EXPOSURE OF STREET FOOD CONSUMERS TO SODIUM AND FAT IN THE KUMASI METROPOLIS

by

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DECLARATION

I hereby declare that this submission is my own work towards the MPhil and that, it contains no material to the best of my knowledge previously published by another person or material which has been accepted for the award of any other degree of the University, except where due acknowledgement has been made in text.

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ABSTRACT

Most foods eaten away from home have been linked to poor diet quality and adverse dietary factors such as high sodium, fat and sugar levels which are related to obesity and cardiovascular diseases. This study set out to analyse the sodium and fat content of street foods and to further quantify the risk of consumers to CVD in the Kumasi Metropolis. Fifteen (15) popular food vendors of light soup typically eaten with fufu, fried rice, and noodles 'indomie' were interviewed using a structured questionnaire. Forty-five (45) food samples were collected and analysed for their sodium content and fatty acid composition. Atomic absorption spectroscopy was used to determine the sodium content while Soxhlet extraction methods were used to estimate total fat content of the food samples (Noodles, light soup and fried rice). Triglyceride content was assessed using an Agilent 1260 HPLC system with a refractive index detector. Two hundred and fifty (250) food consumers were also interviewed to assess their frequency and quantity of consumption of street foods. Sodium and fat intakes by consumers per week was calculated by multiplying the frequency of consumption in a week and serving sizes (or weight in grams) for each food consumed by the salt/fat content of that food. 'Indomie' and fried rice, which are processed by frying, had more sodium and fat than soup. The fat and sodium contents per serving of 'indomie', fried rice, and soup were 112.11g and 862.90 mg, 61.02 g and 709.61 mg, and 13.03 g and 583.02 mg respectively. The results also revealed that samples high in sodium were also high in fat. Intakes of 'indomie' and fried rice at the 95th percentile were associated with significant risk (Hazard Index > 1.0). However, consumers of light soup were not

at risk even at the 95th percentile.

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DEDICATION

To My Lovely Family

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LIST OF ABBREVIATIONS

ADI Acceptable Daily Intake

ALA Alpha Linolenic Acid

ANOVA Analysis of Variance

AOCS American Oil Chemistry Society

AT Averaging Time

BW Body Weight

BGDID	British Government Department for International Development
C	Chemical
CDI	Chronic Daily Intake
CHD	Coronary Heart Disease
CHIM	Centre for Health Information Management
CVDs	Cardiovascular Diseases
CR	Contact Rate
DHA	Docosahexaenoic Acid
ED	Exposure Duration
EF	Exposure Frequency
EPAs	Ecosapentaenoic Acids
EPA	Environmental Protection Agency
FAO	Food and Agricultural Organisation
HDL	High Density Lipoprotein
HI	Hazard Index
HPLC	High Performance Liquid Chromatography
HQ	Hazard Quotient
ICD	International Classification of Diseases
IOF	International Oils and Fats
IPTFAs	Industrially Produced Trans Fatty Acids
KNUST	Kwame Nkrumah University of Science and Technology
LA	Linoleic Acid
LDL	Low Density Lipoprotein
LCPUFAs	Long Chain Polyunsaturated Fatty Acids

MUFA	Monounsaturated Fatty Acid
NCDs	Non Communicable Diseases
NHF	National Heart Foundation
NOAEL	No Observed Adverse Effects Levels
PUFA	Polyunsaturated Fatty Acid
RfD	Reference Dose
SFAs	Saturated Fatty Acids
TAGs	Triglyceirdes
TFA	Trans- Fatty Acid
UCSFMC	University of California San Francisco Medical Centre
UL	Tolerable Upper Intake Level
WHO	World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Street foods according to the definition of FAO, are ready to eat foods and beverages, prepared and / or sold by vendors and hawkers, especially in streets and similar public places (FAO, 1997a). Street foods represent a significant part (about 40%) of urban food consumption for millions of low-and-middle-income consumers, in urban areas on a daily basis (FAO, 2000; Steyn and Labadarios, 2011).

Mostly street foods are sold in stands , cart or kiosk on the street or pavements and other places such as school premises, beaches, terminals of rails and buses (Steyn and Labadarios, 2011) . According to the World Health Organisation, depending on where street foods are prepared, they can be grouped as foods prepared in small-scale food factories or traditional workshops; foods prepared in the home, foods prepared in markets; and foods prepared on the street (WHO, 2010b) . Other foods such as fast foods on the other hand are sold mostly in buildings or structures off the street with or without seats (Steyn and Labadarios, 2011).The expansion of the street food sector can be linked to the rapid population growth of urban areas coupled with the need for employment of the urban population, and ready access to prepared and convenient foods (Delisle, 1990). This has led to the springing up of food vendors and hawkers to feed the numerous people who migrate from rural to urban centers and large working people away from their place of residence (Tedd *et al.,* 2003). The growing street food sector offers easy access to inexpensive food for urban residents (Rheinländer *et al.*, 2008) and have immense variety both traditional as well as fast foods (Chakravarty, 2009) . According to Ohiokpehai (2003), population group such as students are totally reliant on street foods and busy mothers use street foods as a supplement for their

children's nutrition (Micah *et al.*, 2012) . The working class and professionals whose work schedules do not allow them to prepare their own food also depend on street foods (Ohiokpehai, 2003). Moreover, the Popularity of street foods as a job prospect cannot be ruled out because of the huge demand and the fact that no formal training is needed to start this business, low start-up cost, source of regular earning where families can be involved, and interesting and innovative (Chakravarty, 2009).

Touching on the job prospects and the street foods contribution to the economy, street food vending serves as an employment source to many people in the country (Ghana), 94% of which are females (BGDID, 2014). Women do own street food business centers and are also often employed in the street food sector up to about 70 to 90% in some parts of the globe (Tedd *et al.*, 2003). However in countries such as Bangladesh,the majority of street food vendors are men, with women-primarily the vendors' wives (Ohiokpehai, 2003). In some FAO studies, women indicated they sell foods to enhance their households food security and to also improve their financial independence (FAO, 1997b). According to another research, low income families spend over 40% of their house hold budget on street foods and for many people, street foods comprise 30% of their calorie intake (Maxuell *et al.*, 2000). In Ghana street food vending contributes substantially to the urban economy providing a turnover and a profit of about US$100 million and US$24 million respectively (BGDID, 2014).

Street foods consumption is a public health concern, because consumers have a high risk of developing diarrhea and other food borne diseases due to contamination and unhygienic conditions that are often associated with it in low income countries (WHO, 2007a). Another concern is their high calories and fat (Christakis and Fowler, 2007), amount of salts used, and the

method of preparation involved (Koodagi *et al.*, 2013). Some of the methods of preparation include frying, roasting, boiling, baking and steaming, as well as served raw with pre processing techniques (Koodagi *et al.*, 2013). Considering the fact that blood pressure level is a strong risk factor for CHDs and stroke, sodium intakes could be used to predict the risk of CVDs (Jiang *et al.*, 1999b).

Awareness creation on consumption of balanced diets and good eating behaviours will include cutting down salt intakes, and industrially-produced trans-fatty acids (IPTFAs), minimising the intakes of fats that are saturated and increased intakes of high fiber sources such as vegetables, fruits, legumes ,and whole grains and cereals (Bosu, 2013).

