KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, GHANA

Investigating the Impact of Nutrition and Physical Activity on Cardiometabolic Diseases among Adults in Kumasi, Ghana

By

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DECLARATION

I hereby declare that this thesis is my own work and that, to the best of my knowledge, it contains no previously published material except where references have been duly cited, neither has it in part or whole been presented for another degree in this university or elsewhere.

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ABSTRACT

Cardiometabolic disease prevalence has been on the rise not only in the developed countries but also in the emerging economies of developing nations. Unhealthy diet and physical inactivity contribute to the increasing prevalence of cardiometabolic conditions, including obesity, and diabetes with perception of body image being suggested to be a predictor of overweight/obesity development. This study assessed the relationship between nutrition and physical activity level on cardiometabolic traits among 302 healthy Asante adults in Kumasi. A cross-sectional study was conducted in the urban Oforikrom Municipality. Trained field workers administered questionnaires. Demographic and anthropometric data were collected and venous blood samples were taken for biochemical tests. A 3-day repeated 24-hour dietary recall was used to assess dietary intakes. Physical activity was assessed with global physical activity questionnaire (GPAQ). Data was entered into Microsoft excel and analysed with SPSS version 25. There were 126 males (41.7%) and 176 females (58.3%) in the study with mean age of 38.17±9.6 years. About 2 in 5 participants were centrally obese while hyperglycaemia prevalence was low (FBG ≥ 7 mmol/l = 1.3%). Metabolic syndrome and high risk of coronary heart disease (coronary risk) were present in 5.3% and 36.1% of study population, respectively. High coronary risk was strongly associated with LDL (r= 0.921, p-value < 0.001), HDL (r = -0.758, p-value < 0.001), and TC (r= 0.892, pvalue < 0.001). Binary logistic regression showed that high TG and high LDL had significant effects on increased coronary risk (OR=14.2, 95% CI= 1.3-153.5, p-value= 0.029 and OR= 121.4, 95% CI= 15.4-958.3, p-value< 0.001, respectively). Based on WHO's physical activity recommendation of 600 MET- minutes/ week, 68.5% of participants were physically active. Mean energy intake for both males and females was below their RDA. Intake of antioxidant micronutrients (zinc, vitamin C and E) were generally low. Fewer participants (44%) were able to correctly perceive their body image. Among obese people, 26% thought they were normal weight and this could account for why 2 in 5 overweight/obese persons did not desire to lose weight. The

difference in prevalence of both metabolic syndrome and high coronary risk between participants who correctly perceived their body image and those who did not was not statistically significant. In conclusion, cardiometabolic disease and other CVD risk factors were high among apparently healthy adults in Oforikrom Municipality.

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ABBREVIATIONS

AI	Adequate intake
BMI	Body Mass Index
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
FBG	Fasting blood glucose
GPAQ	Global Physical Activity Questionnaire
HbA1c	Glycated Haemoglobin
HDL-C	High Density Lipoprotein Cholesterol
IDF	International Diabetes Federation
LDL-C	Low Density Lipoprotein Cholesterol
MET	Metabolic Equivalents
mmol/L	Millimole per Liter
NCEP ATP III	National Cholesterol Education Program Adult Treatment Panel III
RDA	Recommended Dietary Allowance
SBP	Systolic Blood Pressure
SPSS	Statistical Package for the Social Sciences
T2DM	Type 2 Diabetes Mellitus
TC	Total Cholesterol
TG	Triglyceride
µg/dL	Microgram per deciliter
WC	Waist Circumference
WHR	Waist-to-Hip ratio
WHO	World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

Cardiometabolic disorders or diseases are multifactorial traits arising from the interaction of a number of different factors including genetic and epigenetic factors, diet, physical activity and changes in living environments (Malik *et al*., 2013: Vimaleswaran and Loos, 2010). The obesity, diabetes, dyslipidaemia and hypertension cluster are known factors which increase cardiovascular diseases (CVD) risk and these non- communicable diseases typically co-exist in the same individual (Pi- Sunyer, 2002).

Obesity, hypertension and type 2 diabetes mellitus (T2DM) are among the common cardiometabolic conditions whose prevalence have been on a dramatic rise in the past two decades not only in advanced countries but also in emerging economies of developing nations (Malik *et al*., 2013: Vimaleswaran and Loos, 2010). Though a global epidemic, there is considerable variation globally in the obesity and diabetes problem (Agyemang *et al*., 2016). About 415 million representing 9% and 650 million representing 13% of the global adult population have Type 2 Diabetes Mellitus and are obese respectively (IDF, 2015; WHO, 2017). In Sub- Saharan Africa, an estimated 8% of adults aged above 25 years suffer from diabetes (Alwan, 2010). The situation in Ghana is not much different as about 15%, and 3.2% of adult women and men aged 15- 49, respectively, are obese according to the Ghana Demographic and Health Survey (2014) findings. It has been shown, however, that the urban cities in Ghana have higher prevalence of obesity than rural Ghana mainly due to increasing westernization of diet and low physical activity level with urban obesity prevalence standing at 34% in women and 7% in men aged 25-70 (Agyemang *et al*.,

2016). According to Agyemang *et al*. (2016), 9% of women and 10% in men living in urban Ghana had type 2 diabetes.

Hypertension is a significant public health concern globally and in Ghana as well with both urban and rural areas experiencing relatively high prevalence of high blood pressure. Hypertension burden stands at 16% in urban Ghana and 9% in rural Ghana (Awuah *et al*., 2014; GDHS, 2014; Agyemang *et al*., 2016). The increases in cardiometabolic disease prevalence have been linked to rising trends of overweight/ obesity. For instance, according to the Ghana Demographic and Health Survey (2014), hypertension was a more serious health concern in obese people with 27% of 995 obese women and 51% of 111 obese men being hypertensive.

Popkin *et al*. (2012), stated that the obesity epidemic with its attendant non- communicable diseases was being fuelled by changes in physical activity and diet patterns termed as the nutrition transition. Characterized by increased consumption of sugar-sweetened beverages, edible oils and highly processed or refined foods as well as reduced physical activity levels and increasing sedentary behavior, the nutrition transition which used to be a concern mainly in the higher income countries is now widespread even in rural areas of middle and low income countries in Asia and sub Saharan Africa.

Perception of body image has been suggested to be a predictor of overweight/ obesity development (Duda *et al*., 2007). According to Benkeser *et al*. (2012), having the right perception about their weight status made overweight/ obese women about ten times more likely to desire weight loss compared to normal weight women (OR: 10.12; CI: 8.04-12.72). Understanding individual preferences for various body sizes is of utmost necessity in designing approaches and interventions for preventing and halting the fast rise of obesity prevalence with its attendant metabolic consequences (Duda *et al*., 2007; Benkeser *et al*., 2012)

1.2 PROBLEM STATEMENT

Unhealthy diet and physical inactivity have been shown to contribute to the increasing prevalence of cardiometabolic conditions such as obesity, T2DM, dyslipidaemia and hypertension (Popkin *et al*., 2012). There are a myriad of complications and consequences of these conditions including reduced productivity and economic growth as well as reduced life expectancy (Danquah *et al.*, 2012). The International Diabetes Federation (2015), noted that type 2 diabetes mellitus led to the death of about 4,790 adults in Ghana. The Action to Control Cardiovascular Risk in Diabetes Study (2008), found that a percentage rise in plasma glucose level leads to a corresponding increase in cardiovascular risk by 18% and a 12-14% mortality risk.

High blood pressure has been shown to lead to many complications including cardiovascular diseases (Law *et al*., 2009). However, in spite of these fatal complications of hypertension, the Ghana Demographic and Health Survey (2014) revealed that about 63% and 86% of women and men, respectively aged 15-49 who had hypertension were unaware of their hypertensive status. This is quite alarming as awareness of their disease condition is the first course of action in managing hypertension and other chronic diseases in order to prevent premature disability and death (GDHS, 2014). Without proper awareness, the current trend of non-communicable disease is expected to keep rising.

1.3 MAIN OBJECTIVE

The cardinal aim of the study was to assess the relationship between nutrition and physical activity level on cardiometabolic traits among adults in Kumasi.

1.4 SPECIFIC OBJECTIVES

1. To assess the prevalence of cardiometabolic diseases (obesity, type 2 diabetes, dyslipidaemia and hypertension) and cardiovascular disease risk.
2. To assess nutrient intake and physical activity level of participants.
3. To assess participants' body image perceptions and their relation to obesity.
4. To assess the relationship between nutrition, physical activity and cardiometabolic disease parameters.

1.5 JUSTIFICATION

The Genes, Obesity and Nutrition in Ghana (GONG) Pilot study is the first study of its kind in Ghana. The project is a collaborative work between researchers from the Universities of Chester and Reading, UK and KNUST, Ghana and seeks to identify genetic markers and relevant gene-diet interactions associated with obesity and type 2 diabetes in the Ghanaian population. Results from this study will reinforce the need for more nutrigenetics research that will provide scientific evidence and guidelines for designing nutrigenetics- based personalized nutrition interventions for prevention and control of obesity and type 2 diabetes among Ghanaians.

The study will add to the existing literature on cardiometabolic diseases among Ghanaians and also add to the understanding of the relationship between awareness of weight status and body image perception or dissatisfaction on one hand and the complications of obesity on the other hand, an area that has not been explored much although research in obesity keeps increasing.

CHAPTER TWO

LITERATURE REVIEW

2.1 OVERVIEW OF CARDIOMETABOLIC DISEASES

Globally, cardiometabolic diseases are leading causes of high health- care expenditure, disability, reduced life span and mortality (Kones and Rumana, 2017). According to Kivimaki *et al.* (2017), at age 60, persons with just one cardiometabolic disease were estimated to have life expectancy reduced by 6- 10 years compared to persons who have no such condition. The development and progression of cardiometabolic diseases like hypertension and diabetes mellitus are due to interaction between genetic variations and environmental factors (diet, physical activity, and other lifestyle factors) (Ndisang and Rastogi, 2013). Altered exonic splicing resulting in defective gene regulation could lead to development of cardiometabolic complications (Ndisang and Rastogi, 2013). The term "cardiometabolic disease" was initially used in exercise physiology literature by Pescatello to describe a cluster of disorders- central adiposity, hyperinsulinemia, glucose intolerance, dyslipidaemia and hypertension- which together lead to type 2 diabetes mellitus as well as cardiovascular diseases (Fisher, 2006).

Increased episodes of inflammation have been recognized as a significant pathophysiological factor in cardiometabolic complications. Obesity and diabetes mellitus are associated with increased oxidative and inflammatory activities that progressively cause tissue injury that can result in cardiovascular and kidney complications such as myocardial infarction and end- stage kidney disease (Ndisang, 2010). It has been suggested that proinflammatory cytokines including tumour necrosis factor alpha (TNF-α), interleukin 1β, interleukin 6 (IL-6) and resistin play significant roles in dyslipidaemia, endothelial function impairment and insulin signaling dysfunction (Ndisang, 2010; Ndisang and Rastogi, 2013). Defective oxidative metabolism has also been reported to have a hand in visceral fat gain and subsequent occurrence of insulin resistance (Saljoughian, 2016).

Cardiometabolic diseases are chronic conditions which have also been referred to as 'lifestyle' diseases mainly because the traditional risk factors are associated with lifestyle habits like unhealthy diet, physical inactivity, smoking and drinking thus many strategies for prevention and management of these conditions have involved specific recommendations for behavioural and lifestyle changes (Saljoughian, 2016; Sidney *et al*., 2016). It was estimated by the United States Center for Disease Control (CDC) in 2007 that doing away with only three risk factors namely: smoking, sedentary lifestyle and unhealthy diet would avert 80% of type 2 diabetes mellitus and 80% of cardiovascular diseases and stroke (Saljoughian, 2016). However, it has been difficult to achieve these gains as many interventions have not been efficient in producing long- term improvements in prudent dietary, physical activity and other lifestyle behaviours and thus the pandemic continues (Kraushaar and Kramer, 2009). According to Kraushaar and Kramer (2009), these lifestyle interventions have been inefficient firstly because of inadequate knowledge about cause- effect association between recognized disease risk and disease outcome parameters and secondly due to lack of consumerization (appeal or attractiveness to participants or at- risk individuals) and individualization or personalization.

2.2 OBESITY: DEFINITION AND CAUSES

The World Health Organization has defined obesity as excessive accumulation of fat that can impair health (WHO, 2016). Basically, obesity is a reflection of energy imbalance that is, positive energy balance occurring as a result of dietary or caloric intake exceeding energy expenditure (Popkin *et al*., 2012). However, obesity is multifactorial and involves the interplay of genetic and epigenetic factors and lifestyle factors in the pathogenesis and progression of the condition (Vimaleswaran and Loos, 2010) thus the two main theories for the aetiology of obesity namely the

genetic or endocrinology hypothesis and the energy balance hypothesis. Proponents of the former hypothesis argue that there are biological underpinnings of fat mass accumulation or lipogenesis and that obesity is an inherited condition whereas advocates of the latter hypothesis acknowledge positive energy balance as the reason for obesity development (Van Vliet-Ostaptchouk *et al*., 2012). Proper comprehension of the interrelatedness of the two concepts is necessary for understanding the pathogenesis of obesity and development of policies and other interventions for prevention and management.

It has been suggested that biological insults experienced during foetal and infant developmental stages influence the development of obesity and other chronic diseases in later adult life (Popkin *et al*., 2012).

2.2.1 Obesity Prevalence

Obesity is a growing worldwide pandemic with affected persons in the millions. The prevalence of obesity has been increasing in all low- and middle- income countries and indeed globally since the 1980's (Popkin *et al*., 2012). Findings from the Non- Communicable Disease Collaboration analyses of over 19 million adults revealed that prevalence of obesity globally doubled from 1975 to 2014. The results also estimated obesity (as defined by BMI $\geq$ 30 kg/m^2) prevalence as ranging between 11% and 15% (Collaboration NCDRF, 2016).

In Sub Saharan Africa, similar worrying trends of rising obesity prevalence have been observed amidst the battle against undernutrition and infectious diseases. According to the NCD Risk Factor Collaboration study, mean BMI in Africa increased from 21.9 kg/m^2 (21.3–22.5) to 24.9 kg/m^2 (24.6–25.1) in women and from 21.0 kg/m^2 (95% CI 20.3–21.7) to 23.0 kg/m^2 (22.7–23.3) in men after standardizing for age (NCD-RisC, 2017). In Ghana, the increasing obesity trend is present.

