 20.7 g to 16.7 g as a result of changing diet patterns.

In a cross-sectional study examining dietary fibre intake by age, sex, and race, Storey et al. (2014) reported that, on average, non-Hispanic, black females consumed less fibre per day (12.7g/day) compared with European-American women (15.7g/day). Thus, European-American women had a higher intake compared to their Ghanaian counterparts (14.6 g) in this study. Non-hispanic, African American males had an intake of 15.0g/day (Storey & Anderson, 2014) which

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was quite lower than what was observed in this study (16.3 g). In another cross-sectional study examining the dietary quality of African American and Hispanic families, African American mothers had a median fibre intake of 8.8g/day compared to 14.5g/day in Hispanic mothers (Kong et al., 2014). These low intakes in such countries could be attributed to low cost of processed foods which makes them more attractive and convenient compared to expensive unrefined foods high in fibre.

A study by Gibson et al. (2015) in which dietary macronutrient components and food sources were compared between native and Diasporic Ghanaian adults showed a lower intake (6.7g) among native Ghanaian adults.

The mean energy intake (1899±753 kcal) was also similar to intakes in a Nigerian study (1877 kcal) that investigated the nutritional knowledge, nutritional intake and nutritional status of hypertensive patients in Ondo state. However, values for carbohydrate and fat intake were lower in that study compared to this study. It was also observed that the mean intake for protein for Nigerian participants was higher (89.7 g) compared to Ghanaian participants in this study (45.1±20.0 g). These differences could be due to differences in food patterns and behaviours between the two countries.

Compared to acceptable Macronutrient Distribution ranges from IOM (IOM, 2005), fat intake of the participants was within acceptable range of 20-35%. Protein intake was lower than recommended intake of 10-35%. Carbohydrate intake, on the other hand was higher than recommended intake of 45-65%.

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5.5 Lipid Profile of hypertensive patients

The mean total cholesterol, triglyceride, HDL-C and LDL-C values for participants were within normal range (TC-3.0-5.2 mmol/L, TG-0.10-1.7 mmol/L, HDL-C-1.03-1.55 mmol/L, LDL-C-2.5-3.5 mmol/L). These results were similar in a comparative cross-sectional study by Asibey et al. (2018) on the interplay of adipokines in the pathogenesis of essential hypertension except for total cholesterol which was high (5.5 ± 1.4 mmol/L) in that study. Also, a cohort study carried out in Sweden on the relation between lipid profile and new-onset atrial fibrillation in patients with systemic hypertension (Swedish Primary Care Cardiovascular Database [SPCCD]) showed normal values for all parameters except total cholesterol (5.4 ±1.1 mmol/L) at baseline (Mourtzinis et al., 2018). Comparisons for gender in this present study, however, showed that the mean lipid profile for females were significantly higher ($p<0.05$) than males which confirms findings from research show women have more total body fat than men which affects lipid profile. The high amount of adipose tissue in the body causes an increase in the rate of lipolysis and free fatty acid turnover that leads to the pathological damage of non-adipose tissue organs such as the liver, pancreas, and blood vessels. The increased flow of free fatty acids directly from the portal system to the liver leads to an increase in the production of Very Low Density Lipoprotein (VLDL) that is rich in triglycerides. Also, there is an increase in the activity of cholesterol ester transfer protein (CETP) and a decrease in lipoprotein lipase (LPL) activity which leads to increased levels of LDL-C and decreased levels of HDL-C in the blood circulation (Okop, Levitt, & Puoane, 2015; Romano Oliosa, 2019; Schorr et al., 2018; Vuvor & Harrison, 2017).

Another study in Hungary by Simonyi et al. in 2007 which sought to determine the relationship between serum lipids and blood pressure in obese patients recorded higher values for mean total

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cholesterol (7.26 ± 1.86 mmol/L), triglycerides (4.19 ± 2.15 mmol/L) and LDL (4.49 ± 2.15 mmol/L) though HDL (1.39 ± 0.63 mmol/L) was within normal range.

Furthermore, higher levels of triglycerides and lower levels of HDL were recorded for hypertensive men in a study that investigated lipid profile in hypertensive men with androgen deficiency (Nasonenko, Vizir, & Sadomov, 2018). Differences in the results of these studies may be as a result of the differences in the study population, geographical location as well as mode of testing.