1.2 Problem Statement

Diet related diseases including CVDs contribute significantly to disease burdens and deaths (WHO, 2009b). Globally, diet related diseases contribute up to 63% of the 57 million deaths annually, with about 80% of these deaths occurring in non-industrialised countries (including Ghana) (WHO, 2010a).

In most African countries, deaths attributable to CVDs are now next to infectious diseases, accounting for 10% of total deaths (WHO, 2008) and it is estimated that this burden of CVD will double from 1990 to 2020 (Mbewu, 2009).

According to the Centre for Health Information Management (CHIM) of the Ghana Health Service in 2008, the number of new cases of high blood pressure presented at the outpatient departments of facilities in Ghana have increased over ten folds from 49,087 in 1988 to 505,180 in 2007 and also increased from 60,000 in 1990 to around 700,000 in 2010 (Bosu, 2013).

Hypertension and stroke are causes of deaths, admissions and renal failure in Ghana (PlangeRhule *et al.*, 1999; Owusu, 2007) .

These deaths lead to loss of human capital as well as increased costs attributable to healthcare due to non-optimal blood pressure (Gaziano *et al.*, 2009).

Available evidence points to the fact that changes in diets due to nutritional transition; increase in high calorie diets rich in fats, oils ,sodium and sugars contribute to rise in CVDs incidence both in developed and developing countries (Hu, 2008) . Processed foods and mostly foods eaten away from home have been associated with poor diet quality and adverse dietary factors related to obesity and cardiovascular diseases, including high contents of saturated fat, sodium, and sugars (Paeratakul *et al.*, 2003) . Several studies have been conducted in Ghana and other parts of the globe assessing the microbial contamination, chemical contamination and the general safety of street foods. Also CVD risk prediction have been done in some studies using decision tools such as prediction formulae typically the Framingham risk scores in the United States and tables providing easy identification of persons with the risk of CVDs (Batsis and LopezJimenez, 2010).

However studies on street foods and associated CVDs risk among consumers of street foods is limited especially in Ghana.

1.3 Justification

The dependence on street foods is high; with 2.5 billion people consuming street foods on daily basis worldwide (FAO, 2007). Street foods are composed of complex variety and combination of both micronutrients and macronutrients (Helen Black *et al.*, 2013) and contribute significantly to

the daily energy intakes of adults (13% to 50%) and (13% to 40%) in children (Steyn *et al.*, 2013). Habitual consumption of street foods may therefore increase a disease risk (Helen Black *et al.*, 2013) .

The study revealed the risk of consumers to CVDs and provided a research based knowledge that will inform policy making and also strengthen public health education on the use of fats and salts (sodium) in the preparation of street foods

1.4 Objectives

To assess the exposure of street food consumers to sodium and fat, in the Kumasi Metropolis.

1.5 Specific Objectives:

To achieve the general objective, the study specifically:

1. Assessed the knowledge and perception of consumers on sodium and fat intakes.
2. Determined sodium content and fat composition of selected street foods
3. Estimated fat and sodium intakes of consumers from the selected street foods
4. Conducted an exposure assessment from the consumption of sodium and fat from street foods.

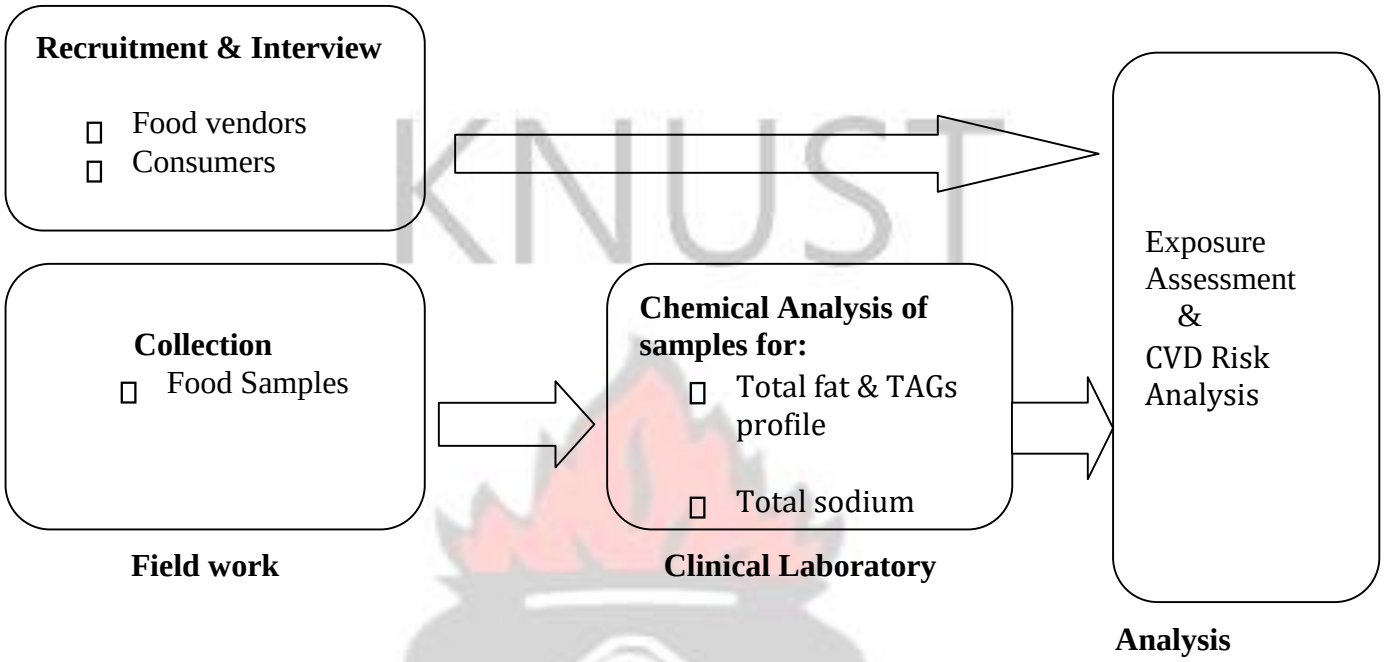


Figure 1.1: Flow chart indicating the study design CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

The literature reviewed was done through internet search for published articles which are related and relevant to the topic and objectives of the study. Keywords combinations such as cardiovascular diseases, street foods, sodium, and fat were used in the search. References from published articles were also retrieved and searched manually.

2.2 General overview of cardiovascular diseases

Globally, diet related diseases (NCDs) are on the ascendency (Boutayeb, 2006). Most deaths (seven out of ten) in developing countries will be attributable to NCDs by the year 2020 (Nahla *et al.*, 2014). Cardiovascular Diseases (CVDs),among the diet related disease are the leading causes of morbidity, disability and mortality globally (Boutayeb, 2006).

Cardiovascular diseases are diseases that affect organs such as the heart, blood vessels or both (Kelly and Fuster, 2010) .

CVDs span across many parts of the globe which are undergoing health transition and significantly contribute to disease burdens (Reddy and Katan, 2004a).

Cardiovascular diseases according to the International Classification of Diseases (ICD, 10th Revision), include: rheumatic fever, hypertensive diseases. Other forms of heart disease are ischemic heart diseases ,pulmonary heart disease, diseases of pulmonary circulation and cerebrovascular diseases (stroke) (WHO, 1992). CVDs affect people of all age groups belonging to different races (Mensah and Brown, 2007). What are thought to be the causes of CVDs are many and diverse with hypertension and atherosclerosis being the commonest cause (Dantas *et al.*, 2012) .