Findings from a systematic review by Ofori- Asenso *et al*. (2016), revealed that the more recent studies (2007 to 2016) reported higher overweight and obesity prevalence compared to the earlier studies (1998- 2006). It was also found that an estimated 25.4% (95% CI 22.2–28.7%) and 17.1% (95% CI = 14.7–19.5%) of Ghanaians were overweight and obese respectively with more women being obese than men (21.9% vs 6.0%). Taking the regions into account, however, it is seen that the more urbanized regions have higher obesity prevalence compared to the less urbanized ones. The Greater Accra region had the highest rate of obesity (28.5%) followed by the Ashanti region (16.7%) with the Northen region recording the lowest rate of 3.7% for women aged 15-49 years (GDHS, 2015). For the men, prevalence of obesity was still highest in Greater Accra region (7.3%) followed again by Central region (3.4%) and lowest in the Volta region (0.3%) (GDHS, 2015). According to Popkin *et al*. (2012), it has been estimated that by 2030, over 1.2 billion adults will be obese globally.

2.2.2 Obesity Measurements

2.2.2.1 Body Mass Index

The Body Mass Index (BMI) is a weight-for-height index frequently used as a measure of generalized obesity which is obtained by dividing the weight (in kilograms) of an individual by the square of the height (in metres) (WHO, 2016). It classifies weight status as underweight, normal weight, overweight and obese as shown in Table 2.1.

Table 2.1: BMI categorization by WHO

Classification	BMI ($kg/m^{2)}$
Underweight	<18.5
Normal	18.5 – 24.9

Overweight	25.0-29.9
Obese	>30

(WHO, 2016)

2.2.2.2 Waist Circumference (WC) and Waist-To-Hip Ratio (WHR)

Waist circumference and waist-to-hip ratio are measures of central obesity or abdominal fat mass. Studies have proven that compared to body mass index, waist circumference serves as a more sensitive criterion for the determination of cardiovascular risk as visceral adipose tissue is known to be metabolically active producing prothrombotic and proinflammatory cytokines that have been implicated in the development of cardiometabolic diseases (Saljoughian, 2016).

The National Heart, Lung and Blood Institute (NHLBI) and the American Heart Association (AHA) define abdominal obesity as waist circumference ≥102cm for men and ≥88 cm for women whereas the International Diabetes Federation defines it as waist circumference ≥94 cm for men and ≥80 cm for women (Alberti *et al*., 2009). WHO (2008), defines abdominal obesity as WHR above 0.90 and 0.85 for men and women, respectively.

2.2.3 Co-Morbidities of Obesity

Obesity leads to dire health consequences and is associated with many co-morbid conditions including: pulmonary embolism, asthma, osteoarthritis, gallbladder disease and oesophageal, breast, ovarian, pancreatic and colorectal cancers (Guh *et al*., 2009).

A systematic review by Kivimaki *et al*. (2017), revealed that as body mass index increases, the risk of having multiple cardiometabolic morbidities (that is, minimum of two of the following conditions: type 2 diabetes, stroke and coronary heart disease) also increases. Compared to healthy weight individuals, overweight persons had a double risk whereas obese persons had more than

ten times risk. Results from many randomized control trials show that high BMI is strongly associated with diabetes mellitus (Kivimaki *et al*., 2017). Obesity also elevates dyslipidaemia and systemic inflammation risk which could eventually lead to both diabetes mellitus, hypertension and other vascular diseases (Van Gaal *et al*., 2006).

Aside detrimental health outcomes, it has been suggested that obese individuals suffer stigmatization, low self-esteem and unfulfilling relationships (Medeiros de Morais *et al*., 2017).

2.2.3.1 Type 2 Diabetes Mellitus

Type 2 diabetes occurs as a result of insufficient secretion of insulin by pancreatic beta cells or inability of the tissues to effectively utilize the insulin produced (insulin insensitivity) and this leads to elevated blood glucose levels that is, hyperglycaemia, a key feature of the condition (IDF, 2015). Known predisposing factors of type 2 diabetes mellitus include central obesity, lipid disorders, ageing and physical inactivity (IDF, 2015). Fasting blood glucose level of 7.0 mmol/L or higher or glycated haemoglobin level of 6.5% or greater is used to diagnose type 2 diabetes mellitus (WHO, 2010a).

Obesity has been reported to be strongly associated with the development of type 2 diabetes mellitus. Field *et al.* (2001), found out that persons with BMI of 35.0 kg/m^2 were 20 times more likely to develop diabetes compared to persons with normal BMI that is, 18.5 kg/m^2 to 24.9 kg/m^2. It has been shown that vitamin D plays a role in enhancing insulin sensitivity. However, in obese persons, vitamin D's effect on insulin sensitivity may be jeopardized (Reyman *et al*., 2014).

2.2.3.2 Hypertension

Hypertension, termed high blood pressure, is a condition in which there is persistently elevated pressure of blood flow in the blood vessels or arteries. Blood pressure (BP) has been typically classified according to the WHO guidelines for the management of hypertension (1999) and the Seventh Report of the Joint National Committee (JNC 7) on Prevention, Detection, Evaluation and Treatment of High Blood Pressure published in 2004 as follows:

Table 2.2: JNC 7 Classification of blood pressure for adults

Blood Pressure classification	SBP (mm Hg)	DBP (mm Hg)
Normal	< 120	and < 80
Prehypertension	120- 139	or 80- 89
Stage 1 hypertension	140- 159	or 90- 99
Stage 2 hypertension	≥ 160	≥ 100

SBP- systolic blood pressure, DBP-diastolic blood pressure

The new 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guidelines for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults published in 2018, however, has come up with a modified classification as follows:

Table 2.3: Categories of blood pressure in adults

Blood Pressure classification	SBP (mm Hg)	DBP (mm Hg)
Normal	< 120	and < 80
Elevated	120- 129	and < 80
Hypertension		
Stage 1	130- 139	or 80- 89
Stage 2	≥ 140	≥ 90

Whelton *et al*., (2018)

According to this new guideline, hypertension is now described as SBP of 130- 139 or a DBP of 80- 89 mm Hg. This new guideline is most invaluable as a support in high blood pressure prevention or treatment decisions in untreated adults.

Obesity, smoking, alcoholism, advancing age, physical inactivity and excessive sodium intake are well known causes of hypertension (Whelton *et al*., 2018). Many epidemiological studies have unfailingly found a direct association between overweight/ obesity and hypertension with estimates of about 40% of hypertension being accounted for by obesity. It comes as no surprise, therefore, that the prevalence of obesity and hypertension have risen simultaneously over the past few decades (Whelton *et al*., 2018).

2..2.3.3 Dyslipidaemia

Dyslipidaemia is a cardiometabolic condition usually defined as the presence of one or a combination of the following serum lipids and lipoproteins: elevated triglyceride levels, elevated total cholesterol level, elevated low density lipoprotein cholesterol levels (LDL-c) and reduced high density lipoprotein levels (HDL-c) (Kasabe *et al*., 2017).

Dyslipidaemia, one of the co- morbid conditions of obesity, is a known risk factor for atherosclerosis and other cardiovascular diseases (Van Gaal *et al*., 2006). Insulin insensitivity secondary to obesity is known to stimulate elevated intracellular triglyceride production with release of non- esterified fatty acid as well as increasing very low density lipoprotein levels while concurrently decreasing HDL-c (Krentz, 2003).

2.3 PERCEPTION OF BODY IMAGE AND ITS ASSOCIATION WITH OBESITY

Body image is a subjective notion about one's physical appearance based on weight, shape and extent of satisfaction with one's appearance (Medeiros de Morais *et al*., 2017). It has been suggested that body image perception and dissatisfaction are linked to obesity- related habits including binge eating and attempted weight loss (Wardle *et al*., 2001). Body image is also associated with impairment in physical and mental facets of quality of life, low self- esteem and

self- confidence, productivity and psychosocial performance (Polivy *et al*., 2013; Mintem *et al*., 2015). Sociocultural beliefs and practices have been cited to influence perception of the ideal body with many African cultures accepting and promoting larger body sizes as ideal especially for women (Ejike, 2015). Puoane *et al*. (2010), in their study of black african adolescent girls in Cape Town, observed that obese girls preferred to be obese mainly because it made them look respectable and healthy. They also observed that a resistance to weight-loss was fuelled by the notion that slender-looking people had HIV/ AIDS or tuberculosis. According to Duda *et al*. (2007), age influenced a woman's weight preference and readiness to lose weight, noting that older women were not so willing to lose weight. Duda *et al*. (2007), also reported in their study of 305 women attending radiology clinic in Accra that, images whose corresponding body mass index were 26.1 kg/m^2 and 26.5 kg/m^2 were most preferred.

Understanding body image preference is said to be crucial in designing and implementing public health interventions for obesity (Benkeser *et al*., 2012).

2.4 CARDIOMETABOLIC DISEASE RISK FACTORS

2.4.1 Non-Modifiable Risk Factors

2.4.1.1 Family History

Cardiometabolic complications are diseases whose genes can be inherited thus these chronic diseases run through family lines. Apart from determining a person's risk of cardiometabolic disease like obesity or diabetes, genetic factors also tend to alter the effects of lifestyle risk factors that is, diet and physical activity (Kilpelainen and Franks, 2014). Findings from family and twin studies by Poulsen *et al.* (1999), showed that between 30- 70% of type 2 diabetes risk could be due to genetic variation. Cederberg *et al.* (2015), also showed that having a family history (that is, first or second degree relative) of type 2 diabetes confers a two- fold diabetes risk on an individual.

Such individual were also shown to be more likely to become overweight or obese compared to those who had no family history of type 2 diabetes.

2.4.1.2 Age

Ageing comes along with compromise in general health including cardiovascular health and this could be a result of factors such as reduced insulin sensitivity which increases diabetes risk and thickening of arterial walls which could lead to increases in blood pressure (Chang and Halter, 2003). Compared with younger people, older persons tend to have higher homocysteine levels, a metabolic compound that has been associated with cardiovascular events (McCully, 2015). It has been suggested that during the menopausal transition, progressive ovarian function loss and hormonal changes leads to fat mass increase with accumulation of adipose tissues more in the abdominal region than in the femur- gluteal region (Fu *et al*., 2011).

2.4.1.3 Gender

Studies have shown that there are differences in cardiometabolic disease risk, progression, prevalence and morbidity between the genders (Humphries *et al.,* 2017). Although women and men have most of the cardiometabolic disease risk factors in common, prevalence of traditional risk factors such as smoking and alcohol abuse is higher in men. However, cardiovascular mortality rates in women is higher than in men worldwide owing to the fact that there are several cardiovascular risk factors that are female- specific such as pregnancy (Humphries *et al.,* 2017).

2.4.2 Modifiable Risk Factors

2.4.2.1 Diet

Excessive intake of macronutrients (carbohaydrates, fats and proteins) leads to obesity and its consequent metabolic complications. According to Popkin *et al*. (2012), increased consumption of sugar- sweetened beverages, saturated fats mainly from animal food sources, trans fat from vegetable oils have been majorly responsible for the surge in prevalence of cardiometabolic conditions including obesity and diabetes.

Adequate amounts of vitamins are needed for optimal physiology and prevention of chronic diseases. Vitamin D deficiency has been suggested to affect insulin sensitivity (Reyman *et al*., 2014). Vitamins B6, B12 and folate are involved in metabolism of homocysteine, a free- radical producing metabolic by- product that increases atherosclerosis susceptibility via induction of endothelial dysfunction thus leading to hypertension and other CVD's (Ganguly and Alam, 2015). Vitamin E is also reported to inhibit oxidation of LDL-c in compromised vascular endothelium (Zhang et al., 2016). Many studies have reported a link between high dietary sodium intake and the development of high blood pressure (Whelton *et al*., 2018).

2.4.2.2 Physical Activity Level

Research has clearly shown that physical activity affects a person's risk of developing a cardiometabolic disease. Whereas increased physical activity exerts positive effects on glucose control and generally enhances cardiometabolic health (Kilpelainen and Franks, 2014; Gillen *et al.*, 2014), sedentary lifestyle promotes energy imbalance and subsequent adiposity thus increasing cardiometabolic disease risk (Popkin *et al.,* 2012). Many population and epidemiological studies have intimated that physical inactivity is one of the aetiologies of obesity and its concomitant chronic conditions like atherosclerosis, diabetes and hypertension (Popkin *et al*., 2012). Reduced

physical activity has been attributed to increasing access to advance technologies that lessen energy expenditure at work as well as changes in transportation, leisure and entertainment activities (Bell *et al*., 2002; Monda *et al*., 2008). A minimum of 30 minutes moderate intensity exercise each day of the week or at least for 5 days is recommended by the American Heart Association to reduce cardiovascular risk (Fletcher *et al.*, 2013). The World Health Organization advocates a minimum of 75 minutes of vigorous intensity aerobic activity or 150 minutes of moderate intensity aerobic activity per week for adults aged 18- 64 years in order to reduce non-communicable diseases and to improve cardiorespiratory and muscular fitness (WHO, 2010b).

2.4.2.3 Other Lifestyle Factors

Stress has been linked to the development and progression of cardiometabolic diseases. Work related stress and other stressful experiences including physical abuse can affect health and increase risk of many chronic conditions (Kivimaki and Steptoe, 2018). In individuals who have a high atherosclerotic plaque burden, stress could be a trigger of cardiovascular metabolic and subsequent cardiovascular disease (Kivimaki and Steptoe, 2018). Stress- pathophysiological changes that could lead to cardiometabolic conditions include pro- inflammatory responses, elevated sympathetic activation with accompanying increases in blood pressure and pro-coagulant responses (Kivimaki and Steptoe, 2018).

Nicotine and other harmful chemicals in cigarette and tobacco impair vascular endothelial function thereby facilitating atherosclerotic plaque formation (Rezk-Hann *et al*., 2018). According to O'Keefe *et al.* (2007), alcohol abuse could lead to impaired glucose control and elevated cardiovascular risk.

CHAPTER THREE

MATERIALS AND METHODS

3.1 STUDY DESIGN

The cross-sectional design was employed in this study to assess the burden of cardiometabolic disease in the study population.

3.2 STUDY SITE

The study was conducted in the Oforikrom Municipality in Kumasi, Ashanti region after being randomly selected from the District Assemblies in Kumasi. The Oforikrom Municipal Assembly is one of the five (5) Municipal Assemblies carved out of the Kumasi Metropolitan Assembly and inaugurated on 15th March, 2018. Oforikrom serves as the capital of the Oforikrom Municipal Assembly. There are seventeen (17) recognized communities in this Municipal Assembly with an estimated total population of 360,254 (www.ghanadistricts.com).