5.6 Dietary fibre, blood pressure and anthropometry

There was no significant relationship ($p > 0.001$) between dietary fibre and BMI as well as dietary fibre and visceral fat. This result was also observed in a study by Buscemi et al., (2018) where investigators sought to examine the association between fibre consumption and BMI over an 18-month period. There was no significant association between dietary fibre intake and BMI at baseline. However, another study on whole grain and fibre consumption found associations with lower body weight in US adults. Higher consumption of whole grains was inversely associated with lower BMI (O'Neil, Zanovec, Cho, & Nicklas, 2010). This same trend was observed in a cross-sectional study in Saudi Arabian females within the ages of 18 and 30 years. An inverse relationship was found between mean dietary fibre intake, BMI and visceral fat (Bano, Alshammari, & Almedan, 2015). Another study in Japan, showed that soluble dietary fibre intake with other nutrients was significantly inversely associated with visceral fat area (Ozato et al., 2019). Viscous dietary fibre increases satiety due to its bulk and also delays gastric emptying which helps in weight loss thereby accounting for the inverse relationship for both BMI and visceral fat (Slavin, 2013).

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Though other studies have found inverse relationships between dietary fibre, BMI and visceral fat, the direct relationship found in this study could be due to the age range of the population. The studies noted above had populations younger in age compared to this study. A study on BMI in Ghana showed that obesity increased with age especially within the age range of 55-64 years in which the mean age of this study falls (Amoah, 2003). This could also be as a result of the low intake of dietary fibre in this study.

There was no significant association between dietary fibre intake and blood pressure which could be due to the low intake of dietary fibre by participants. However, the mechanism for reducing blood pressure by dietary fibre is not fully understood as some studies have shown eithera significant or insignificant relationship (Maki et al., 2007; Sun et al., 2018; Threapleton et al., 2013; Khan et al., 2018)

5.7 Dietary fibre and lipid profile

Results from this study showed an insignificant negative correlation ($p > 0.05$) for both dietary fibre intake and total triglycerides and dietary fibre intake and HDL-C. The decrease of cholesterol and triglycerides is due to the reduction of absorption of cholesterol, the excretion of fat and bile acids, and probably, the inhibition of synthesis of cholesterol in liver (Villanueva-Suárez et al., 2019)

Studies that have evaluated the relationship between dietary fibre and HDL-C have given inconsistent results. Studies performed in Asian populations supported the fact that dietary fibre was associated with HDL-C while randomized controlled trials in patients with hypertension suggested that increased intake of soluble dietary fibre was not associated with increased HDL-C.

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A meta-analysis by Yanai et al., (2014) showed that the use of barley did not significantly alter HDL-C (p = 0.07) in both healthy and hypercholesterolemic individuals. Also, a clinical trial carried out in China examined the effect of oat consumption on cholesterol levels in Chinese adults with mild to moderate hypercholesterolemia. The authors reported that the HDL-C level remained the same in the intervention group after 6 weeks (Zhang et al., 2012). Zhou et al. (2015) found that a dietary fibre intake of over 30 g/day might be beneficial to males for improving their plasma HDL-C while observing no significant association between dietary fibre intake and TC, LDL-C and TG.

Hannon et al., (2018) in a cross-sectional study also found an inverse relationship between dietary fibre consumption and triglycerides among adults with overweight and obesity which was also observed in this study. The inverse relationship could have possibly been as a result of bile acids binding to dietary fibre during digestion making them less available for micelle formation. The low rate of micelle formation then affects the absorption of cholesterol and triglycerides (Slavin, 2013).

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CONCLUSION

Dietary fibre is known to have numerous health benefits which include weight regulation. The major source of dietary fibre in this study was cereals and grains. Mean BMI was in the overweight category and visceral fat was high among hypertensive patients though lipid profile was normal for majority of the participants. Finally, findings in this study showed no significant association between dietary fibre, blood pressure, BMI and visceral fat. An insignificant negative correlation, however, was observed for dietary fibre and TC and dietary fibre and HDL-C.

RECOMMENDATIONS

Education on the adequate intake of dietary fibre among hypertensive patients must be considered and enhanced by healthcare personnel especially dietitians. More studies of this nature must be done in Ghana to quantify the intake of the various types of fibre such as soluble and insoluble fibre in the diet as they have different physiological effects on the body with regards to disease prevention and management. Also, studies on dietary fibre content in foods, especially Ghanaian foods must be done to help improve dietary fibre intake.

LIMITATIONS

The fibre content of some Ghanaian foods were not available and thus had to be substituted with similar foods from other countries which were available

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APPENDIX 1

CONSENT FORM

DEPARTMENT OF DIETETICS

SCHOOL OF BIOMEDICAL AND ALLIED HEALTH SCIENCES

COLLEGE OF HEALTH SCIENCES

UNIVERSITY OF GHANA

STUDY TITLE: RELATIONSHIP BETWEEN DIETARY FIBRE INTAKE AND BLOOD PRESSURE, LIPID PROFILE AND ANTHROPOMETRIC MEASUREMENTS OF HYPERTENSIVE PATIENTS

I am **EDINAM AKU NUMADZI**, a final year MSc.Dietetics student of the School of Biomedical and Allied Health Sciences, University of Ghana.