2.3 Knowledge and perception of consumers on dietary fat and sodium

Population knowledge, attitudes and behaviours contribute to the consumption of salt and fat and can be changed (Sarmugam *et al.*, 2013). As a result, efforts aimed at reducing salt intake among populations are often aimed at raising the awareness levels of consumers (Land *et al.*, 2014). Consumers may consider costs, availability of various types of food, convenience and location of joints in their decision to visit a particular joint (Farhana and Islam, 2011). Other consumers consider some factors within their environment including accessibility to healthy diets (Monsivais *et al.*, 2010), knowledge , self-efficacy , attitudes and beliefs (Parmenter *et al.*,

2000). The health belief model (HBM) of behaviour change identifies perceive threats, "cues to action" which could be internal or external, and self-efficacy as being critical to bridging the

knowledge and behaviour gap (Becker, 1974). Higher levels of education and incomes have influence on individuals nutrition knowledge (Hendrie *et al.*, 2008) . Places where more salt is added in cooking and during eating, education and awareness creation among consumers is vital

(Sarmugam and Worsley, 2014). It is also said that age influences consumption decisions (Aidoo, 2009). As consumers grow, their consumption pattern is informed by such factors as availability of food, access to new information, past experiences, and changes in individuals physiology (Wendt and Kinsey, 2007). Worsley, has identified two types of knowledge that are relevant in order for consumers to make reasonable choices: (1) Declarative knowledge, otherwise called knowledge of "what is" (*i.e.*, awareness of things and processes) or "know that" knowledge (for example, consumers need to be aware of amount of salt/fat required by an individual in a day); and (2) Procedural knowledge, (or "know how" knowledge). This type of knowledge is about how to accomplish certain tasks. For example, how to decide to reduce the fat content of a packaged product by reading labels and possible ways of cutting down the quantity of salt used during cooking by the use of natural herbs and spices (Worsley, 2002) . Age , gender , education and income are also some human characteristics that are seen to influence diet related behaviours and the quality of diets (Groth *et al.*, 2001; Mullie *et al.*, 2010). Individuals within households that generate low incomes, with poor status of education , males and adults who are relatively younger use salt discretionary (Grimes *et al.*, 2010) .

Additionally, people who earn less income stand lesser chance of consuming balanced diets compared with their counterparts who earn more income (Darmon and Drewnowski, 2008). Their health consequently according to Nikolić *et al.* (2014) are at a significant risk from diseases that are related to diets.

2.4 Sodium and fat composition of street foods

Street foods are sources of an affordable chemical food substances to different groups of people within the society , not excluding the poor people in our urban areas (Ohiokpehai, 2003). They are composed of a complex variety and combination of both micronutrients and macronutrients (Helen Black *et al.*, 2013).

Consumption of foods away from home is of a high interest due to their total fat composition, fats of trans configuration, salt and sugar according to studies conducted and the fact that these constituents of street foods can lead to the development of diet related diseases (Steyn *et al.*, 2013).

The nutrient composition of foods eaten away from home vary among vendors (Draper, 1996). The variation in nutrient composition could be due to varied use of ingredients (Tee *et al.*, 1989)and methods of preparation/processing (Carlos and Ribeiro, 2013) .

Similar studies have also indicated the influence of various methods of food preparation on the nutrient composition of foods especially animal sources of food such as meat (García-Arias *et al.*, 2004; Gokolu *et al.*, 2004)**.**

Frying for instance increases the fat content of food, the food loses water and takes up more fat in the process (Pokorn *et al.*, 2003) .

In Calcutta, 500 g of an average street food meal contains 12-15 g fat(Steyn *et al.*, 2013)
Another study by (Nazni and Jaganathan, 2014) in the Salem District of India, a street food (Panipoori) contains 70-120 g fat by proximate analysis. In Australia, the mean sodium in a fast food product is 471mg/100 g and 605 mg per serving (Garcia *et al.*, 2014).

According to the University of California San Francisco Medical Centre (UCSFMC) (2016), any food item with sodium content of at least 400 mg is high in sodium.

2.4 Exposure and risk assessments

2.4.1 Principles of exposure and risk assessments

According to the Framingham Heart Study in 1995, a risk is a characteristic that can be measured, can be linked to a disease as its cause and can be used to predict the chance of getting the disease. In the food and nutrition context, it can be said to be the chance of and extent of health problem (negative effect) within human population arising from the consumption of a food or a substance in food (Tijhuis *et al.*, 2012).

Assessing risk therefore means determining the tendency that a health problem will occur and the severity of the problem be it economic or social within a specific time (Gerba *et al.*, 1996). Risk assessment offers an opportunity to determine the severity of an adverse health effects and to effectively distribute tools and materials to minimise risk (Gerba *et al.*, 1996). Significant difference exists between what is described as a 'risk' and a 'hazard'. In nutrition and food related fields, a Hazard is a food component that can cause a health problem or threat and it (hazard) is described as a risk if its exposure is significant (Tijhuis *et al.*, 2012).

Assessing risk entails four stages; Identification of the hazard, assessment of exposure, hazard characterisation and finally, risk characterisation (Gerba *et al.*, 1996; Tijhuis *et al.*, 2012). The first two stages involve describing the hazardous substance and the type of harm it can cause; for

instance, identification of a component of food and indicating the potential effect it may have on the human body, and then determine the amount (concentration) of the food component and its frequency of consumption within the population under study.

The third stage involves measuring the possible health effects that may result following the intake of the food component. This is referred to as the dose-response relationship. The dose most often is stated as milligrams of the ingested substance per body weight in kilograms (mg /kg/ day) (Gerba *et al.*, 1996). Most often the mathematical expression is plotted displaying the response as the dose increases within an organism and the approach is different from substances that have a thresh effect or otherwise (Tijhuis *et al.*, 2012) .

For non-carcinogenic substances, the dose- response rate is characterized by deriving the no observed adverse effect level (NOAEL) which is the substantial quantity that can be used within animals and would not pose any negative effects (Tijhuis *et al.*, 2012). Tolerable upper intake level (UL) is used for nutrients, and in the USA, Reference Dose (RfD) is used. The terminologies used above are referring to the amount of a food component (or other substances within the environment) that if taken over a long period of time will be deemed safe and will offer some protection to majority of the population ,98% (WHO, 1994).

The general equation for determining dietary exposure assessment according to (WHO, 2005) is given as:

$$\text{Dietary exposure} = \sum \frac{(\text{Food chemical concentration X Food consumption})}{\text{Body weight}}$$

Mathematically, it is expressed as milligram per kilogram body weight (mg/kg) and based on the exposure figures and the guidance levels some conclusions can be drawn (WHO, 2005) . Thus exposures that are more than the UL or RfD have the tendency of causing harm (negative effect)

, but this harm cannot be assured and the assurance of no potential harm following intakes that are lower than the UL or RfD cannot also be guaranteed (EPA, 1993) .

Studies (exposure assessments) set out to assess the consequences following the intake of a substance in food are done within a time frame (WHO, 2005). For non-carcinogenic or (substances with threshold), a period of thirty (30) years and an adult body weight of seventy kilograms (70kg) is used (Gerba *et al.*, 1996).

The latter stage of risk assessment entails characterization of risk. At this stage, the amount ingested or inhaled and dose–response are put together to produce the possibility (probabilities) of potential adverse effect occurring in the population in which the substance has been ingested with fixed conditions of exposure.