3.3 STUDY POPULATION

Free- living and apparently healthy (with no physical complaints or prior diagnosis of cardiometabolic disease) adult volunteers, both males and females were recruited for the study.

3.4 SAMPLE SIZE

Three hundred and two (302) participants were involved in the GONG pilot study. The Quanto software (version 1.2.4) was used to do the power calculation to determine the sample size needed to see a significant association of the Fat mass and obesity-associated (FTO) genetic variant (with minor allele frequency >10%) with cardiometabolic traits such as BMI.

3.5 SAMPLING PROCEDURE

Five (5) communities (Ayeduase, Bomso, Ayigya, Oforikrom and Kotei) were selected randomly from the list of communities in the Oforikrom Municipal Assembly. In each community, a central point was located (a vehicle station, market place or other landmark). A field worker entered the first house that faced either North, South, East or West of that central point and simple randomly recruited one respondent from each household. Upon exiting a house, the next house was entered and the house-level selection process repeated.

3.6 INCLUSION CRITERIA

- Age: 25 years to 60 years of age
- Asante (both parents must be Asante)
- Apparently healthy

3.7 EXCLUSION CRITERIA

- Subjects less than 25 years old or older than 60 years
- Those with existing cardiovascular complications or disease
- Those with previous history of hypertension, T2DM or CVD
- Subjects with any communicable or non-communicable chronic diseases
- Pregnant women
- Subjects on lipid lowering drugs/ anti-diabetic drugs/ anti-hypertensive drugs

A medical screening questionnaire was developed to screen participants for inclusion or exclusion from the study.

3.8 DATA COLLECTION

Structured questionnaires were used to elicit information about participants' demographic characteristics, dietary intakes, physical activity levels, body image perception, sleep and sunshine exposure patterns and medical history. Field workers were trained prior to the start of data collection. Survey instruments were also pre-tested on 10th July, 2018 to enhance field workers' understanding of questionnaires, ensure clearness and avoid ambiguity. Data collection took place from 16th July to 17th August, 2018.

3.8.1 Anthropometry

The following anthropometric data were taken: height, weight, percentage visceral fat, body fat percentage, waist circumference and hip circumference. The measurements were taken with respondents wearing light clothing. Height was measured with a stadiometer (Seca 213 mobile stadiometer, Germany) to the nearest 0.1 cm with participants standing upright. Weight was measured using an OMRON Body Composition Analyzer to the nearest 0.1kg. The same equipment provided values for body mass index (BMI), percentage body fat (BF) and visceral fat (VF). Waist and hip circumference measurements were taken using a non-extensible measuring tape with participant in light clothing. The waist circumference (WC) was measured just above the naval to the nearest 0.1 cm whereas the hip circumference (HC) was measured at the level of the greater trochanter to the nearest 0.1 cm. Waist-to-hip ratio (WHR) was calculated by dividing WC by HC. Obesity was defined as WC and WHR >102cm and >0.90 for males and >88cm and >0.85 for females, respectively as recommended by WHO (WHO, 2016).

Weight categories based on BMI were defined according to the WHO (2016), criteria as follows: <18.5 kg/m^2 as underweight; 18.5 – 24.9 kg/m^2 as normal weight; 25.0-29.9 kg/m^2 as overweight; and >30 kg/m^2 as obese.

3.8.2 Dietary Assessment

A three- day repeated (two weekdays and one weekend) 24- hour dietary recall method was used to elicit information concerning participants' dietary intake. Participants were requested to recollect all meals taken as well as the times of meal consumption in the previous day. Common household measures were used to estimate the actual quantities of foods and drinks consumed by the participants. The nutritional composition of foods eaten was then analyzed using the Nutrient Analysis Template (Food Science and Nutrition Department, University of Ghana, 2010).

3.8.3 Blood Pressure Measurement

Subjects were seated and an appropriately sized cuff was placed on the upper arm. Blood pressure, both systolic and diastolic readings, was taken in triplicates in five minute intervals using the digital sphygmomanometer (OMRON, Japan). The mean blood pressure values were computed and recorded. Blood pressure was categorized as follows: Normal- systolic blood pressure (SBP) <120 mm Hg and diastolic blood pressure (DBP) <80 mm Hg, elevated or pre-hypertension- SBP 120–139 mm Hg and DBP 80- 89 mm Hg and Hypertension- SBP ≥140 mm Hg or DBP ≥90 mm Hg (WHO, 1999).

3.8.4 Physical Activity Assessment

The health-related physical activity level of participants was measured using the interviewer-administered Global Physical Activity Questionnaire (GPAQ) version 2 developed by the WHO

for physical activity surveillance. This questionnaire contains 16 questions (P1- P16) which gathers information on respondent's engagement in physical activities under three domains or settings (work- related activity, transportation and recreational activities) as well as sedentary behaviour. Total physical activity per week was calculated in Metabolic Equivalents (MET-minutes) and respondents who had total physical activity ≥ 600 MET- minutes/ week were classified as active while those who had < 600 MET- minutes/ week were classified as inactive in accordance with WHO recommendations on physical activity for adults (WHO, 2010b; www.who.int).

3.8.5 Body Image Perception

Participants' perception of their body image was assessed using the Stunkard Figure Rating Scale (FRS). The scale consists of a series of nine (9) human silhouettes of males and females with the first being the leanest and the ninth being the most obese based on BMI classifications.

3.9 Biochemical Data

About 7 ml of an 8-12 hour fasting blood sample was collected via venipuncture from each participant by a trained phlebotomist for determination of lipid profile, glycated haemoglobin and fasting plasma glucose. About 4 mL of the blood sample was dispensed into a gel activator tube and the remaining 3 mL was dispensed, 1.5 mL each, into a fluoride tube for fasting blood glucose (FBG) and an EDTA tube for glycated haemoglobin test. Ice chests containing ice packs were used to temporarily store and transport blood samples from the field to the Clinical Analyses Laboratory, KNUST for analysis. Serum was obtained from the blood samples in the gel activated tube by centrifuging for ten minutes using and an eppendorf centrifuge 5804 at 4000 rotations per

minute (rpm). Test kits from Medsource Ozone Biomedicals Pvt. Ltd. were used for all the biochemical tests.

3.9.1 Principle of Fasting Plasma Glucose

$$\text{Glucose} + O_2 + H_2O \xrightarrow{\text{Glucose Oxidase}} \text{Gluconic acid} + H_2O_2$$

$$H_2O_2 + \text{Phenol} + \text{4 -aminoantipyrine} \xrightarrow{\text{Peroxidase}} \text{Red quinoneimine complex} + H_2O$$

Glucose oxidase oxidizes glucose present in plasma to yield gluconic acid and hydrogen peroxide which subsequently reacts with hydroxybenzoate and 4-aminoantipyrine in the presence of peroxide enzyme to give a red-violet quinoneimime dye.

3.9.1.1 Method

The blood samples in the fluoride tubes were centrifuged for about 5 minutes in a centrifuge (automatic integra 400 plus, Roche Diagnostics GmbH, Germany) after being allowed to stand for about 10 minutes. About 10 µL of the plasma obtained after centrifugation was pipetted into labeled test tubes and 1 mL of glucose reagent was added. The test tubes were incubated in a water bath at a temperature of 37°C for 10 minutes. A blank was prepared by pipetting about 10 µL of deionized water into a labeled test tube and adding 1 mL of glucose reagent to it. The absorbance of the solution was read at 510 nm using a semi- automated spectrophotometer (Biolabo Diagnostic Kenza Biochemistry Try, France) to determine blood glucose concentration.

3.9.2 Glycated Haemoglobin (HbA1c) Test Principle

Whole blood is haemolyzed and then mixed with weak binding cation- exchanging resin continuously for 5 minutes. Non glycated haemoglobin adheres to the resin during mixing thereby detaching the glycated haemoglobin in the precipitate. The precipitate binding the glycated haemoglobin is divided from the resin by a filter after mixing. The ratio of absorbance of glycated

haemoglobin fraction to the total haemoglobin fraction is measured to determine the percentage of glycated haemoglobin (Gabbay *et al.*, 1977; Gonen and Rubenstein, 1978).

3.9.2.1 Method

Preparation of haemolysate

About 250 µL of the lysing reagent was pipetted into already labelled sample tubes after which about 50 µL of properly mixed whole blood was added and then incubated at room temperature for complete lysis of erythrocytes to occur.

Preparation of glycated haemoglobin

Pre- filled resin tubes had their stoppers removed and then about 100 µL of haemolysate was added. Into the resin tubes, the resin separators were inserted such that the rubber sleeve of the separators was about 1 cm above the resin suspension surface. The haemolysate in the labeled tubes were mixed for 5 continuous minutes on a stirrer and afterwards, the resin separators were inserted to firmly pack resin at the bottom for the supernatant to enter the separator tubes. The supernatant was transferred into a cuvette and absorbance was read at 415 nm using distilled water as blank.

Preparation of total haemoglobin

About 5 mL of deionised waterwas pipetted into previously labelled tubes after which about 20 µL of haemolysate was added to each tube and then properly mixed after which absorbance was read at 415 nm against distilled water blank.

Percentage of glycohaemoglobin A1 (GHbA1%) was determined using the formular below

$$\frac{Abs\ of\ glycohaemoglobin\ (Ghb)}{Abs\ of\ total\ haemoglobin\ (Thb)}\ X\ 5.2\ (assay\ factor)$$

Using a conversion table, percentage glycated haemoglobin A1c (HbA1c %) corresponding with the %GHbA1 calculated was obtained.

3.9.3 Lipid Profile [Serum Triglyceride (TG), Total Cholesterol (TC), Low Density Lipoprotein Cholesterol (LDL-C), High Density Lipoprotein Cholesterol HDL-C)]

The gel and clot activator tubes with about 4 ml blood samples were allowed to stand for about 30 minutes after which they were centrifuged (Eppendorf Centrifuge 5804, Eppendorf Netheler-Hinz, Germany) for about 10 minutes at 4000 rpm to obtain the serum. Lipid profile parameters were determined from the serum using reagents from Fortress Diagnostics Limited, UK.

3.9.3.1 Serum Triglycerides Test Principle

Triglycerides + H_2O $\xrightarrow{Lipase}$ glycerol + fatty acids

Glycerol + ATP $\xrightarrow{GK,\ Mg^{2+}}$ glycerol -1-phosphate + ADP

Glycerol - 1-phosphate + O_2 $\xrightarrow{GPO}$ H_2O_2+ dihydroxyacetone phosphate H_2O_2

+ 4- aminoantipyrine + p – chlorophenol $\xrightarrow{Peroxidase}$ 4- (p- benzoquinone-monoimino)- phenazone + 2H_2O + HCL

GPO - glycerol phosphate oxidase, GK - glycerol kinase

3.9.3.1.1 Method For Determining Serum Triglyceride (TG) Concentration

Using a sterile automatic micropipette, about 10 µL of serum was pipetted into a labelled sterile test tube and 1000 µL of triglyceride reagent was added afterwards. The test tube was gently stirred and incubated for 5 minutes in a 37℃ water bath. Concentration of triglyceride was determine by

reading absorbance of the red coloured dye at 505 nm with 1 cm light path cuvette in a semiautomated spectrophotometer.

3.9.3.2 Total Cholesterol (TC) Test Principle

Cholesterol Esters $\xrightarrow{CHE}$ Cholesterol + Fatty Acids

Cholesterol + O_2 $\xrightarrow{CHO}$ Cholesten-3-one + H_2O_2

2 H_2O_2 + 4- aminoantipyrine + Phenol $\xrightarrow{Peroxidase}$ Quinoneimine + 4 H_2O CHE- cholesterol esterase, CHO- cholesterol oxidase

3.9.3.2.1 Method For Determining Total Cholesterol Concentration

Using a sterile automatic micropipette, about 10 µL of serum was pipetted into a labelled sterile test tube and 1000 µL of cholesterol reagent was added afterwards. To 10 µL of deionized water in another test tube, 1000 µL of cholesterol reagent was added to constitute the blank solution. After gentle stirring, the test tubes were incubated in a 37°C water bath for 5 minutes after which absorbance was read at 500 nm using a semi- automated spectrophotometer.

3.9.3.3 Determination Of Serum HDL-C Concentration

A semi- micro assay was used in determination of serum HDL-C concentration. Using a sterile automatic micropipette, about 200 µL of serum transferred into a labelled sterile test tube and about 500 µL of HDL precipitant reagent was added. LDL-C got precipitated from the serum leaving the HDL-C as supernatant when the reagent which contains phosphotungstic acid and magnesium chloride was added. After gentle mixing, the test tubes were incubated at room temperature for 10 minutes followed by centrifuging at 4000 rpm for 10 minutes in an Eppendorf

Centrifuge after which the CHOD-PAP method was used to estimate HDL-C content. A blank solution was prepared by pipetting about 100 µL of deionized water into a sterile test tube followed by addition of about 1 mL of HDL reagent. About 100 µL of the supernatant serum HDL was pipetted into sterile test tubes followed by addition of 1 mL HDL reagent after which the test tubes were gently mixed and incubated at 37℃ in a water bath for 5 minutes. HDL- cholesterol concentration was then determined by measuring absorbance at 500 nm using a semi- automated spectrophotometer (Humalyzer Junior, Human GmBH Germany).

3.9.3.4 Serum LDL-C Concentration

The Friedewald formula below was used to compute concentration of LDL-cholesterol in all the samples:

LDL-C = TC − [HDL-C + (TG/ 2.2)] (mmol/l).

3.10 DEFINITIONS

Central obesity was categorised as WC ≥ 102 cm (men) and ≥ 88 cm (women). Overweight and obesity were also defined as BMI ≥ 25.0 kg/m^2 and BMI ≥ 30.0 kg/m^2 respectively (WHO, 2008: WHO, 2006). Type 2 diabetes was defined as FBG ≥ 7 mmol/l or HbA1c ≥ 6.5% (WHO, 2006). Mean BP ≥ 140/90 mm Hg was designated as hypertension (WHO, 1999). Serum lipids were defined as follows: elevated triglycerides ≥ 1.69 mmol/L, elevated total cholesterol ≥ 5.17 mmol/L, elevated LDL ≥ 3.36 mmol/L and reduced HDL < 1.03 mmol/L (men) and < 1.29 mmol/L (women) (NCEP ATP III, 2001).