I wish to conduct a research on anthropometry, dietary fibre and lipid profile of hypertensive patients attending the Dietetics Department of the University of Ghana Hospital in partial fulfillment of my MSc. degree in Dietetics.

INFORMATION SHEET

This study seeks to determine the relationship between dietary fibre intake on blood pressure, lipid profile and anthropometry of hypertensive patients attending the Dietetics Unit of the University of Ghana Hospital. You have been invited to partake in this study to assess your anthropometry, dietary fibre intake and lipid profile. If you agree, you will be kindly requested to provide information about your health, diet and physical activity**.** Information from your folder will also be assessed to complete other relevant information pertaining to the study with your permission. No blood samples will be collected in this study.

Your participation in the research is entirely voluntary. You may withdraw from the study at any point of the study if you so desire and this will not affect your normal care offered to you at the Dietetics department. You will be given the opportunity to ask any question you do not understand about the research.

We do not envisage any risk to your participation in this study apart from some inconveniences

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that may occur during the interview and your weight and height measurements. Competent and experienced health personnel will ensure that potential discomfort is minimized. Results of the survey will be given to your dietician so that you can be counselled or treated if necessary.

All information you provided during this project will be kept confidential. The forms will not bear your name or any other personal identities but codes will be assigned to each questionnaire and documents that will be used during the study. The data obtained from the study will be useful to improve interventions in the dietary management of hypertension.

You will not incur any cost as a result of your participation in this study

For further enquiries about this research, you can contact the following addresses below:

Researcher's Contact

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Department of Nutrition and Dietetics

University of Ghana

+233-501374051

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University of Ghana

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CONSENT FORM

I have fully explained to ..... the nature and purpose of the above described research, its procedure, risks and benefits.

I have allowed the subject to ask questions and have answer and will answer to the best of my ability, all questions relating to the study.

I,..... have read or has been read to me in a language I understand and understood the nature and purpose of the proposed study. I am aware of the fact that I can withdraw from the study at any point in time without receiving any objection. My signature or thumbprint below indicates that I have given my consent to partake in this study.

.....

Name of Researcher Signature Date

(+233 200531019)

.....

Name of Participant Signature Date

.....

Name of Witness Signature Date

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APPENDIX II

PARTICIPANT'S CODE:..... DATE: .....

SECTION 1: SOCIO-DEMOGRAPHIC DATA

1. Gender... Male [ ] Female [ ]
2. Age ..... years
3. Religion... Christian [ ] Muslim [ ] African Traditionalist [ ] Other .....
4. Marital Status... Single [ ] Married [ ] Divorced [ ] Separated [ ] Widowed [ ]

SECTION 2: MEDICAL HISTORY

5. Duration of hypertension diagnosis .....
6. Drugs taken .....

SECTION 3: SOCIO-ECONOMIC DATA

7. What is your employment status? Employed [ ] Unemployed [ ] Retired [ ]
8. Occupation.....
9. Educational level Primary [ ] JHS [ ] SHS [ ] TERTIARY [ ]

SECTION 4: PHYSICAL ACTIVITY

10. Do you do any form of physical activity/exercise? YES/NO

11. What type of exercise do you do?

Slow Walking [ ]	Aerobics [ ]	Dancing [ ]	Household chores [ ]
Brisk Walking [ ]	Cycling [ ]	Swimming [ ]	Running [ ]
Fast Cycling [ ]	Fast Swimming [ ]	Gardening [ ]	Football [ ]
Basketball [ ]	Volley Ball [ ]	Treadmill [ ]	Rowing Machine [ ]
Heavy occupational manual work [ ]		Jogging [ ]	

Other .....

12. How many days in a week do you exercise?

Once a week [ ]

2 times a week [ ]

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3 times a week [ ]

4 times a week [ ]

5 times a week [ ]

6 times a week [ ]

Every Day [ ]

13. How long do you exercise for?

15 minutes [ ]

30 minutes [ ]

40 minutes [ ]

60 minutes [ ]

> 60 minutes [ ]

14. During the last 7 days, how much time did you usually spend sitting on a weekday?

_____ Hours per day

_____ Minutes per day

15. During the last 7 days how much time did you usually spend sitting on a weekend day?

_____ Hours per day

_____ Minutes per day

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SECTION 5: FOOD FREQUENCY QUESTIONNAIRE

For the following foods, please indicate the number of times eaten in a week and how much eaten using the serving models provided.