Risks other than cancer (Non-cancer) are explained using hazard quotient (HQ) if the substance in question is one (single).

$$\text{Hazard quotient (HQ)} = \frac{\text{Average daily dose during exposure period (mg/kg/day)}}{\text{RfD (mg/kg/day)}}$$

If the HQ is lower than 1, there is no risk, however HQs above 1 suggest a risk within the ingested population but the risk cannot be assured (Gerba *et al.*, 1996).

If multiple substances or exposures are involved in a study, hazard index (HI) is used. HI is the addition of the different hazard quotients for each substance (chemical) under assessment in a study (Gerba *et al.*, 1996) .

2.4.2 Risk factors of cardiovascular diseases (CVDs)

Batsis and Lopez-Jimenez (2010), iterates the relevance of quantifying the risks of CCDs within individuals and populations. Individuals as well as populations should know their risk of CVDs at any stage in their lifetime, for it enables managers and other authorities within the public health sector to quantify disease burden (Lloyd-Jones *et al.*, 1999). Risk analysis involves identification of risks factors and examination of the potential and consequences in order to avoid the occurrence of diseases in populations (WHO, 2007c).

CVD risk prediction have been done in some studies using decision tools such as prediction formulae typically, the Framingham risk scores used in the United States and tables that helps to identify clients who are potentially at risk of disease (Batsis and Lopez-Jimenez, 2010). Several factors including age, smoking of tobacco, gender, activity levels, intake of alcohol, poor diet, genetics, high blood pressure, high blood sugar, high blood lipids, psychological issues, low incomes earnings , low status of education and environmental pollution are said to be responsible for diseases of the heart (Finks *et al.*, 2012; Micha *et al.*, 2012).

Even though there is a variation between the contribution of individual factors among communities and different ethnic backgrounds, the overall effect of these factors are always the same (Yusuf *et al.*, 2004). The above factors can lead to the development of atherosclerosis and advance into vulnerable plaques, reducing the lumen of vessels and subsequently prevent the smooth flow of blood to essential organs including the heart and the brain (WHO, 2007b) . Deaths due to cardiovascular diseases are on the ascendency in non-developed countries due to changes in lifestyle such as tobacco smoking, intake of alcohol, physical inactivity, diabetes, psychosocial factors, hypertension and dietary habits (Masoumeh *et al.*, 2014).These Western lifestyles and other factors are responsible for about 90% of cases of the heart and brain related conditions (Steyn *et al.*, 2005).

While some risk factors can be modified by an individual, others are non- modifiable (Lucero *et al.*, 2014) .

Diets and lifestyle are crucial in the aetiology of cardiovascular diseases(CVDs) (KhosraviBoroujeni *et al.*, 2012). Some components of diets such as fats (including saturated) and salt are linked to CVDs and increased intakes of fruits and vegetables are associated with reduced risk of CVDs and cancers (WHO, 1990; Research, 1997) .

Though modifications in lifestyle is said to reduce CVDs events, (Stampfer *et al.*, 2000),over consumption of high calorie diets, rich in sodium and fats, and easily digested and absorbed can cause inflammation, impair the sensitivity of insulin and result in some abnormal changes in metabolism (Reddy and Katan, 2004b).

Most diets that are cardiovascular friendly are functional in nature and offer other advantages (benefits) in addition to the nutrients they contain (Alissa and Gordon, 2012).
Functional foods tend to contain omega-3 fatty acids, pectins, β-glucan and psyllium (Alissa and Gordon, 2012) .

Soluble fibres including pectins, β-glucan and psyllium are known to reduce bad cholesterol(LDL-cholesterol) and prevent bile acid recycling without affecting HDL cholesterol (Reddy and Katan, 2004c; Erkkil¨a and Lichtenstein, 2006).

Among the dietary constituents, fat and sodium have been said to be the most significant predisposing factors of CVDs (Reddy and Katan, 2004b).

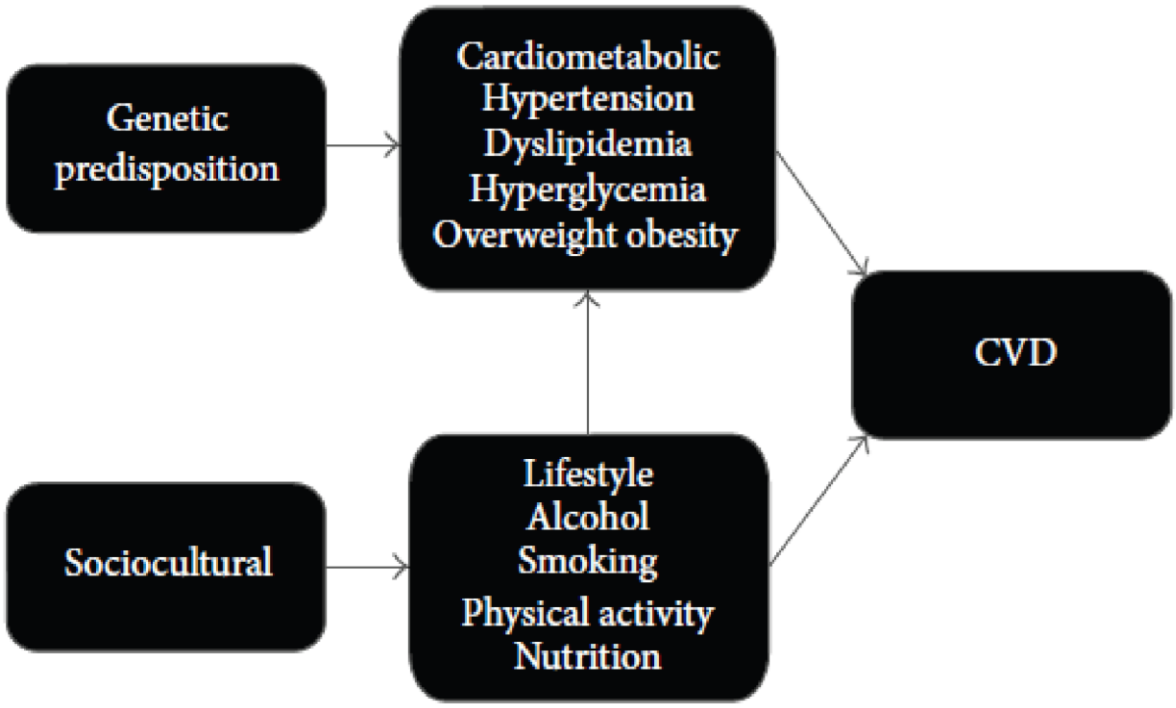


Figure 2.1:Causal pathway for cardiovascular diseases (Stoner et al., 2013)

2.4.3 Dietary fat and risk of cardiovascular diseases

Studies have been conducted investigating the linkage between the intake of fats and CVDs (WHO, 2007b). The linkage was attributed to the role of fat in increasing blood cholesterol, lipoproteins and triglycerides resulting in atherosclerosis (Reddy and Katan, 2004c). The consequences of fats deposits in blood vessels, the impairment of blood flow and the potential for inflammation is been elaborated recently (Kris-Etherton *et al.*, 2001). Other studies have also pointed out the detrimental effects of fats on blood pressure (Reddy and Katan, 2004c). Diets that are low in fat were initially prescribed by experts in food and nutrition but failed to consider the quality of the fat but recently authorities in the food and nutrition related fields stress on the quality of fat (FAO, 2008). Saturated fats, unsaturated fats (be it mono or polyunsaturated) and the

amounts of the essential fatty acids including linoleic (LA), alpha linolenic (ALA), eicosapentanoic acid (EPA) and docosahexaenoic acid (DHA) predict the quality of fats (DHA) (Ursula *et al.*, 2014).