Metabolic syndrome was classified as the presence of at least three of these five conditions: impaired fasting plasma glucose (≥ 5.6 mmol/L), elevated blood pressure (systolic ≥ 130 mm Hg

or diastolic ≥ 85 mm Hg), reduced high density lipoproteins (< 1.03 mmol/L in men and < 1.29 in women), elevated triglycerides (≥ 1.7 mmol/L) and central obesity (waist circumference ≥ 102 cm in men and ≥ 88 cm in women) (NCEP ATP III, 2001).

The ratio of total cholesterol to HDL cholesterol is a useful index for the prediction of coronary heart disease risk. TC/HDL-C ratio < 3.5 was designated as low coronary risk while high coronary risk was defined as TC/ HDL-C ≥ 3.5 (Lima *et al*., 2011).

Body dissatisfaction was defined as the difference or discrepancy between a participant's chosen actual and ideal body image. If a participant chose the same image silhouette as actual and ideal body image, thereby receiving a score of zero, the participant was said to have no body dissatisfaction. Any other score was indicative of dissatisfaction with body image. (Mutale *et al*., 2016).

3.11 DATA ANALYSIS

Data was entered in Microsoft excel and the Statistical Package for the Social Sciences (SPSS) version 25 was employed for analysis of data. Sociodemographic characteristics, anthropometric and biochemical parameters were analyzed using descriptive statistical analysis and expressed as percentages, frequencies, means and standard deviations. Physical activity data were processed and analysed in line with the Global Physical Activity Questionnaire (GPAQ) version 2 analysis framework. The Nutrient Analysis Template was used to analyze dietary intake of various macro and micro nutrients. Pearson's Chi-square test was used to analyse associations between categorical variables. Means of continuous variables were compared using one- way analysis of variance (ANOVA). Correlation analysis was performed to determine associations between nutrient intake, cardiometabolic syndrome (metabolic syndrome) parameters and cardiovascular

disease risk. Binary logistic regression analysed effects of cardiometabolic risk factors on coronary risk. P- value ≤ 0.05 was deemed to be statistically significant for all analysis.

3.12 ETHICAL APPROVAL

The study received approval from the Council for Scientific and Industrial Research (CSIR) Institutional Review Board (IRB) on 8th June, 2018 for a one year period (Ref: RPN 003/CSIRIRB/2018). Also, the Metro Director of Health Services, Kumasi granted approval for the study to be carried out (KMHD/MPHs/13). All study participants agreed to partake in the study by appending their signatures to the printed consent form.

CHAPTER FOUR

RESULTS

4.1 INTRODUCTION

This chapter presents findings of the study. It reports sociodemographic, anthropometric and biochemical data, physical activity level, dietary intake and body image perception gathered from 302 apparently healthy adults in Oforikrom municipality.

4.2 SOCIODEMOGRAPHIC AND LIFESTYLE CHARACTERISTICS OF RESPONDENTS

The study involved 302 participants of which 126 (41.7%) were males and 176 (58.3%) were females. Majority of the participants were in the age category of 25 to 39 years (58.6%). Majority 166 (55.0%) of study participants were married or cohabiting. Participants who were single numbered 108 (35.8%). Only 16 (5.3%) participants were educated up to the tertiary level but the majority 181 (59.9%) had up to Junior high school or Form four education. Fifteen (5.0%)

participants had no formal education. Informal occupations like trading dominated 245 (81.1%) while participants who were unemployed numbered 28 (9.3%). One hundred and fifty seven, representing 52.0% lived in compound houses. Few participants smoked (4.7%) while those who took alcohol numbered 88 (30.2%). Majority of participants 207 (68.5%) met the WHO recommendation of at least 600 MET- minutes of physical activity per week. Table 4.1 displays the demographic and lifestyle characteristics of study participants.

Table 4.1 Sociodemographic and lifestyle characteristics of participants

Sociodemographic data	Frequency	Percentage
Age category (years) 25 – 39	177	58.6
40 – 49	79	26.2
50 – 60	46	15.2
Total	302	100.0
Sex		
Male	126	41.7
Female	176	58.3
Total	302	100.0
Marital status		
Single	108	35.8
Married or cohabiting	166	55.0
Divorced or separated	20	6.6
Widowed	8	2.6
Total	302	100.0
Education		
None	15	5.0
Primary	22	7.3
JHS	181	59.9
SHS/Voc/Tech	68	22.5
Tertiary (degree)	16	5.3
Total	302	100.0
Occupation		
Formal	29	9.6
Informal	245	81.1
Unemployed	28	9.3
Total	302	100.0
Housing		
Separate	92	30.5
Semi- detached	26	8.6
Flat/apartment	24	7.9

Compound house	157	52.0
Hut(same compound)	1	0.3
Kiosk/ container	1	0.3
Living quarters attached to office/shop	1	0.3
Total	302	100.0
Alcohol intake		
Yes	88	30.2
No	203	69.8
Total	291	100.0
Smoking Yes		
	14	4.7
No	281	95.3
Total	295	100.0
Physical Activity		
Meet WHO recommendation	207	68.5
Below WHO recommendation	95	31.5
Total	302	100.0

Some responses missing for certain participants resulting in total less than 302 for some variables

4.2 ANTHROPOMETRIC, BIOCHEMICAL AND CARDIOMETABOLIC DISEASE PARAMETERS OF PARTICIPANTS

The prevalence of cardiometabolic diseases and other cardiovascular disease risk factors among healthy adults are presented in Table 4.2. One hundred and seventy- six participants representing 58.3% were overweight or obese. Central obesity was higher in women than in men (68.2% vs 2.4%) with an overall prevalence of 40.7%. The prevalence of hypertension stood at 28.5%. Low prevalence of hyperglycaemia based on fasting blood glucose and glycated haemoglobin were recorded at 1.3% and 4.1%, respectively. Prevalence of dyslipidaemia was 64.5%. Serum total cholesterol and low density lipoprotein (LDL) levels were high in 191 (63.9%) and 147 (49.2%) of participants respectively. Metabolic syndrome was present in 5.3% of the study participants. Assessment of participants' risk of developing coronary heart disease (coronary risk) using TC/HDL ratio revealed that 108 (36.1%) out of 299 participants had high coronary risk.

Table

4.2 Prevalence of cardiometabolic conditions among healthy adults in Kumasi

Cardiometabolic condition	Total, N	Frequency	Percentage
Obesity (BMI)			
Overweight	302	108	35.8
Obesity	302	68	22.5
Overweight/obesity	302	176	58.3
Central obesity (WC)			
Men ≥102 cm	126	3	2.4
Women ≥ 88 cm	176	120	68.2
Overall	302	123	40.7
Hypertension			
High blood pressure	302	86	28.5
Prehypertension	302	121	40.1
Hypertension *			
High blood pressure	302	181	59.9
Elevated blood pressure	302	26	8.6
Hyperglycaemia FBG			
≥ 7 mmol/l	300	4	1.3
HbA1c ≥ 6.5%	296	12	4.1
Dyslipidaemia	299	193	64.5
High TC	299	191	63.9
High TG	299	19	6.4
High LDL-C	299	147	49.2
Reduced HDL-C	299	4	1.3
Coronary risk low			
	299	191	63.9
high	299	108	36.1
Metabolic Syndrome	300	16	5.3

*blood pressure classification based on new 2017 ACC/ AHA/ AAPA/ ABC/ ACPM/ AGS/ APhA/ ASH/ ASPC/ NMA/ PCNA Guidelines for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults. Some biochemistry data missing for some participants.

The prevalence of metabolic syndrome and coronary risk by some sociodemographic and lifestyle factors are displayed in Table 4.3. A very low prevalence of metabolic syndrome was observed in men (0.8%) compared to an 8.6% prevalence in women. Similarly, prevalence of high coronary risk was higher in females (41.1%) than in males (29.0%). With respect to age, metabolic

syndrome prevalence was highest among the 50 to 60 year olds (13.0%) and least among the 25 to 39 year olds (1.1%). The trend was similar in prevalence of high coronary risk- 52.2% in the 50 to 60 year olds and 29.1% in the 25 to 39 year olds. All of these associations were statistically significant.

Statistically significant difference was observed in the prevalence of metabolic syndrome between active participants (3.4%) and inactive participants (9.5%). High coronary risk was present in 42.1% of inactive participants and in 33.3% of active participants but this was not significant statistically. Differences in prevalence of metabolic syndrome in those who took alcohol (2.3%) and those who did not (5.9%) was not statistically significant. Also, a statistically not significant difference in prevalence of high coronary risk was observed between alcohol consumers (32.6%) and non- alcohol consumers (35.6%). The difference in prevalence of both metabolic syndrome and high coronary risk between participants who correctly perceived their body image and those who did not was not statistically significant.

4.3 Prevalence of metabolic syndrome and coronary risk by sociodemographic and

Table

lifestyle factors

Sociodemographic/	Metabolic syndrome		Coronary risk lifestyle factor	
Gender	Present	Absent	Low	High
Male	1 (0.8%)	124 (99.2%)	88 (71.0%)	36 (29.0%)
Female	15 (8.6%)	160 (91.4%)	103 (58.9%)	72 (41.1%)
P- value	**0.003**		**0.038**	
Age				
25 – 39	2 (1.1%)	173 (98.9%)	124 (70.9%)	51 (29.1%)
40 – 49	8 (10.1%)	71 (89.9%)	45 (57.7%)	33 (42.3%)
50 – 60	6 (13.0%)	40 (87.0%)	22 (47.8%)	24 (52.2%)
P- value	**0.001**		**0.006**	
Physical Activity				
Inactive	9 (9.5%)	86 (90.5%)	55 (57.6%)	40 (42.1%)
Active	7 (3.4%)	198 (96.6)	136 (66.7%)	68 (33.3%)
P-value	**0.049**		0.156	
Alcohol intake Yes				
	2 (2.3%)	85 (97.7%)	58 (67.4%)	28 (32.6%)
No	12 (5.9%)	190 (94.1%)	130 (64.4%)	72 (35.6%)
P- value	0.242		0.686	
Image Perception				
Correct	6 (4.5%)	127 (95.5%)	86 (64.7%)	47 (35.3%)
Wrong	10 (6.0%)	157 (94.0%)	105 (63.3%)	61 (36.7%)
P- value	0.616		0.810	

Data shown as frequencies and percentages. Fischer's exact test was used to compare categorical variables with two groupings while chi- square was used in comparing variables with three or more groupings.

The means of various anthropometric, biochemical and lifestyle parameters of study participants were compared and are displayed in Table 4.4.

The mean age was significantly higher for females (39.74±9.79) than for males (35.97±9.02). None of the biochemical data recorded a statistically significant mean difference between males and females. Also, females recorded higher values for BMI (28.79±4.96), Waist circumference (93.71±13.12) and visceral fat (8.04±3.36) compared to males: BMI (23.63±3.12), WC

(81.75±10.05) and visceral fat (7.99±10.75). These mean differences were all statistically significant. Mean systolic blood pressure was significantly higher for men (130.25±18.14) than for women (123.91±18.62) and although mean diastolic blood pressure was also higher for men (85.17±15.20) than for women (83.20±11.72), the difference was not significant statistically. Females recorded a significantly higher mean reclining or sedentary hours (4.80±2.59) compared to the males (4.20±2.57). Mean sleep hours was also higher in females (7.20±1.34) than in males (6.97±1.47) although not significant statistically.

Table

4.4 Comparison of means of anthropometric, biochemical and lifestyle parameters of participants

Parameter	Total, N= 302	Male, N= 126	Female, N= 176	p- value
Age	38.17±9.6	35.97±9.02	39.74±9.79	**0.001**
Anthropometric data				
BMI kg/m^2	26.63±4.99	23.63±3.12	28.79±4.96	**0.000**
WC (cm)	88.72±13.3	81.75±10.05	93.71±13.12	**0.000**
VF %	8.02±7.39	7.99±10.75	8.04±3.36	0.958
Physiological data				
SBP (mm Hg)	126.56±18.66	130.25±18.14	123.91±18.62	**0.003**
DBP (mm Hg)	84.02±13.29	85.17±15.20	83.20±11.72	0.223
Lifestyle N= 301				
Sedentary hours	4.55±2.59	4.20±2.57	4.80±2.59	**0.048**
Sleep hours	7.10±1.40	6.97±1.47	7.20±1.34	0.162
Biochemical data				
FBG mmol/l, N=300	4.37±0.89	4.31±0.58	4.42±1.06	0.305
HbA1c %, N= 296	5.27±0.57	5.27±0.49	5.26±0.62	0.928
TC mmol/l, N= 299	5.52±1.05	5.41±1.08	5.60±1.02	0.119
HDL mmol/l N= 299	1.76±0.20	1.78±0.19	1.75±0.20	0.144
LDL mmol/l N= 299	3.31±1.09	3.19±1.09	3.40±1.08	0.106
TG mmol/l N= 299	0.98±0.31	0.97±0.34	0.99±0.41	0.733

Mean differences were compared using independent sample t- test. P- values in bold show statistically significant associations.

Figure 4.1 compared physical activity level among male and female participants and showed that a higher proportion of men (71.4%) met the WHO requirement of at least 600 MET-minutes per week for physical activity compared to the women (66.5%).