Food	**Number of times eaten per week**	**Not applicable**	**Portion size**
CEREALS AND GRAINS			
Oats			---------- soup ladles
Tom brown / Weanimix			---------- soup ladles
Wheat porridge			---------- soup ladles
Corn porridge (koko)			---------- soup ladles
Hausa koko			---------- soup ladles
Kenkey (Ga/ Fante)			--------- fist size
Waakye			-------- stew ladles
Banku			-------- fist size
Plain rice / Jollof rice/ fried rice			--------- stew ladles
Brown/unpolished rice			--------- stew ladles
Cornflakes			--------- cups
Weetabix			--------- pieces
Tuozaafi			--------- fist size
ROOTS AND TUBERS			

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Fufu			--------- fist size
Kokonte			--------- fist size
Boiled/fried plantain			-------- full fingers
Boiled/ fried yam			--------- round slices
Gari/eba			--------- cups
BAKED PRODUCTS			
Wheat bread			--------- slices/rolls
Sugar Bread			--------- slices/rolls
Tea bread			--------- slices/rolls
Butter bread			--------- slices/rolls
Meat pie / doughnut / rock buns/biscuit			--------- pieces
others			
LEGUMES, NUTS AND SEEDS			
Cooked beans/ Beans stew			--------- stew ladles
Roasted Groundnut			---------- cups
Roasted cashew nut			-------- cups
Agushie			---------- cups

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Groundnut soup			---------- soup ladles
Palm soup			--------- soup ladles
Koose			---------- pieces
FRUITS			
Pawpaw			--------- whole fruit
Orange			--------- whole fruit
Banana			--------- fingers
Mango			--------- whole fruit
Watermelon			-------- wedges
Pineapple			--------- whole fruit
Grapes			-------- pieces
Apple			--------- whole fruit
Fruit juice			-------- glass
others			
VEGETABLES			
Vegetable stew			---------- stew ladles
Kontomire stew			---------- stew ladles
Tomato stew			---------- stew ladles
Garden egg stew			---------- stew ladles
Okro/ayoyo/ademe			

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soup/stew			---------- stew ladles
Salads (lettuce, cabbage, carrot, green pepper, shallot)			---------- stew ladles
Beetroot			---------- stew ladles
Cauliflower			---------- stew ladles
others			

SECTION 6: ANTHROPOMETRY

1. **Weight:…… kg**
2. **Height: …….cm**
3. **BMI: …….kg/m^2**
4. **Visceral fat: ……**

LIPID PROFILE

Total Cholesterol- ……mmol/L

Triglycerides- …….mmol/L

HDL-C- ……..mmol/L

LDL-C- …….mmol/L

Thanks for your cooperation!

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Table A.2 Detailed correlation table between dietary fibre, blood pressure, BMI, VF and lipid profile.

	DFI	SBP	DBP	BMI	VF	TC	TG	HDL-C	LDL-C
DFI									
SBP	.078								
	.285								
DSP	.132	.577*							
	.07	0.00							
BMI	.042	.44	.62						
	.572	.55	.40						
VF	.021	.136	.052	.620*					
	.772	.063	.477	.000					
TC	.025	.016	.042	-.023	-.008				
	.758	.84	.61	.774	.919				
TG	-.091	.46	.40	.035	.185	.293*			
	.259	.576	.614	.666	.021	.000			
HDL-C	-.015	.041	.004	.018	-.038	.255*	-.112		
	.858	.612	.567	.830	.641	.002	.171		
LDL	.056	.008	.017	-.018	-.006	.897	.170	-.040	
	.497	.925	.832	.824	.946	.000	.037	.623	

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UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES
ETHICAL AND PROTOCOL REVIEW COMMITTEE

Ref. No.: EPRC/APRIL/2019

April 25, 2019

Edinam Aku Numadzi
Department of Nutrition and Dietetics
SBAHS
Korle-Bu

ETHICAL CLEARANCE

Protocol Identification Number: ***CHS-Et/M.9 – 5.6/2018-2019***

FWA: 00018577 9 **IORG: 0005170** **IRB: 00006220**

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) at its April 25, 2019, full board meeting reviewed and approved your re-submitted research protocol.

Title of Protocol: "The Effect of Dietary Fibre Intake on Lipid Profile and Anthropometric Measurements of Hypertensive Patients"

Investigator: Edinam Aku Numadzi

This approval requires that you submit six-monthly review report(s) of the study to the Committee and a final full review report to the EPRC at the completion of the study. The Committee may observe, or cause to be observed, procedures and records of the study before, during and after implementation.

Please note that any significant modification(s) to this project/study 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 study to the EPRC 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 study. You will therefore be required to furnish the Committee with any manuscript for publication.

This ethical clearance is valid till April 26, 2020.

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

Signed: .....

Professor Andrew Anthony Adjei
Chair, Ethical and Protocol Review Committee

cc: Provost, CHS
Dean, SBAHS
Head, Department of Nutrition and Dietetics