Individual fatty acids, have different impact in maintaining the balance of fats/oils, lipoproteins and platelets in blood (Hu *et al.*, 1994) . The saturated fatty acids (SFAs) and monounsaturated fatty acids are synthesised but polyunsaturated fatty acids (PUFAs) such as linoleic acid (LA) and alpha-linolenic acid (ALA), are not synthesised in the body and must supplied in our diets. (Katan *et al.*, 2004).

The Omega-3 (n-3) fatty acids are known for their cardiovascular protective mechanism (Mozaffarian, 2008). Omega-6 (n-6) fatty acids have been identified to reduce triglyceride concentrations,cholesterol, and LDL cholesterol (Hu and Willett, 2002). To ensure a healthy heart and blood vessels, it is advisable that the intake of both n-6 and n-3 PUFAs is balanced

(Katan *et al.*, 2004).

Fats that are saturated increase blood levels of LDL -cholesterol (Hu *et al.*, 2001). The SFAs with more than 12 carbons lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0) and stearic acid (18:0) have the ability of increasing blood cholesterol but, SFAs with less than 12 carbons do not increase blood cholesterol levels (WHO, 2007c).

Trans-fatty acids (TFAs) originate from two sources that is industrially produced partially hydrogenated fat used in manufactured products, and the other source animal and animal products such as meat and dairy (Stender *et al.*, 2006).

Intake of fatty acids of trans-configuration mostly those industrially prepared (trans-18:2 isomer) are linked to heart related diseases (Mozaffarian *et al.*, 2009). TFAs harmfully raise the levels of

LDL-cholesterol in blood and reduce HDL-cholesterol, creating the enabling environment for inflammation and impair insulin sensitivity (Mensink *et al.*, 2003).

This property of increasing LDL- cholesterol and decreasing HDL- cholesterol by trans- fatty acids according to metabolic and epidemiological studies raises the chances of CVDs among people who consume them (Hu and Willett, 2002). According to the National Heart Foundation of Australia (NHF, 2009) fatty acids that are saturated and are of trans –configuration form plaques in arteries (atherosclerosis), reducing the lumen of blood vessels and in effect increasing blood pressure**.** Micha *et al.* (2010), indicated that isomers of trans fatty acids (18:1 isomers) are found in foods prepared using vegetable oils that are hydrogenated partially, including biscuits, chips, popcorn, margarine, fried foods, and bakery foods.

According to WHO (2007b) ,increased intake of more than one-third of total calories from fat will result in a high intake of SFAs which subsequently can lead to a gain in body weight According to Kasim-Karakas *et al.* (2000) intakes of oils and fats lower than one-fifth of the total may raise the chance of low intakes of vitamin E and other fatty acids that are essential to the human body and possibly can trigger modification in HDL cholesterol .

However, it has been demonstrated that consuming more monounsaturated and polyunsaturated fats than saturated and unsaturated fatty acids of trans-configuration will effectively minimise events of CVDs compared to decreasing the total intakes of fat (Laaksonen *et al.*, 2005). Recent recommendations suggest the intakes of foods that yields not more than 30% of calories from fat, further specifies not more than 10% of calories from SFAs, PUFAs should yield up to

10% of the calories and MUSAs should yield 15% of the calories (WHO, 2003a; WHO, 2004; Mosca *et al.*, 2011) to prevent weight gain.

Mackay and Mensah (2004) and the American Dietary Guideline, (2010), recommend that daily fat/cholesterol intakes should be maintained at not more than 300 mg to ensure decrease in blood lipid levels,which promotes atherosclerosis.

According to studies conducted by WHO (2007c) dietary cholesterol determines serum cholesterol concentration and if cholesterol intakes from diet is minimised to 100 mg per day will correspondingly minimise blood cholesterol levels by 1% (Howell *et al.*, 1997).

Diets low in fat but rich in carbohydrates are suggested to minimise the risk of CHD since lower intakes of SFAs among human populations provide low risk and SFAs raise the concentrations of LDL (Frank *et al.*, 2014). Mensink and Katan (1992) however states that diets low in fat but rich in carbohydrates minimise HDL-cholesterol thereby increasing fasting concentrations of triglycerides.

Improved consumption of fats of good quality (both MUFA and PUFA), reducing SFAs, cholesterol and fats of trans-configuration will protect the heart and the blood vessels (Mendis *et al.*, 2001).

Changing oils used for cooking by mixing different (Mendis *et al.*, 2001) or using genetically modified oilseeds will offer the opportunity to improve the quality of fats in our diets (Mendis *et al.*, 2001) .

2.4.4 Dietary sodium and risk of cardiovascular disease

Agencies both local and international have realized the contribution of lifestyle and diet, most especially sodium intakes on blood pressure (Vollmer *et al.*, 2001). Salt rich diets have been tipped as a major factor of CVDs globally due to their ability to raise blood pressure across different age

groups (Vollmer *et al.*, 2001). High blood pressure is a leading risk factor for CVDs and sodium in our diets is seen as causally associated with high blood pressure even though some high blood pressure cases do not have known causes (Meneton *et al.*, 2005).

Sodium is a vital mineral found in the extracellular fluid and it is responsible for maintaining blood volume, acid-base balance, nerve impulse transmission, and also ensures that cells function normally (WHO, 2012)**.** Chemically, common salt is made up of sodium and chlorine but sodium can be in different forms (Turnbull, 2003). Consumption of sodium from diets depends basically on cultures and behavior of populations in relation to diets (Turnbull, 2003).

Our diets are made of several components and though cutting down intakes of sodium is an aspect of a good diet, cutting down sodium is similar to the realization of other diet related goals aimed at decreasing the intakes of calories and potassium consumption (Whelton *et al.*, 2012) .

Naturally, sodium can be obtained from diverse kinds of foods including dairy(milk), beef and sea fishes (WHO, 2012). Sodium is also present in processed foods including breads, crackers and meats (Webster *et al.*, 2010b). Most condiments also contain sodium (Wu Leung *et al.*, 2011). Meals high in processed foods and contain less fruits and vegetables are mostly high in sodium (Webster *et al.*, 2010a).

Commercial foods (including street foods) made from cereals and grains, soups, sauces, and meats that are cured account for most sodium consumed both in industrialized and nonindustrialised countries (Whelton *et al.*, 2012). Most of the salt in the diets of people in nonindustrialised countries is added during cooking (discretionary salt use) while in the industrialized countries the salt emanates from processed foods (Brown *et al.*, 2009) .

Elliott, (2007) hints that the intakes of salt among populations across the globe are more than the philological needs.

The US joint 2010 *Dietary Guidelines* recommends not more than 1500 mg/d in African-Americans, people of 51 years of age, and people with hypertension, diabetes mellitus, or chronic kidney disease, and not more than 2300 mg/d in all others.

In many cases, peoples' sodium consumption far exceeds 2000 mg in a day (equivalent to 5 g salt/day) (WHO, 2007b). If hypertension is indeed a causal factor of CVDs, a high dietary intakes of sodium among human populations from all sources should be reduced to avoid the risk of CVDs (Jiang *et al.*, 1999a) .