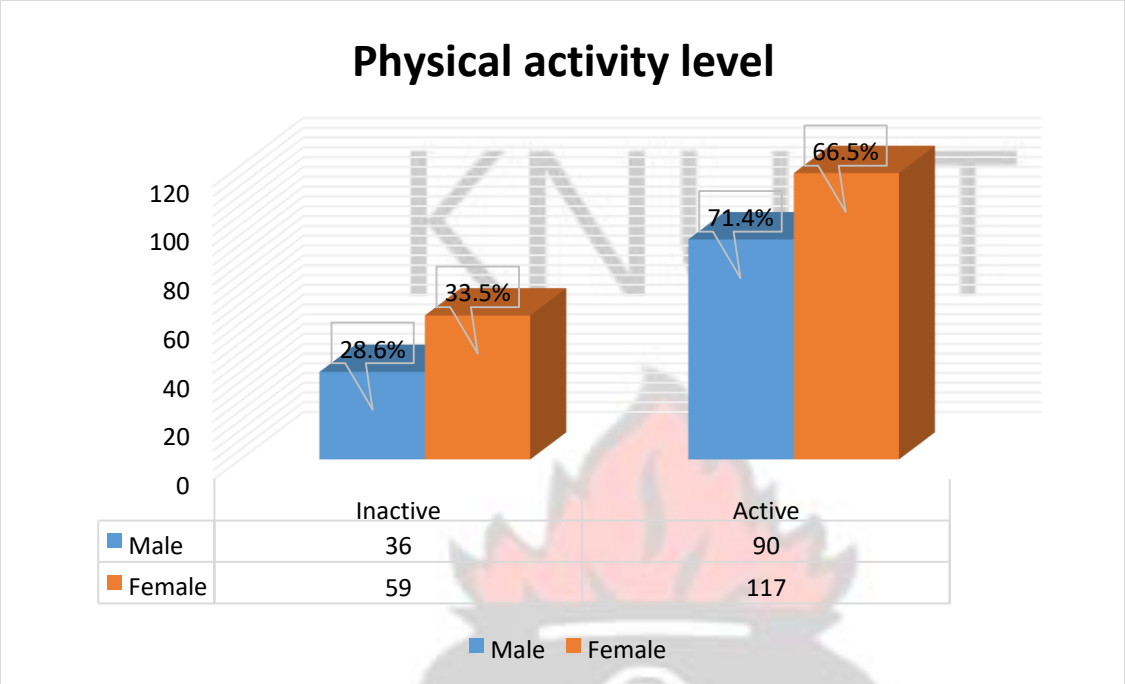

Figure 4.1 Participants' physical activity level

4.3 NUTRITIONAL STATUS AND DIETARY INTAKE OF PARTICIPANTS

Participants' nutritional status based on their body mass index is displayed in Table 4.5. Male participants recorded a 1.6% underweight prevalence compared to 0.6% in females. The females, however, recorded a much higher prevalence of obesity (36.4%) compared to their male counterparts who only saw a 3.2% obesity prevalence. These differences were statistically significant (p-value < 0.001). Overweight/obesity prevalence was highest (69.6%) in participants aged 40 to 49 years and following closely at 67.4% was the group aged 50 to 60 years. The highest occurrence of normal weight individuals was recorded by the age group of 25 to 39 years old (48.0%). These differences were, however, not statistically significant (p-value = 0.105).

4.5 Nutritional status of participants

	Underweight	Normal	Overweight	Obese	p-value

Table

Sex					
Male	2 (1.6%)	87 (69.0%)	33 (26.2%)	4 (3.2%)	**0.000**
Female	1 (0.6%)	36 (20.5%)	75 (42.6%)	64 (36.4%)	
Age 25-39					
	2 (1.1%)	85 (48.0%)	54 (30.5%)	36 (20.3%)	0.105
40-49	1 (1.3%)	23 (29.1%)	35 (44.3%)	20 (25.3%)	
50-60	0 (0.0%)	15 (32.6%)	19 (41.3%)	12 (26.1%)	

Data shown as frequencies and percentages. Comparison was done using chi-square.

Table 4.6 compared mean intakes of energy and macronutrients obtained from analysis of 24-hour dietary recall data with respect to body mass index of participants. The normal weight individuals had higher mean intake of carbohydrates, protein and fat compared with any of the other three weight statuses and these differences were statistically significant. Although the mean fibre intake was also higher in the normal weight group (23.2±11.5) compared to any of the other three weight statuses: underweight (23.1±12.7), obese (20.3±11.7) and overweight (19.7±9.2), the differences seen were not statistically significant. The underweight group had higher mean energy intake (1807.7±1291.2) compared to any of the other three groups but the differences were not statistically significant.

Table 4.6 Intake of energy, macronutrients and fibre by nutritional status

Nutrient	**Underweight**	**Normal**	**Overweight**	**Obese**	**p- value**
Energy (kcal)	1807.7±1291.2	1771.2±713.8	1553.6±606.7	1567.5±705.5	0.067
Protein (g)	39.9±9.6	57.8±24.6	51.1±22.4	48.9±23.4	**0.035**
Fat (g)	27.2±5.6	55.7±29.3	47.6±24.8	49.7±25.1	**0.047**
Carbohydrate (g)	232.8±122.6	260.1±104.0	226.7±85.8	220.8±89.2	**0.016**
Fibre (g)	23.1±12.7	23.2±11.5	19.7±9.2	20.3±11.7	0.083

Values are means ± Standard Deviation. One- way analysis of variance (ANOVA) was used to compare means of nutrient intake.

Table 4.7 displays the mean intake of macro and micronutrients of participants. Mean energy intake for both males (1915.18±710.80 kcal) and females (1456.61±599.92 kcal) were found to be below the recommended daily allowance (RDA) for moderately active adults. Mean vitamin C intake for both males and females were higher than their respective RDA. The nutrient that had the highest percentage of participants consuming at least their RDA was carbohydrates at 97.6% of men and 86.9% of women. Sodium followed closely with 92.1% and 85.2% of men and women respectively consuming at least 1500 mg of sodium daily. The least consumed nutrient for both gender was vitamin E which saw 7.1% of men and 4.0% of women consuming at least the recommended daily allowance.

Table

4.7 Mean nutrient intake of participants

Nutrient	RDA/AI		Mean intake		% meeting RD
	Male	Female	Male, N= 126	Female, N= 176	Male
Energy (kcal)	2600	2000	1915.18±710.80	1456.61±599.92	18.3
Protein (g)	56	46	64.25±25.10	45.36±19.21	57.9
Fat (g)	65	65	58.20±29.71	46.13±23.60	34.9
CHO (g)	130	130	279.36±102.02	210.16±79.73	97.6
Fibre (g)	38	25	24.52±11.93	19.00±9.36	9.5
Micronutrients					
Iron (mg)	8	18	12.64±4.59	9.53±4.33	89.7
Potassium (mg)	4700	4700	3073.64±1663.81	2446.18±1164.06	12.7
Sodium (mg)	1500	1500	3171.92±1334.91	2328.64±871.71	92.1
Zinc (mg)	11	8	9.45±4.21	6.50±3.23	24.6
Vitamin C (mg)	90	75	104.06±50.76	88.63±51.85	54.8
Vitamin E (mg)	15	15	7.67±4.52	6.15±3.56	7.1
Folate (mcg)	400	400	346.33±192.39	254.31±161.50	27.0
Vitamin B_{12} (mcg)	2.4	2.4	4.73±3.96	3.08±2.36	73.0

Source of RDA/ AI: Institute of Medicine. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington (DC): The National Academies Press; 2002.

4.4 PARTICIPANTS' PERCEPTION OF THEIR BODY IMAGE

Figure 4.1 shows participants' ability to choose a body silhouette from the figure rating scale that correctly matches their current weight status. It was observed that majority of participants, 198 (56%) were unable to perceive their weight status correctly.

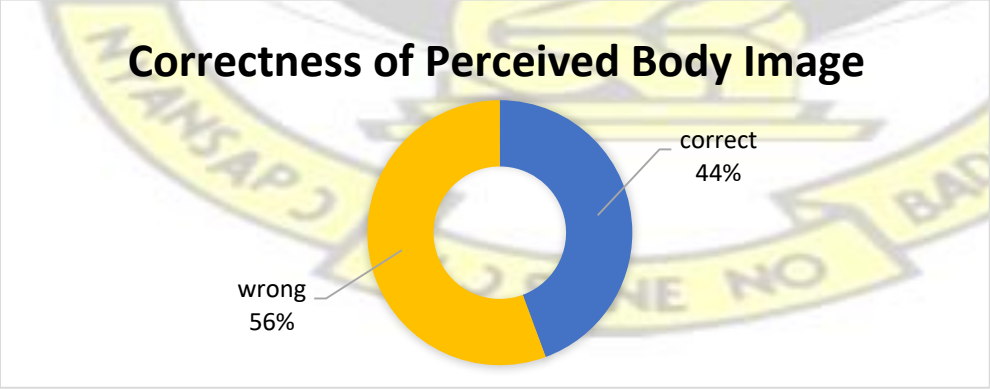

Figure 4.2 Correctness of participants' perceived body image

According to Table 4.8 which displays the ability of participants in various weight status to correctly select their corresponding body image, 71.3% of overweight people were unable to correctly perceive that they were overweight. Similarly, a high proportion of obese (91.2%) and underweight (66.7%) people were not able to correctly perceive their body image. The associations were statistically significant (p-value< 0.001).

Table 4.8 Correctness of participants' perceived body image based on their Nutrional status

	Correctness of perceived body image		
Nutritional status	**Correct**	**Wrong**	**P-value**
Underweight	1 (33.3%)	2 (66.7%)	**0.000**
Normal	96 (78.0%)	27 (22.0%)	
Overweight	31 (28.7%)	77 (71.3%)	
Obese	6 (8.8%)	62 (91.2%)	

Data shown as frequencies and percentages. Comparison was done using chi-square.

Table 4.9 displays participants' body image dissatisfaction. A statistically significant difference (p-value = 0.018) was observed between proportion of males that were dissatisfied with their body image (50.8%) and females that were dissatisfied with their body image (64.8%).

Table 4.9 Body image dissatisfaction among participants

	Body dissatisfaction status		P-value
Gender	**Satisfied**	**Dissatisfied**	**0.018**
Male	62 (49.2%)	64 (50.8%)	
Female	62 (35.2%)	114 (64.8%)	
Total	124 (41.1%)	178 (58.9%)	

Data shown as frequencies and percentages. Fischer's exact test was used to compare data.

Table

The desire of participants to lose weight based on body mass index and waist circumference is displayed in Table 4.10. The obese group recorded the highest weight loss desire (73.5%) followed

by the overweight group in which 50% desired to lose weight. As expected, none of the underweight participants desired weight loss. Overall, 59.1% of overweight/obese participants desired to lose weight. Among participants with high waist circumference, 60.2% expressed a desire to lose weight. The differences observed in for both body mass index and waist circumference were statistically significant (p-value< 0.001 for both).

Table 4.10 Participants' desire for weight loss

BMI	**Weight loss desire**	
	Yes	**No**
Underweight	0 (0.0%)	3 (100%)
Normal	14 (11.4%)	109 (88.6%)
Overweight	54 (50.0%)	54 (50.0%)
Obese	50 (73.5%)	18 (26.5%)
p- value < **0.001**		
WC		
Normal	44 (24.6%)	135 (75.4%)
High	74 (60.2%)	49 (39.8%)
p- value < **0.001**		

Data shown as frequencies and percentages. Comparison was done using chi-square for BMI while Fischer's exact test was used for WC.

Table 4.11 shows the body image or weight status that participants preferred their spouses to be. A greater proportion of females (50.6%) preferred normal weight spouses compared to males (45.2%) who preferred normal weight spouses. Whereas no male wanted an underweight spouse, 2.8% of females said they preferred underweight spouses. Of the males, 54.8% preferred an overweight/ obese spouse while 46.6% of females preferred overweight/ obese spouse. Overall, 50.0% of the participants preferred overweight/ obese spouses. The differences were not significant.

Also, when participant BMI was compared with their preferred spousal body image, it came out that while 33.3% of underweight participants preferred overweight/ obese spouses, 46.3%, 53.7% and 51.4% of normal, overweight and obese participants, respectively, preferred overweight/ obese spouses. These differences were however not statistically significant.

Table 4.11 Participants' preferred partner or spouse look

Gender	Preferred spouse look			
	Underweight	**Normal**	**Overweight**	**Obese**
Male	0 (0.0%)	57 (45.2%)	65 (51.6%)	4 (3.2%)
Female	5 (2.8%)	89 (50.6%)	75 (42.6%)	7 (4.0%)
Total	5 (1.7%)	146 (48.3%)	140 (46.4%)	11 (3.6%)
p- value= 0.144				
Participants' BMI				
Underweight	0 (0.0%)	2 (66.7%)	1 (33.3%)	0 (0.0%)
Normal	2 (1.6%)	64 (52.0%)	54 (43.9)	3 (2.4%)
Overweight	1 (0.9%)	49 (45.4%)	52 (48.1%)	6 (5.6%)
Obese p-value= 0.903	2 (2.9%)	31 (45.6%)	33 (48.5%)	2 (2.9%)

Data shown as frequencies and percentages. Comparison was done using chi square. Variables compared did not show statistically significant difference.

4.5 RELATIONSHIP BETWEEN NUTRIENT INTAKE AND CARDIOMETABOLIC PARAMETERS

The relationship between nutrient intake and various cardiometabolic factors after controlling for age and gender are shown in Table 4.12. Significant but weak positive correlation was found between protein intake and BMI (r= 0.130, p-value = 0.026), fibre and systolic blood pressure (r= 0.116, p-value = 0.048) and between potassium intake and systolic blood pressure (r= 0.135, pvalue = 0.021). A significant but weak negative correlation was found between fat intake and glycated haemoglobin (r= -0.115, p-value = 0.050). Additionally, vitamin C showed weak negative

correlation with total cholesterol (r= -0.033, p-value = 0.578), triglycerides (r= -0.006, p-value = 0.914) and LDL (r= -0.034, p-value = 0.562). These correlations were not statistically significant. No association was found between carbohydrate intake and total cholesterol (r= 0.000, p-value = 0.998).

Table 4.12 Association between nutrient intake and cardiometabolic parameters

Protein	0.130(**0.026**)	0.078(0.182)	0.044(0.453)	0.013(0.827)	-0.014(0.811)	-0.143(0.015)	0.038
Fat	0.093(0.115)	0.031(0.603)	-0.045(0.444)	-0.051(0.384)	-0.025(0.666)	-0.115(**0.050**)	0.031
Carbohydrate	0.024(0.677)	-0.061(0.300)	0.069(0.238)	0.018(0.765)	-0.071(0.224)	-0.079(0.177)	0.000
Fibre	-0.005(0.934)	-0.064(0.274)	0.116(**0.048**)	0.043(0.466)	-0.063(0.284)	-0.039(0.565)	0.006
Iron	0.059(0.318)	-0.010(0.859)	0.029(0.620)	-0.008(0.891)	-0.040(0.497)	-0.095(0.104)	0.019
Potassium	0.052(0.376)	0.009(0.883)	0.135(**0.021**)	0.038(0.522)	-0.031(0.603)	-0.050(0.391)	0.020
Sodium	0.011(0.853)	-0.059(0.318)	0.061(0.302)	0.001(0.984)	-0.086(0.141)	-0.077(0.189)	0.001
Zinc	0.067(0.251)	0.026(0.659)	0.034(0.560)	0.012(0.843)	0.002(0.972)	-0.114(0.051)	0.047
Vitamin C	-0.041(0.489)	-0.041(0.485)	0.057(0.328)	0.019(0.745)	0.003(0.962)	0.010(0.869)	-0.03
Vitamin E	0.027(0.645)	0.011(0.851)	0.009(0.877)	-0.031(0.598)	-0.003(0.960)	-0.076(0.195)	0.004
Folate	0.033(0.574)	0.026(0.660)	0.052(0.377)	0.008(0.898)	-0.052(0.373)	-0.034(0.560)	0.020
Vitamin B_{12}	-0.005(0.931)	0.019(0.743)	0.006(0.923)	-0.026(0.652)	-0.006(0.919)	-0.057(0.330)	0.047

Partial correlation analysis between nutrient intake and cardiometabolic disease parameters. Correlation is significant at p- value ≤ 0.05 (2- tailed). Controlling variables: age and gender.

Nutrient BMI WC SBP DBP FBG HbA1c TC intake r (p-value) r (p-value) r (p-value) r (p-value) r (p-value) r (p-value) r (pEnergy 0.069(0.239)

4.5 RELATIONSHIP BETWEEN ANTHROPOMETRIC CHARACTERISTICS AND CARDIOMETABOLIC DISEASE PARAMETERS AND CORONARY RISK

The association between cardiometabolic disease parameters and coronary risk was analyzed using bivariate correlation as displayed in Table 4.13. Waist circumference, systolic blood pressure and diastolic blood pressure showed significant but weak correlation with coronary risk. The strongest significant association was a positive correlation observed for LDL and coronary risk (r= 0.921, p- value < 0.001). Fasting blood glucose, glycated haemoglobin and BMI had weak but statistically not significant correlation with coronary risk.

Table 4.13 Bivariate Correlation between cardiometabolic disease parameters and coronary risk

Cardiometabolic disease parameter	Coronary risk (TC/HDL ratio) r (p- value)
WC	0.122 **(0.035*)**
BMI	0.074 (0.201)
SBP	0.151 **(0.09**)**
DBP	0.155 **(0.007**)**
FBG	0.084 (0.150)
HbA1c	0.073 (0.213)
TG	0.406 **(0.000**)**
LDL	0.921 **(0.000**)**

*correlation is significant at the 0.05 level (2- tailed). **correlation is significant at the 0.01 level (2-tailed).

The binary logistic regression performed between cardiometabolic parameters and coronary risk (Table 4.14) showed that only high TG and high LDL showed independent significant predictions for coronary risk (OR=14.2, 95% CI= 1.3-153.5, p- value= 0.029 and OR= 121.4, 95% CI= 15.4958.3, p-value< 0.001, respectively). The other parameters did not exhibit significant effects on high coronary risk.

Table 4.14 Binary logistic regression between cardiometabolic disease parameters and coronary risk

Cardiometabolic parameter		B	High Coronary risk			
			95% CI			
			OR	Lower	Upper	p- value
WC	High	0.472	1.602	0.753	3.412	0.221
	Normal		1.000			
SBP	High	-0.033	0.967	0.344	2.718	0.950
	Normal		1.000			
DBP	High	-0.210	0.810	0.361	1.819	0.610
	Normal		1.000			
TG	High	2.652	14.182	1.310	153.483	**0.029**

	Normal		1.000			
LDL	High	4.799	121.420	15.384	958.304	**0.000**
	Normal		1.000			

CHAPTER FIVE

DISCUSSION

5.1 BACKGROUND AND LIFESTYLE CHARACTERISTICS OF RESPONDENTS

From this study, prevalence of smoking and alcohol consumption among participants was 4.7% and 30.2%, respectively and this was consistent with findings from Obirikorang *et al*. (2015), who observed prevalence of 4.5% and 19.2% for smoking and alcohol consumption, respectively, among healthy adults in urban and rural Ashanti region. Majority of participants (81%) had informal jobs (typically 'non-white collar' jobs that usually require few years of or no formal education) and this could be due to the low level education recorded as about 67% of participants had been educated up to the basic school level only.

About 31.5% of the study population were considered inactive as they could not meet the WHO recommendation for physical activity that provides health benefits. At the moment, there is limited data for physical activity and sedentary behaviours in Ghana. It has been estimated however, that physical inactivity among adults in the West African sub region stands at 13% (Abubakari *et al*., 2009). Female participants in this study were significantly more sedentary than the males (4.80±2.59 vs 4.20±2.57 sedentary hours per day, p- value= 0.048; 33.5% vs 28.6% 'inactive'), in line with findings from Abubakari *et al*. (2009) and Gregory *et al*. (2007) who reported sedentary lifestyle to be more common in women than men.

5.2 PREVALENCE OF CARDIOMETABOLIC DISEASES AND CORONARY RISK

5.2.1 Prevalence of Obesity

The Oforikrom Municipality is a largely urban area in Kumasi and it has been shown in various studies that increasing urbanization, characterized by availability of calorie dense, refined sugar- rich, high fat foods and reduced physical activity levels is associated with increasing prevalence of cardiometabolic diseases including obesity (Obirikorang *et al*., 2015; Agyemang *et al*., 2016). The prevalence of obesity in this study was 22.5% with females being significantly (p- value < 0.001) more obese (36.4%) than males (3.2%). The prevalence of overweight/ obesity in the study population was 58.3%. These findings are comparable to results from the RODAM study that reported obesity prevalence of 33.9% in women and 6.9% in men. A higher prevalence of obesity

(50.0%) was reported among apparently healthy adults in urban Kumasi by Obirikorang *et al*. (2015). Prevalence of obesity for both men (2.5%) and women (16.7%) in the Ashanti region as reported in the 2014 Ghana Demographic and Health Survey was lower than in this present study but the lower prevalence could be accounted for by the presence of teenagers aged from 15- 19 years who were included in the Demographic and Health Survey (GDHS, 2014). The results also agree with what has been the case in many studies that observed Ghanaian females to be more obese than males (Escalona *et al*., 2004; Obirikorang *et al*., 2015; Agyemang *et al*., 2016).

Abdominal obesity as measured by waist circumference showed that significantly more women (68.2%) had larger waist line compared to men (2.4%) (p- value < 0.001).

Prevalence of obesity was also seen to be highest in participants aged 50 – 60 years (26.1%) followed by 25.3% in those aged 40-49 years but least (20.3%) in those aged 25- 39 years. It has been shown that ageing- related muscle loss reduces basal metabolic energy expenditure and

subsequent total energy expenditure (Snijder *et al*., 2006) and ageing- related hormonal changes especially in middle aged women leads to more abdominal deposition of fat (Fu *et al.*, 2011).

It has been suggested that poverty and overweight/ obesity are linked and that growth stunting resulting from foetal and childhood undernutrition typically prevalent in developing countries like Ghana, could lead development of obesity in later adult life thus possibly partly accounting for high obesity prevalence in the population (Eberwine, 2002).

5.2.2 Prevalence of Hypertension, Hyperglycaemia and Dyslipidaemia

High blood pressure is one of the co- mobid conditions of obesity and a known risk factor for cardiovascular diseases. A prevalence of 28.5% was reported for high blood pressure among the study participants and prehypertension prevalence stood at 40.1%. The mean systolic blood pressure for males was significantly higher than for females (130.25±18.14 mm Hg vs 123.91±18.62 mm Hg, p- value= 0.003). Diastolic blood pressure was also higher for males compared to females though not significant (85.17±15.20 vs 83.20±11.72 mm Hg, p- value= 0.223). Obirikorang *et al*. (2015), reported a similar hypertension prevalence of 32.7% with significantly more males being hypertensive than females ($p < 0.001$) in urban Kumasi. Agyemang *et al*. (2016), also found that mean systolic and diastolic blood pressure were both higher in men than women in urban parts of Ghana. Studies have shown that men under the age of 65 years consistently have blood pressure higher than women of the same age group with this observed difference being evident at the beginning of adolescence and continuing through adulthood (Cutler *et al*., 2008; Syme *et al*., 2009; Everett and Zajacova, 2015). Syme *et al*. (2009), observed among adolescents that gender difference in blood pressure is influenced largely by lower peripheral

resistance during and after a mental challenge like a math-stress test, and by lower stroke volume while lying down, standing and sitting in females compared to males.

Based on the fasting plasma glucose cut- off of ≥ 7 mmol/l, a 1.3% prevalence of hyperglycaemia was recorded. However, using glycated haemoglobin measurements, 4.1% of the study population had poorly controlled blood glucose. The vast majority of participants thus had well controlled blood glucose levels. Other studies in urban parts of the Ashanti region reported higher prevalence of hyperglycaemia including 9.6% in the study by Obirikorang *et al.* (2015). The WHO reported in 2014 that the prevalence of diabetes in Ghana was 5.6% (WHO, 2014).

High prevalence of elevated total cholesterol (63.9%) and low density lipoprotein (49.2%) was recorded in this study population. Prevalence of elevated triglycerides (6.4%) and decreased high density lipoprotein (1.3%) were somewhat low. Obirikorang *et al*. (2015), reported similar prevalence of elevated triglycerides (9.6%), elevated low density lipoprotein (61.5%) and elevated total cholesterol (42.3%) but higher prevalence of reduced HDL (59.6%). The prevalence of dyslipidaemia in this study was 64.5%. Asamoah- Boakye *et al*., (2017), reported a similarly high dyslipidaemia prevalence of 63.8% among type 2 diabetics in Kumasi. This high prevalence of dyslipidaemia among the study population could be due to inadequate dietary fibre intake and excess carbohydrate intake. It was observed that for both genders, mean intake of dietary fibre was lower than the RDA while mean carbohydrate intake exceeded RDA for both genders. Studies have shown that dietary fiber in vegetables, fruits, whole grains and legumes help reduce LDL cholesterol while increasing HDL cholesterol (Zhou *et al*., 2015). Excessive carbohydrate intake has also been shown to lead to obesity and increase in serum lipids (Popkin *et al*., 2012). High serum LDL coupled with low HDL is considered an atherogenic lipid profile that predisposes and individual to cardiovascular diseases (Alshehri, 2010).

5.2.3 Prevalence Of Metabolic Syndrome And Coronary Risk

Metabolic syndrome has been shown to increase risk of developing cardiovascular diseases such as coronary heart disease by two- fold while increasing by five-fold, the risk of developing type 2 diabetes mellitus (Alshehri, 2010).

The prevalence of metabolic syndrome among participants in this study was 5.3% and this is lower than the 18% prevalence reported by Akpalu *et al*., (2011) among the free living Ghanaian population. Prevalence of high coronary risk was 36% among participants. Metabolic syndrome was significantly higher in females than in males as well as in 50 to 60 year olds than in 40 to 49 and 25 to 39 year olds. The same trend was observed for high risk of coronary heart disease (Table 4.3) emphasizing the need for screening of middle aged individuals for metabolic syndrome parameters for prevention and early detection.

Metabolic syndrome was again significantly higher in inactive participants (9.5%) than in active participants (3.4%) (Table 4.3). Inactive participants similarly had higher occurrence of high coronary risk compared to active participants though not statistically significant (Table 4.3). Physical activity has been shown to exert positive influences on obesity and glucose control and to generally enhance cardiometabolic health thus affects a person's risk of developing a cardiometabolic disease or CVD (Kilpelainen and Franks, 2014; Gillen *et al*, 2014).

The bivariate correlation analysis between cardiometabolic disease parameters and coronary risk showed that all the lipid profile parameters had significant association with coronary risk. Triglycerides and low density lipoprotein had direct association with coronary risk (LDL: r= 0.921, p- value < 0.001; TG: r=0.406, p- value = 0.000) implying that increases in low density lipoprotein

and triglycerides could directly increase risk of coronary heart disease among apparently healthy adults. Asamoah- Boakye *et al*. (2017), observed similar associations (TG: r =0.291 p-value = 0.000; LDL: r = 0.783, p-value = 0.000) among type 2 diabetics at Komfo Anokye Teaching Hospital. Also, waist circumference, systolic and diastolic blood pressure all had significant direct association with coronary risk implying similarly that increases in those parameters could increase one's risk of coronary heart disease. In a bid to establish the effects of the cardiometabolic parameters that had significant direct association with coronary risk, a binary logistic regression was performed. The outcome (Table 4.14) showed that high TG and high LDL had significant effects on increased coronary risk. Having high triglyceride levels was shown to put an individual at 14- fold increased risk of coronary heart disease compared to having normal triglyceride levels (OR=14.2, 95% CI= 1.3-153.5, p- value= 0.029). Also, high LDL levels confers a 121- fold increased risk of coronary heart disease (OR= 121.4, 95% CI= 15.4-958.3, p-value< 0.001).

5.3 DIETARY INTAKE

Results from analysis of dietary intake from the 3 day repeated 24-hour dietary recall of participants revealed that mean energy intake for both males (1915 kcal) and females (1456 kcal) were below the RDA (2600 kcal for males and 2000 kcal for females) for moderately active individuals. Consequently, 18.3% and 13.1% of males and females, respectively, met their RDA. Carbohydrate- based foods or staples contribute most to the diet of the Ghanaian population and this was seen in the proportion of participants who met their RDA for carbohydrates (97.6% for males and 86.9% for females).

Evidence has shown that adequate dietary intake of antioxidant micronutrients are essential in slowing or preventing occurrence of diabetes, atherosclerosis and further CVD's resulting from

systemic inflammation and oxidative stress (Van Gaal *et al*., 2016). Vitamin C was thus found to be negatively correlated, though not significantly, with total cholesterol (r= -0.033, p-value = 0.578), triglycerides (r= -0.006, p-value = 0.914) and LDL (r= -0.034, p-value = 0.562) suggesting that higher intakes of the vitamin may lead to lower levels of the serum lipids. Apart from vitamin C, mean dietary intake for other antioxidant micronutrients namely vitamin E and zinc were below RDA for both males and females (Table 4.7). While over 50% of both males and females met the RDA for vitamin C, intake of vitamin E (7.1% males and 4.0% females met RDA) and zinc (24.6% males and 24.4% females met RDA) were poor.

The greatest male- female disparity in micronutrient intake was recorded for iron which saw 89.7% and 4.5% of males and females, respectively, meeting their RDA. Seidu (2018), reported a similar trend among adults in the Wa municipality. Poor dietary intake could be responsible for high prevalence of anaemia (40.5%) among women in the Ashanti region recorded in the 2014 Demographic and Health Survey report (GDHS, 2014).

In Ghana, during the lean season which usually peaks from June to August, prices of foodstuff increases and accessibility usually decreases for market-dependent households especially (FAO, 2018) and could lead to inadequate consumption and possible nutrient deficiencies. This may also account for the low dietary intake of some nutrients reported in this study as data was collected between July and August, 2018.