For instance reducing the consumption of sodium to less than 2000 mg per day significantly reduces both systolic and diastolic blood pressures and CVDs of all kinds across all age groups (WHO, 2009c).

There has been an association between urbanization and increased sodium consumption (Poulter *et al.*, 1990) . This association was brought to bear in a migration study in Kenya among farmers who initially consumed less salt in rural areas but had high blood pressures following their movement to urban centres in Kenya (Poulter *et al.*, 1990).

Several other studies among human populations have also revealed the linkage of salt intakes and elevated blood pressures (He and MacGregor, 2002). Deaths that are attributable to elevated blood pressure is about 13% globally (WHO, 2009a).Trial studies that are aimed at preventing high blood pressure have proven that sodium reduction is enough to prevent hypertension (WHO, 2007b). Not enough studies have been conducted analysing the relationship existing between the intakes of sodium from diets and CVD specific mortalities (Tuomilehto *et al.*, 2001; Geleijnse *et al.*, 2007).

A mean sodium reduction of 77 mmol per day has proven to be sufficient enough to minimise systolic and diastolic blood pressures by 1.9mmHg and 1.1 mmHg respectively (Nagata *et al.*, 2004). Increased sodium intakes (loading) can result in oxidative stress and also cause changes in both the heart and blood vessels (Lai EY *et al.*, 2010).

According to (Matavelli *et al.*, 2007; Susic *et al.*, 2011) elevated intakes of sodium can cause high excretion of albumin, oxidative stress, damage to the renal arteries, high pressure in the glomerulus and other renal complications independently of blood pressure .

It is established that sodium loading reduces the efficacy of hypertensive drugs (Heerspink *et al.*, 2012). It suppresses blockers of the system involving renin-angiotensin-aldosterone by preventing the release of rennin from the renal-glomerula apparatus according to Appel *et al.* (2011).

The pathway leading to hypertension and hypertension due to salt-sensitivity has been extensively explained by Johnson and his colleagues in 2005. They indicated that salt-sensitivity likely results from the vasoconstriction of renal system as a result of a hyperactive sympathetic nervous system and renin-angiotensin system activation (Johnson *et al.*, 2005) . During the period of renal vasoconstriction, high blood pressure is independent of salt (salt resistant) but dependent on rennin, and the renal system (kidney) being normal but as time goes on, a disease condition (arteriolosclerosis), may develop in the blood vessels leading to the glomerulus with inflammation in the interstitial tubules; this makes the hypertension sensitive to salt, becomes volume dependent and renal-dependent pathway (Johnson *et al.*, 2005).

Frohlich *et al.* (2011) writes that in relatively younger adults with blood pressures within the desired range, should they take in more sodium than potassium, they are at risk of developing left ventricular mass; the phenomenon is severe when blood pressures are high meaning that high

intakes of sodium makes organs such as heart, large arteries and kidneys to be sensitive to stimuli (Levy *et al.*, 1990). Sodium intakes have been associated with left ventricular hypertrophy across the different age groups (adults, children and adolescents) (Daniels *et al.*, 1990). Studies have shown that cutting down sodium consumption can lead to regression in left ventricular hypertrophy, irrespective of the levels blood pressure (Bochud *et al.*, 2012).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area

The study was conducted in the Kumasi Metropolis of the Ashanti region. In terms of population, it is next to Accra, with a population size of over two million (2,035,064) with females (1,062,806) constituting about fifty-two percent (52%) of the total population according to the 2010 Population and Housing Census. Approximately 11,415 food sellers (vendors) were found operating in the metropolis of Kumasi as at the end of 2014 according to the Environmental Health and Sanitation unit of the Kumasi Metropolitan Assembly. Food is sold in almost all corners and spaces in the Metropolis, including lorry stations and markets. A few of the vendors sell their food on a larger scale involving the use of hired labour. The vendors are often trained by experts from the Metropolitan Assembly, Food and Drugs Authority and multinational company Nestlé Corporation, as well as the Food Science Department of KNUST.

3.2 Recruitment of participants and collection of food samples

Stratified random sampling was used to select three study sites within the Metropolis namely; Kejetia, Adum Central Market and KNUST campus. These sites were chosen because they are the commercial areas within the Metropolis and also have cluster of schools/offices where there is high patronage of street foods. Study sites were considered as strata. Within each stratum, an observational study was conducted to select fifteen (15) vendors of *fufu* eaten with light soup, fried rice and noodles 'indomie' who had more consumers. Three (3) food samples were purchased from each vendor on three different occasions (Monday, Wednesday and Saturday). All the food samples were collected in aseptic polythene bags and transported in a cold box to the University food science laboratory for storage pending chemical analysis within 1hour after collection. In all 45 food samples were collected.

3.2.1 Sample size determination

The 236 consumers of the popular street food joints were selected to achieve 80% power based on the Cochcrane formula using a confidence interval of 95%, margin of error 5% and Proportion of street food consumers 19% (Steyn and Labadarios, 2011). The consumers were conveniently sampled and interviewed as and when they came to buy the foods after an informed consent was obtained. On the average, seventeen (17) consumers were recruited from each vendor.

3.2.2 Inclusion and exclusion criteria

The study involved vendors of popular street foods of fufu, fried rice and noodles popularly known as 'indomie' and their consumers within the selected areas in the Kumasi Metropolis. It however excluded non-street food vendors (canteens, restaurants) and their consumers. Consumers, who

were known hypertensives, had other heart diseases, diabetes, and other diet related conditions were also excluded.

3.3 Data collection tools and techniques

Data collection comprised both self-administered and interviewer-administered questionnaire and laboratory investigations. The first part of the questionnaire covered demographics, knowledge and perception related to fat and sodium consumption. The second part covered the frequency and quantity of consumption of street foods.

The questionnaire contained twenty-six questions; five (5) related to Demographics, sixteen (16) thus, eight (8) questions each related to knowledge of personal consumption of both fat and sodium. Three (3) of the questions covered the perceptions of consumers on fat and sodium. The remaining two (2) touched on their frequency and quantity of consumption of street foods. To assess knowledge level, each respondent was given a score based on the number of correct responses regarding the toxicological effects of Fat and Sodium mentioned or provided. Questions that were unanswered were considered incomplete and excluded. Scores in the ranges of 70-100%, 50-69%, and below 50% were graded as high, average and low respectively. The overall knowledge score of the population was then determined by dividing the number of correct responses by total respondents who answered that particular question (Yvette and Glasauer, 2014). On perception and efforts made to reduce salt and fat consumption, the participants answered a range of questions with responses including “rarely, sometimes, often”, “yes, no” and “too much, just the right amount, too little”. The remaining two questions of the questionnaire covered the aspect of participants’ frequency and quantity of street food consumption.