5.4 BODY IMAGE PERCEPTION AND DISSATISFACTION

In tackling the ever growing overweight/ obesity problem, the population's knowledge of aetiologies, adverse health outcomes of obesity and the right body size perception do play a role in determining their willingness to partake in interventions.

Wrong perception of body image was observed for 56% of the participants in this study and it gets further alarming when 91.2% and 71.3% of obese and overweight participants, respectively, were unable to perceive their weight status correctly. Interestingly, all underweight or thin participants who misperceived their weight thought they were heavier while among obese people, 26% thought they were normal weight. Having the wrong perception of one's body image could influence health behaviours such as weight loss habits and it has been shown that among overweight and obese persons, underestimation of weight leads to a lack of drive in changing poor lifestyle ultimately resulting in further accumulation of adipose tissue (Gregory *et al*., 2008). This study unsurprisingly revealed that 41% of overweight/ obese persons did not want to lose weight. Studies from the Wa Municipality of the Upper West region by Seidu (2018), revealed similarly high prevalence of wrong body image perception among overweight persons (80.3%) and obese persons (85.2%) with an overall prevalence of wrong body image perception of 52%. In contrast, however, Ejike (2015), found a lower prevalence of body image misperception (26.7%) among Nigerian college students. This study revealed a 58.9% prevalence of body size or image dissatisfaction with females being significantly more dissatisfied (64.8%) than males (50.8%). These findings are consistent with a study by Medeiros de Morais *et al.* (2017) that reported body image dissatisfaction prevalence of 86% in middle aged women, Alipour *et al*. (2015), who reported a 51.6% body image dissatisfaction prevalence among Iranian female college students, Ejike (2015), whose study revealed that 62% of Nigerian college students were dissatisfied with their bodies as well as with Benkesser *et al*. (2012) and Duda *et al.* (2007) who reported prevalence of 76.4% and 75.9% in Ghanaian women aged 18 years and above. The high prevalence of body image dissatisfaction in this study and other studies should be a public health concern for which policies and strategies are needed to address moreover, body image dissatisfaction has been shown to be associated with

unhealthy behaviours including poor dietary practices, physical inactivity and overall poor quality of life (Mintem *et al*., 2015; Medeiros de Morais *et al*., 2017).

According to Ebewine (2002), certain cultures and socioeconomic subgroups associate excess body fat or large body sizes with prosperity and as a sign of enough wealth in families. It has been documented that some ethnic groups in Africa desire larger body sizes especially for their women (Brink, 1995; Fezeu, 2005). Findings from this study unsurprisingly revealed that 50% of participants preferred a spouse who was overweight or obese. More than half of the males in this study (54.8%) preferred an overweight/ obese spouse while 46.6% of the females also desired an overweight or obese spouse. This preference for overweight/ obese spouse encourages potential suitors to "fatten up" in order to look well-to-do thus undermining the fight against obesity (Puoane *et al.*, 2010).

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 CONCLUSION

Among the cardiometabolic diseases assessed, prevalence of obesity (BMI ≥ 30), central adiposity, hypertension and dyslipidaemia were found to be high among study participants. Prevalence of hyperglycaemia, however, was low. Metabolic syndrome prevalence was also low while risk of coronary heart disease was high. Dyslipidaemia was strongly associated with increased coronary risk. The study population was generally 'active' as the majority of participants met the WHO recommendation for physical activity. Fewer study participants correctly perceived their body image. Low dietary intake of antioxidant micronutrients coupled with relatively high prevalence of cardiometabolic diseases and other cardiovascular disease risk factors may predispose apparently healthy individuals to developing cardiovascular diseases.

6.2 LIMITATION

The cross-sectional nature of the study made it impossible to study cause- effect relationships and to assess effect of lifestyle changes over time on prevalence of obesity and other cardiometabolic diseases.

Inasmuch as field workers encouraged participants to report as accurately as possible their physical activity, recall bias in categorization of vigorous and moderate intensity activities and their durations might have led to over- or- under estimation of physical activity level by participants.

6.3 RECOMMENDATION

Considering that Kumasi and Ghana as a whole is undergoing increasing urbanization, it is of utmost necessity that health and allied health workers integrate simple anthropometric measures

of adiposity and screening for cardiometabolic risk factors into standard vital checks to improve evaluation of individual's health status in a bid to halt the increasing prevalence of diet and lifestyle related non- communicable diseases. Public health education and promotion focusing on weight loss and healthy eating strategies especially for overweight or obese persons ought to be explored and intensified seeing that many overweight/ obese participants (59%) desired to lose weight.

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APPENDICES

APPENDIX 1- STUDY QUESTIONNAIRE

Genes Obesity and Nutrition in Ghana (GONG) Study

Participant ID: _____ ID number to be added to every data collection tool

Date: _____

Participant Personal Details

Name:		Title:
Address (include name of area):		Date of Birth: **Age:**
Telephone:	Next closest person Telephone:	Best time to call:
Do you have an email address (for the purposes of results)? E-mail:		

Genes Obesity and Nutrition in Ghana (GONG) Study

Important Field Researcher information

This is the screening and data collection booklet, which is an important part of the study. All information will be kept confidential. This information in the first part of the study taken today will be used for the evaluation of the participant's health and readiness to begin our research study. If successfully screened (Section 1) a participant will then be asked for some additional data as part of the data collection section (Section 2).

Please take your time and complete it carefully and thoroughly with the participant, and then review it to be certain you have not left anything out.

Section 1: The style of the questions in this section is intended to exclude a participant if they do not meet the study criteria very quickly. If you reach a question which suggests you exclude you do not need to continue asking questions as this is a waste of time.

Section 2: is for those participants who are successfully screened to be included in the study. The second section collects further data including demographics and also two diet recalls.

If you have questions or concerns, contact the lead field researcher on the day who can advise you.

Genes Obesity and Nutrition in Ghana (GONG) Study

Section 1: Screening

Day 1

Participant ID: _____

Date: _____

This section of questions enables you to determine whether the participant is included in the study or not.

1) Visual assessment

Please ensure the person you gather details from is **not clinically (morbidly obese - 9 or over on the body image chart)** as they are deemed to be unhealthy.

Is the person morbidly obese (9 or over on chart)?

Yes / No (circle one)

Is Yes exclude and stop here.

2) Ethnicity:

What is your ethnicity? (tick one)

Ewe	[ ]	Guan	[ ]	
Asante	[ ]	Mole-Dagbane	[ ]	
Ga-Adangbe	[ ]	Other	[ ]	specify……

……

Participant must be Akan. If not exclude and stop here for the Kumasi study

3) Age:

What age are you? ……

Participant within age range Yes/ No (circle one) if NO stop here.

Participant must be 25-60 years old inclusive. If not exclude and stop here.

Question 4 a) Absence of malaria

Do you have malaria or are taking treatment for malaria? YES/NO

When was the last time you have an episode of malaria

Undertake the rapid blood test for screening the participant

Malaria blood test (rapid test) result **YES/NO**

If YES, the study concludes here for this participant (see below). **b)**

Kumasi resident

Does the person have 2 ancestral generations who are Akan & who are Kumasi residents (ie parents and grandparents are from Kumasi) **YES/NO** If NO, the study stops here for this participant.

c) Excluding relatedness of the participants

Do you have any blood relatives living in this area? YES/NO

If YES who are they (relationship) and where do they live? (*so we avoid inclusion in the study*)

Are you aware of any of your blood relatives participating in this study? (*to reinforce the above*) YES/NO

If 'YES', please give details

<u>If the person is related to another study participant, we exclude and note reason.</u>

_____

5) Female Participants only – Fertility related questions

a) Are you using contraception? YES/NO

*If 'YES', please give details (including the name of the contraceptive pill or device) (**Exclude if YES**)*

_____ b)

Are you pregnant, lactating or planning a pregnancy in the next year? YES/NO

c) Are you on hormone replacement therapy (HRT) *explain this to the person* YES/NO

If 'YES', how long have you been on HRT?

Is YES to any of the above two questions, then we have to **exclude**.

d) Do you have regular menstrual cycles? (explain) (**<u>Exclude if NO)</u>** YES/NO

All participants

6) Are you taking any B12 or Vitamin D, Calcium or Folate/folic acid (B6) multivitamins/multimineral supplements?

□ Yes □ No

If YES need to exclude. If they suggest they used to take supplements – check if it is more than 3 months ago.

However, if they had only been taking for a few days you can ask them to not take the supplement and go back in a week. You can discuss this with the lead field researcher.

7) Have you been diagnosed as having any of the following (self-reported at this stage)?

a) High blood cholesterol YES/NO
b) High blood pressure (hypertension) YES/NO
c) Thyroid disorder YES/NO
d) Diabetes or other endocrine disorders YES/NO
e) Heart problems, stroke or any vascular disease in the past 12 months YES/NO
f) Inflammatory diseases (e.g. rheumatoid arthritis) YES/NO
g) Renal, gastrointestinal, respiratory or liver disease YES/NO

i) Cancer YES/NO

j) Have you been diagnosed as suffering from any other illness? YES/NO *If 'YES', please give details*

_____

k) Within the past 3 months, have you taken any medication, in relation to the above illnesses, (prescription or non-prescription) YES/NO

If 'YES', what are they and for what reasons?

_____

l) Have you had any surgery within the past 3 months or do you have surgery planned? YES/NO

If 'YES', please give details

(bariatric or weight loss surgery and heart bypass surgery excluded)

_____

m) Have you had any suffered from a pulmonary 3 embolism, deep vein thrombosis, blood clots or had a blood transfusion? YES/NO

If 'YES', please give details

_____

n) Do you have a pacemaker? YES/NO

If any questions indicate YES to a health condition – EXCLUDE

Participation in previous studies:

8) Are you currently taking part in or within the last 3 months been involved in a clinical trial or a research study? YES/NO

If 'YES', please give details:

_____ if YES exclude

9) Have you been screened or contacted recently about a study? YES/NO If 'YES', please give details

_____ **Exclude**

any that are dietary or lifestyle or medical interventions

9) Please tick the boxes that relate to your present diet

□ Mixed food diet (no restrictions) (animal and vegetable sources) □ Vegetarian □ Salt restriction

□ Fat restriction □ Starch/carbohydrate restriction □ Calorie restriction □ Other

If other, please state _____

Dietary information: If they are on a restricted diet - **Exclude**

10) Do you have any food allergies (e.g. gluten or dairy) or intolerances (e.g. lactose)? YES/NO

If YES exclude as they adjust/avoid/modify diet

Family History

11) Have you or your related blood relatives (parents) had any of the following: Check those to which the answer is yes (leave other blank).

Diabetes
Hypertension
Obesity
Ischemic Heart Disease
Coronary Heart Disease
Stroke

Exclude any participants who say YES to both parents for any of the above disease If one parent has the disease its ok to include.
If the parents are deceased, ask if they had any of the diseases.

12) Over counter nutritional supplements

a) Are you taking any over the counter nutritional supplements?

 Yes No

If Yes:

b) What supplementation are you taking? (Brand)

_____ c)

What is the dose of the supplementation? _____ / day

d) How long have you been taking the supplementation? _____

e) Reasons for taking the supplementation? _____

*Dietary supplements are vitamins, minerals, herbs, and many other products. They can come as pills, capsules, powders, drinks, and energy bars. Some supplements may help to assure that you get an adequate dietary intake of essential nutrients

_____

Study participation 1) Ineligible for the study

If participants do not meet the criteria as indicated above, they are EXCLUDED and you do not need to go any further. Please thank the participant for their time.

This form should be returned to the Field Research Supervisor and will be used to calculate numbers approached/screened and the numbers eligible and included.

_____ **2)**

Eligible for the study

If the participant is eligible you will proceed to consent them to the study using the form and undertake the next section of this questionnaire

Genes Obesity and Nutrition in Ghana (GONG) Study

Section 2: Data Collection

Day 1

Participant ID: _____

Date: _____

Demographic data

1) Marital Status: Tick the appropriate box

□ Single □ Married/co-habiting □ Divorced/Separated □ Widowed **2) Gender:**

Tick the appropriate box

□ Male □ Female

3) Education:

Educational level – what is your highest level of education achieved? Tick the appropriate box

a. None [ ]
b. Primary [ ]
c. Junior High School [ ]
d. SHS/Voc/Tech [ ]
e. Tertiary (degree) [ ]
f. Other please specify (eg Masters)

……..

4) Residence:

a) What is the name of the district you live in? (where spend most of week) please state ……

b) What city is this in? (tick one box)

Kumasi [ ] Tamale [ ]

c) What is the level of urbanization of your district? (tick one box) Urban [ ]

Rural [ ]

Semi-rural [ ]

d) How would you describe the type of housing you live in? (tick one box)

Separate house	1
Semi-detached house	2
Flat/apartment	3
Compound house (rooms)	4
Huts/buildings (same compound)	5
Huts/buildings (different compound)	6
Tent	7
Improvised home (kiosk/container, etc.)	8
Living quarters attached to office/shop	9
Uncompleted building	10
Other (specify)	

e) Do you live as a single family or extended (please describe).

5) Religion:

What is your religion?
Muslim [ ] Christian [ ] other, please specify…… **6)**

Occupation:

What is your occupation? (state) .....

7) Household income:

What is the total household income per month before deductions (including wages, rent, grants, sales of vegetables, etc.) of everybody in the household added together?

If you can tell me the amount off hand please do so, otherwise I will read out various income brackets. Please stop me when I say the amount that you think represents the total monthly income of the household. Circle ONE answer only

Less than 1000 cedis……1
1000-1999cedis……..2
2000-2999cedis……..3
3000-3999cedis……..4
4000-4999cedis……..5
5000-5999cedis-……6
6000-6999cedis…….....7
7000-7999cedis-…… 8

Dietary data (print as landscape)

Previous 24 hours dietary recall 1 (to be taken at the first data collection meeting, day 1)

Time	Menu-Type/ place eaten	Description of type of meal/dish/drinks or ingredients/brand	Estimated portion sizes (note any leftovers)	Preparation/ Cooking method	Home-made or purchased
	Break-fast				
	Lunch				
	Supper				
	Snack 1				
	Snack 2				

24 Hours Dietary recall 2: *One typical weekend days recall (typically Sunday)*

Time	Menu-Type/ place eaten	Description of type of meal/dish/drinks or ingredients/brand	Estimated portion sizes (note any leftovers)	Preparation/ Cooking method	Home-made or purchased
	Break-fast				
	Lunch				
	Supper				
	Snack 1				
	Snack 2				

Researcher guidance

Agree an appointment slot for the next data collection (day 2) and the phlebotomists visit. Instruct the participants to fast overnight (8-10 hours) and leave a sample pot for a urine sample (first urine of the day).

Day/date of next visit/time slot:

…….

Note to remind participant to fast overnight (8-10 hours).
Provide container for morning urine sample

End of Day 1 Screening and Data Collection

Genes Obesity and Nutrition in Ghana (GONG) Study

Section 3: Data Collection

Day 2

Participant ID: _____

Date: _____

1) Anthropometric Measurements

Height _____ cm

Weight _____ kg

Body Mass Index (BMI) = kg/m^2 _____

Waist circumference (WC) _____ cm (light clothing)

Hip circumference (HC) _____ cm (light clothing)

Waist/Hip Ratio (WHR) _____ (>1 or <1 or =1) **2)**

Body fat distribution:

Visceral fat (using OMRON scale) _____

Body fat % (using OMRON scale) _____

3) Blood pressure measurement (automated)

Systolic and Diastolic blood pressure_____mmHg

Systolic and Diastolic blood pressure_____mmHg

Systolic and Diastolic blood pressure_____mmHg

Average BP S/D_____mm/Hg (calc by research team)

4) Alcohol consumption:

a) Do you ever drink alcoholic beverages?

□ Yes □ No GO TO QUESTION 5

If yes, answer the following:

b) What is your approximate intake of the following beverages: **Beer**:

□ None □ Occasional□Often If often, _____ times per week.

Wine:

□ None □ Occasional□Often If often, _____ per week

Spirits:

□ None □ Occasional□Often If often, _____ per week

5) Physical activity-related energy expenditure:

<u>These questions ask whether the participant participates in different forms of activity and asks about the duration. Researcher should complete all questions even if the answer is NO or none.</u>

(P1): Does your work involve vigorous-intensity that causes large increases in breathing or heart rate for at least 10 minutes continuously?

(P2): In a typical week, on how many days do you do vigorous intensity activities as part of your work?

(P3): How much time do you spend doing vigorous-intensity activities at work on a typical day?

(P4) Does your work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking [or carrying light loads] for at least 10 minutes continuously?

(P5) In a typical week, on how many days do you do moderate intensity activities as part of your work?

(P6) How much time do you spend doing moderate-intensity activities at work on a typical day?

(P7) Do you walk or use a bicycle (pedal cycle) for at least 10 minutes continuously to get to and from places?

(P8) In a typical week, on how many days do you walk or bicycle for at least 10 minutes continuously to get to and from places?

(P9) How much time do you spend walking or bicycling for travel on a typical day?

(P10) Do you do any vigorous-intensity sports, fitness or recreational (leisure) activities that cause large increases in breathing or heart rate like [running or football,] for at least 10 minutes continuously?

(P11) In a typical week, on how many days do you do vigorous intensity sports, fitness or recreational (leisure) activities?

(P12) How much time do you spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?

(P13) Do you do any moderate-intensity sports, fitness or recreational (leisure) activities that causes a small increase in breathing or heart rate such as brisk walking, (cycling, swimming, volleyball) for at least 10 minutes continuously?

(P14) In a typical week, on how many days do you do moderate-intensity sports, fitness or recreational (leisure) activities?

(P15) How much time do you spend doing moderate-intensity sports, fitness or recreational (leisure) activities on a typical day?

(P16) How much time do you usually spend sitting or reclining on a typical day?

6) Exposure to sunlight and sleep pattern:

About how many <u>hours a DAY</u> would you usually spend outdoors on a weekday and on the weekend? (time outdoors)

	Rainy season	Dry season
Weekday?	[ ]	[ ]
Weekend day?	[ ]	[ ]

What best describes the colour of the skin on the inside of your upper arm, that is your skin colour without any tanning? (untanned skin colour)

Very fair [ ]
Fair [ ]
Light olive [ ]

Dark olive [ ]
Brown [ ]
Black [ ]
Researcher note: The brown and black are most relevant for Ghana community

Sleep patterns

Typically, how many hours per night do you sleep?

	Rainy season	Dry season
Weekdays	[ ]	[ ]
Weekend days	[ ]	[ ]

7) Smoking

Have you ever smoked (cigarettes or other)?

□ Yes □ No

If Yes:

Estimated number per day? _____

If infrequent smoker, number per week?_____

Smoking duration _____ (select months/years)

Female Participants only

This question is **only to female** participants. If male go to next question (9)

8) Menstruation

a) Are you premenopausal/perimenopausal or postmenopausal?

Researcher notes

Premenopausal - relating to the years of a woman's life before the onset of menopause.

Perimenopause or "menopause transition." Perimenopause can begin 8 to 10 years before menopause, when the ovaries gradually produce less estrogen. It usually starts in a woman's 40s, but can start in the 30s as well. Perimenopause lasts up until menopause, the point when the ovaries stop releasing eggs. In the last 1-2 years of perimenopause, the drop in estrogen accelerates. At this stage, many women can experience menopause symptoms. Women are still having menstrual cycles during this time, and can get pregnant.

Menopause. Menopause is the point when a woman no longer has menstrual periods. At this stage, the ovaries have stopped releasing eggs and producing most of their estrogen. Menopause is diagnosed when a woman has gone without a period for 12 consecutive months.

Postmenopause. These are the years after menopause. During this stage, menopausal symptoms, such as hot flashes, can ease for many women. But, as a result of a lower level of estrogen, postmenopausal women are at increased risk for a number of health conditions, such as osteoporosis and heart disease. Medication, such as hormone therapy and/or healthy lifestyle changes, may reduce the risk of some of these conditions. Since every woman's risk is different, talk to your doctor to learn what steps you can take to reduce your individual risk.

Tick the appropriate box

□ premenopausal □ perimenopausal □ postmenopausal

b) If you are premenopausal:

Are you taking any medication?
What medication is this?

c) If you are postmenopausal:

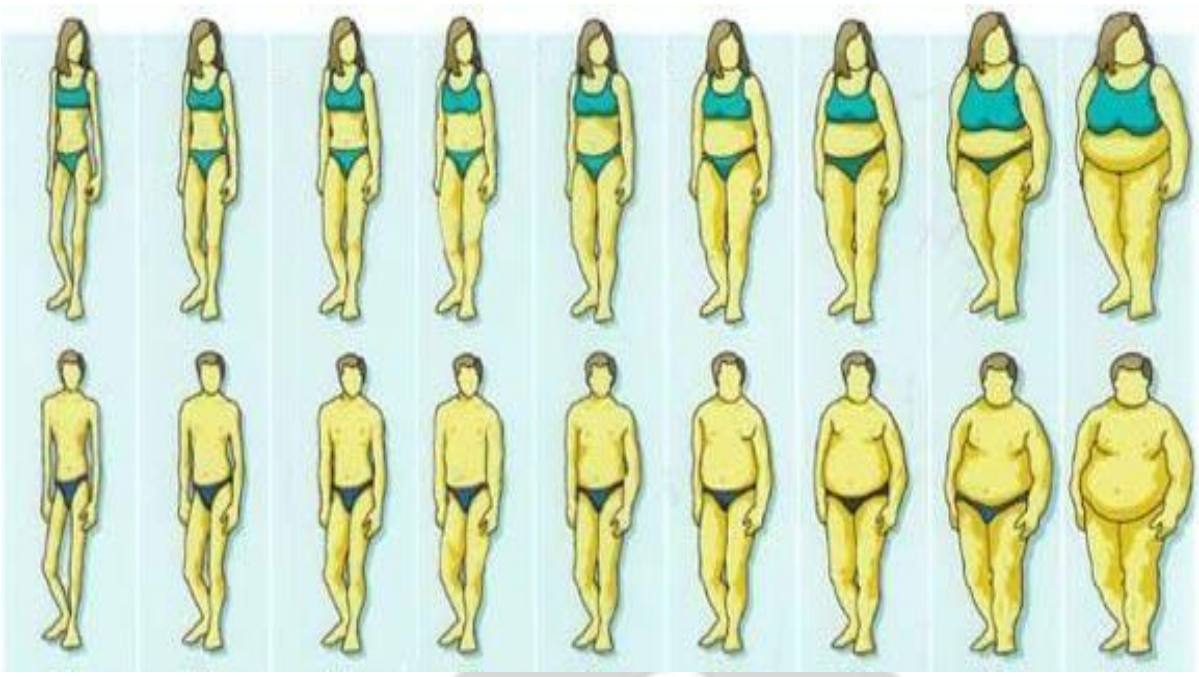
Do you remember when your final menstrual cycle was?

Less than 1 year ago	☐
1-2 years ago	☐
2-5 years ago	☐
More than 5 years ago	☐
Can't remember	☐

---

9) Body image assessment

1. Which of the following do you consider yourself to be (select one only) :
   - Obese [ ] Overweight [ ] Normal weight [ ] Underweight [ ]
   - Don't know [ ] Please look at the pictures provided.
2. What image do you think most closely resembles the way you look at this current time? (Write the number) ……..……
3. Which image best describes how you ideally wish to look?.....
4. *Which image best describes how you think your spouse/partner should look?*.....
5. Which image do you think looks "healthy" for a man/woman? Why? ……
6. Do you desire to lose weight? Yes [ ] No [ ]
7. If yes why? ……
…….……
8. If no why? ……...
…….....



1 2 3 4 5 6 7 8 9

Print landscape Dietary recall 3 (previous 24 hour recall intake to be taken at return appointment)

Time	Menu-Type/ place eaten	Description of type of meal/dish/drinks or ingredients/brand	Estimated portion sizes (note any leftovers)	Preparation/ Cooking method	Home-made or purchased
	Break-fast				
	Lunch				
	Supper				
	Snack 1				
	Snack 2				

End of interview

Genes Obesity and Nutrition in Ghana (GONG) Study

Section 4: Blood collection and analysis

Day 2 Data Collection

Participant ID: _____

Date: _____ **Time blood taken:**

Any other ID (Laboratory):

Name of Phlebotomist:

Confirm fasting overnight fast (8-10 hours): YES/NO
Confirm urine is collected from the first urination of the day YES/NO

Laboratory Investigations:
Serum Triglycerides level: _____
Serum Cholesterol level: _____
Serum low density lipoprotein (LDL) level _____
Serum high density lipoprotein (HDL) level _____
Fasting plasma glucose:_____
Fasting Insulin: _____
Glycosylated Hemoglobin Level (HbA1C): _____
Vitamin B12 Assay _____
Vitamin D_____

Urine sample (5ml) to be labeled and stored in KNUST.
Store some serum or plasma for metabolomics (whatever available)
Genetics blood sample = 3ml (but not less) store on ice packs until reach lab and store in 20/-80ºC.

APPENDIX 2- CONSENT FORM

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH CSIR-IRB CONSENT FORM TEMPLATE

Title: Investigating Gene-Diet Interactions on Cardiometabolic Traits in Healthy Adults in Ghana

Principal Investigator: Dr. Reginald Annan

Address: Department of Kwame Nkrumah University of Science and Technology, Kumasi

General Information about Research: Things to indicate
The objectives of this research work are to identify genetic markers related to cardiometabolic traits as indicators of Type 2 diabetes and obesity risk among healthy individuals in Ghana and to test whether diet and physical activity interact with genes to cause obesity and Type 2 diabetes.
As a participant, certain data will be collected from you including: physical activity level, previous cases of obesity or Type 2 diabetes in your family, blood pressure, weight, height, waist circumference and percentage body fat. Your dietary intake will be assessed using Food Frequency Questionnaire and a

3Day repeated 24hour dietary recall. The questionnaire administration for the data collection is expected to last about 45 minutes. You will be requested to observe an overnight fast that is,, no food or drink except water from 6pm till 6am the next day for blood sample collection from 6am to 9am after which you can break your fast. About 2 teaspoonfuls (10ml) of blood will be drawn in one go from your arm. Three milliliters (3ml) will for testing for obesity related genes and 7ml will be used for biochemical tests (fasting blood glucose, lipid profile, serum insulin level, glycated haemoglobin, and vitamin B12 and vitamin D level). You will also be given a 10ml tube to collect a sample of your first urine of the morning.
Your time and co-operation will be needed for a period not exceeding two days.

Possible Risks and Discomforts
Slight pain will be felt when drawing blood from your vein. However be assured that a welltrained medical personnel will be employed for this.

Possible Benefits
You will receive nutritional advice and will be referred to a dietician if need be. Identifying relevant gene-diet interactions may benefit you in future when seeking for personalized dietary recommendations.

Alternatives to Participation
You will in no way suffer any consequence if you refuse to take part in the study.

Confidentiality
Your name will not be used in any report or publication. We will protect all information that you give us for the purposes of the research such that it cannot be linked to you. However, the ethical committee may have access to your records as part of our responsibility in conducting the research.

Compensation
At the end of the study, you will be given a snack pack and toiletories worth about GHC5 as compensation for your time.

Additional Cost
N/A

Voluntary Participation and Right to Leave the Research
Participating in this research is completely voluntary and out of your free will. You may choose to withdraw from this research. You are also free to refrain from answering any question for reasons of privacy or discomfort. There will be no consequences upon withdrawal from the study.

Termination of Participation by the Researcher
Your participation will only be terminated upon your request to withdraw from the research.

Notification of Significant New Findings

Findings from this research will be disseminated through publication of scientific articles and conference presentations.

Contacts for Additional Information

Should you have any concerns or questions about the study, kindly contact Dr. Reginald Annan on 0201237169.

Your rights as a Participant

This research has been reviewed and approved by the Institutional Review Board and Institutional Animal Care and Use Committee of Council for Scientific and Industrial Research (CSIR-IRB). If you have any questions about your rights as a research participant, you can contact the IRB Office between the hours of 8am-5pm through the landline 0302777651 (ext. 2016) or email address: pselormey@gmail.com. You may also contact the chairman, Mr. Okyere Boateng through mobile number 2028543137 when necessary.

VOLUNTEER AGREEMENT

The above document describing the benefits, risks and procedures for the research title ***(Investigating GeneDiet Interactions on Cardiometabolic Traits in Healthy Adults in Ghana)*** has been read over and explained to me in **(English/ appropriate local language)** and l have perfectly understood the explanation. I have been given an opportunity to have any questions about the research answered to my satisfaction. I agree to participate as a volunteer.

_____	_____	_____
Name	Date	Signature or mark of volunteer

_____	_____	_____
Name	Date	Signature of Witness

_____	_____	_____
Name	Date	Signature of Person taking Consent