3.4 Chemical analysis of food samples

As part of the data collection process, food samples were taken for the analysis of total fat and sodium

3.4.1 Fat extraction

The Soxhlet method was used to extract crude fat according to the American Oil Chemist Society Methods (AOCS Ac 3-44) with modification. The round bottom flask used was washed, rinsed and dried at 103 ºC ± 2 ºC for an hour. It was then cooled to room temperature and the weight noted (W1). Five grams (5 g) of blended sample was weighed into a filter paper, folded and put into a thimble which had already been filled with an adsorbent cotton wool. The thimble was again filled with more adsorbent cotton wool and then placed in the extracting chamber of the soxhlet extractor. About 150 ml of Hexane (99% C_6H_{14}) was poured into the 250 ml round bottom flask and then fixed to the extractor with the condenser fixed. The soxhlet apparatus with the solvent was brought to heating on a heating mantle at about 90 to 100 ºC. Extraction was then done for 3 to 6 hr. Thimble containing defatted sample was removed from the thimble holder. The mantle was turned on to recover Hexane (99% C_6H_{14}) from the mixture of Hexane (99% C6H14) and fat in the round bottom flask by refluxing. The flat bottom flask with the extracted fat was kept in a hot air oven for 15minutes, cooled in a dessicator and then weighed (W2).This experiment was conducted in triplicate.

The percentage Fat was calculated as: $\frac{W2 - W1}{\text{Weight of Sample (g)}} \times 100\%$

W1-Weight of empty flat bottom flask

W2-Weight of flat bottom flask + Extracted fat

3.4.2 Determination of triglyceride content of extracted oil sample

About 300 uL of the extracted oil samples were pipetted into vials, 2 ml hexane was added to each sample and the vials were capped and gently swirled to ensure a uniform mixture.

The vials were then placed in the autosampler and the triglyceride profile analysed using the Agilent 1260 HPLC system fitted with Refractive Index Detector (Agilent Technologies, USA).

The number of samples, sample name, sample vial number and sequence noted. Area under each TAG peak relative to a standard calibration curve was used to quantify the TAGs identified.

Results were reported as g/100 g triglycerides. All samples were analyzed in triplicate.

3.4.3 Sodium determination (Dry -Ashing technique)

The food samples were blended and 2.5-3.0 g weighed into crucibles. The crucibles together with the samples were placed in a furnace and ashed at 500°C overnight. The ash residue was then cooled and dissolved in 10 ml of 10% concentrated nitric acid (HNO_3) added to each sample and filtered through a Whatman filter paper (No.45) into a 100 ml volumetric flask. The solution was then made to the mark (100 ml) with deionised water and digested for 30 min at 150°C in a digester in a fume chamber. The experiment was done in triplicate. The concentration of Na was determined using Atomic Absorption Spectrometer (Spectra AA220FS Model, USA).

The total sodium content in the food samples was then calculated and results expressed mathematically (in mg/kg) as follows:

$$Na\ (mg/kg) = \frac{Average\ Sample\ Reading - Blank \times Dilution\ Factor \times 100ml\ (Volume\ digest)}{Weight\ taken\ (g)}$$

3.5 Nutrient intake assessment

This was done to obtain the intakes of fat and sodium from the selected food samples after obtaining the total weight and frequency of food consumed by participants from the administered questionnaire. Various food quantities were bought according to the prices/amounts indicated by participants in the questionnaire and weighed to obtain the total weight consumed in grams at the laboratory. Nutrient (sodium or fat) intakes per week were calculated by multiplying the frequency of consumption and weights (in grams) of each food consumed per week by the nutrient content. Intakes of fat and sodium were estimated both in per serving and 100grams

3.6 Risk assessment

The potential risk of consumers (non-carcinogenic risk) from the consumption of the selected street foods was done using a probability based approach (Monte Carlo simulation) with the @Risk software (version 6, Palisade Corporation, USA).The simulation was performed at 10,000 iterations.

3.6.1 Chronic daily intake (CDI) calculation

Ingestion was considered the only exposure pathway for fat and sodium in the study. To determine the degree of exposure through ingestion, the following equation was used:

$$CDI_{ingestion} = \frac{C \times CR \times EF \times ED}{BW \times AT}$$ Where:

$CDI_{ingestion}$ is the chronic daily intake (mg/kg/day);

C is the concentration of the chemical (sodium and fat) in selected foods;

EF is the exposure frequency (per day);

ED is the exposure duration (years);

CR is the contact rate (days); BW

is the body weight (kg);

AT is the averaging time (days).

The exposure duration(ED) was assumed to be five (5) years. A mean body weight (BW) of 70 kg was used with an averaging time (AT) of 10950 days (30years multiplied by 365 days in a year).

3.6.2 Non-carcinogenic risk determination

Hazard quotient (HQ) was employed in the determination of the non-carcinogenic risk of consumers. The HQ is the ratio of the chronic daily intakes and the respective reference dose (RfD) of the hazard (Gerba *et al.*, 1996; Cao *et al.*, 2014):

$$HQ = \frac{CDI}{RfD}$$

where RfD is the chronic reference dose for the hazard in mg/kg/day. Risk is considered insignificant provided the ratio is not up to 1 and significant risk exists if it is up to 1 or more (Gerba *et al.*, 1996; Khan *et al.*, 2009).

A reference dose of 2300 mg which is the tolerable upper intake levels of sodium according to the 2010 American Dietary Guideline, and a reference dose of 67 g of fat using the following assumptions;

An acceptable macronutrient distribution range of 30 % for fat (WHO, 2004; WHO, 2015) and an average energy requirement per day for both male and female of 2000 kcal to yield 600 kcal per day from fat.

If one gram of fat yields 9 kcal based on the Atwater method, 600 kcal will yield approximately 67 g of fat.

Since the study involved two hazards (sodium and fat) hazard index (HI), which is the addition of the hazard quotients (HQ) of the various chemicals in the selected food samples was used to determine the risk (non-carcinogenic) to consumers (Gerba *et al.*, 1996).

3.7 Statistical analysis

This was done using SPSS (IBM SPSS Statistics 20). *Pearson Chi square* was used to compare demographic characteristics and consumption of the various selected street foods. Differences in the TAGs composition of the selected foods (Noodles, soup and fried rice) were done using Oneway ANOVA. ρ -values (< 0.05) considered statistically significant and ρ-values (>0.05) were considered statistically insignificant. Data was also presented as proportions with corresponding percentages in parenthesis.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1Results

4.1.1General characteristics of consumers

Out of the 250 study consumers interviewed, males constituted majority 136 (54.4%) of the study population with the remaining 114 (45.6%) being females as shown in Table 4.1

The average age of the population was (25.7±5.4yr). The consumers of noodles 'indomie' were older (26.1±5.9yr) than both consumers of fufu with light soup and fried rice thus (25.5±5.9yr) and (25.2±5.2yr) respectively. With respect to occupation, students formed the majority (45.2%) with 31.6% of them attaining at least post secondary level of education. Comparing demographic characteristics of the study population with the consumption of the various food groups, age and gender were statistically significant (ρ<0.05) while the other characteristics were not significant.

Food Groups

Table 4.1: General characteristics of consumers

Variable	Total (n=250)	Lightsoup (n=82)	Noodles 'indomie' (n=84)	Friedrice (n=84)	*ρ-value*
Age(mean±SD,yr) 16-	**25.7±5.4**	**25.5±5.9**	**26.1±5.9**	**25.2±5.2**	
20	36(14.4%)	17(20.7%)	6(7.1%)	13(15.5%)	0.041
21-30	177(70.8%)	55(67.1%)	59(70.2%)	63(75.0%)	0.041
31-40	31(12.4%)	7(8.5%)	17(20.2%)	7(8.3%)	0.041
40+	6(2.4%)	3(3.7%)	2(2.4%)	1(1.2%)	0.041
Gender					
Male	136(54.4%)	50(61.0%)	34(40.5%)	52(61.9%)	0.007
Female	114(45.6%)	32(39.0%)	50(59.5%)	32(38.1%)	0.007
Educational Level					
None	49(19.6%)	11(13.4%)	24(28.6%)	14(16.7%)	0.108
Basic/Middle level	48(19.2%)	18(22.0%)	13(15.5%)	17(20.2%)	0.108
Senior					
High/Technical	53(21.2%)	19(23.2%)	21(25.0%)	13(15.5%)	0.108
Post Secondary	79(31.6%)	25(30.5%)	20(23.8%)	34(40.5%)	0.108
Postgraduate ***Marital***	21(8.4%)	9(11.0%)	6(7.1%)	6(7.1%)	0.108
Status					
Single	196(78.4%)	66(80.5%)	59(70.2%)	71(84.5%)	0.144
Married	50(20.0%)	15(18.3%)	24(28.6%)	11(13.1%)	0.144
Divorced	4(1.6%)	1(1.2%)	1(1.2%)	2(2.4%)	0.144
Occupation					
Unemployed	2(0.8%)	1(1.2%)	0(0.0%)	1(1.2%)	0.268
Student	113(45.2%)	43(52.4%)	29(34.5%)	41(48.8%)	0.268
Health worker	6(2.4%)	2(2.4%)	2(2.4%)	2(2.4%)	0.268
Artisan/Trader	59(23.6%)	14(17.1%)	26(31.0%)	19(22.6%)	0.268
Teacher	11(4.4%)	3(3.7%)	5(6.0%)	3(3.6%)	0.268
Headpoter	18(7.2%)	7(8.5%)	8(9.5%)	3(3.6%)	0.268
Agric Ext Off	2(0.8%)	0(0.0%)	1(1.2%)	1(1.2%)	0.268
Commercial Driver	29(11.6%)	6(7.3%)	11(13.1%)	12(14.3%)	0.268
Accountant	2(0.8%)	0(0.0%)	1(1.2%)	1(1.2%)	0.268
Electrical/Mech					

Engineer	8(3.2%)	6(7.3%)	1(1.2%)	1(1.2%)	0.268

Continuous data (Age) is presented as mean ±standard error of mean. The data remaining are presented as proportion with percentages in parenthesis.

Majority (66.7%) of the vendors of the selected food samples were females with at least 40% of them being more than 30years. With respect to education, four (4) out of the fifteen vendors did not have any form of education. All the ten women involved in the study were also married whereas their male counterparts were single at the time of the study (table 4.2). Regarding how many years vendors have been in the business, the least number of years in the business was 5years. Most (66.7%) of the vendors interviewed did not have any formal training in street food vending. The few (33.3%) that have had some form of training in street food vending as at the time of the study, mentioned the environmental health and sanitation unit of KMA, KNUST, FDB and KCCR as the institutions that occasionally organize training for them. The vendors however did not have handy measures for measuring salt and oil during food preparation. They rely on their experience (table 4.3)

Table 4.2 General characteristics of vendors

		Food Group			
Parameter	**N=15**	**Noodles (n=5)**	**Fried rice (n=5)**	**Soup**	***ρ*-value**
Sex					
Male	5(33.3%)	3(60.0%)	2(40.0%)	0(0.0%)	0.021
Female	10(66.7%)	2(20.0%)	3(30.0%)	5(50.0%)	0.021
Age(in yrs)					
15-20	1(6.7%)	1(100%)	0(0.0%)	0(0.0%)	0.162
21-30	6(40.0%)	3(50.0%)	2(33.3%)	1(16.7%)	0.162

31-40	4(26.7%)	1(25.0%)	2(50.0%)	1(25.0%)	0.162
41-50	3(20.0%)	0(0.0%)	1(33.3%)	2(66.7%)	0.162
>50	1(6.7%)	0(0.0%)	0(0.0%)	1(100%)	0.162
Education Level					
None	4(26.7%)	2(50.0%)	1(25.0%)	1(25.0%)	0.288
Basic/ Middle School	4(26.7%)	0(0.0%)	3(75.0%)	1(25.0%)	0.288
SeniorHigh/Technical	7(46.7%)	4(57.1%)	0(0.0%)	3(42.9%)	0.288
Marital Status					
Single	5(33.3%)	4(80.0%)	0(0.0%)	1(20.0%)	0.321
Married	10(66.7%)	1(10.0%)	5(50.0%)	4(40.0%)	0.321

Data presented as proportions with corresponding percentages in parenthesis

Table 4.3 Food vending practices

Parameter	**Total (n=15)**	**Food Group**			
Experience in the Business		**Noodles**	**Fried rice**	**Light soup**	***ρ*-value**
5yrs	7(46.7%)	4(57.1%)	2(28.6%)	1(14.3%)	0.042
6-10yrs	5(33.3%)	1(20.0%)	3(60.0%)	1(20.0%)	0.042
11-20yrs	2(13.3%)	0(0.0%)	0(0.0%)	2(100.0%)	0.042
20+	1(6.7%)	0(0.0%)	0(0.0%)	1(100.0%)	0.042
Have Formal Training					
Yes	5(33.3%)	1(20.0%)	1(20.0%)	3(60.0%)	0.02
No	10(66.7%)	3(30.0%)	4(40.0%)	3(30.0%)	0.02
Training Institutions	**(n=5)**				
KNUST	1(20.0%)	1(100.0%)	0(0.0%)	0(0.0%)	0.133
KCCR	1(20.0%)	0(0.0%)	0(0.0%)	1(100.0%)	0.133
FDB	1(20.0%)	0(0.0%)	1(100.0%)	0(0.0%)	0.133
KMA	2(40.0%)	1(100.0%)	0(0.0%)	1(100.0%)	0.133
Plates served per day					
<100	7(46.7%)	2(28.9%)	2(28.9%)	3(42.9%)	0.051
101-200	1(6.7%)	0(0.0%)	0(0.0%)	1(100.0%)	0.051
201-300	3(20.0%)	0(0.0%)	2(66.7%)	1(33.3%)	0.051
No Idea	4(26.7%)	1(25.0%)	1(25.0%)	2(50.0%)	0.051
How do you measure Salt/oil during cooking?	15		**Based on Experience** 15(100.0%)		0.00

Data presented as proportions with corresponding percentages in parenthesis

4.1.2 Knowledge and perception of consumers on fat and sodium

The overall knowledge level of the participants on the influence of diet on our health was high (80.8%). However, consumers' level of knowledge on harmful effects of a high fat diet on health was relatively higher (51.6%) than that of Sodium (29.2%) as recorded in table 4.4. Most of the diseases/conditions the respondents mentioned were correct with few of them being incorrect (Table 4.5). Participants were aware there is recommended daily amounts of sodium and fat but could not state it. Although the consumers have knowledge on the harmful effects of high intakes of fat and sodium, less than 20% make conscious effort at monitoring and/or reducing their daily intakes of fat and sodium. The perception of the vendors is not different from that of the consumers. They also believe that we are what we eat and that excess of both fat and sodium can have effect on the human body. The vendors are of the opinion that, preparation of safe and hygienic food is their reasonability. One of the vendors added that, "my family depends on the same food I prepare. If I prepare an unwholesome food for the public, my family will eat it and fall sick. God will not even forgive me"

Table 4.4 Knowledge of consumers on the effect fat and sodium on health

	FAT				SODIUM			
QUESTION	**N=250 Yes**							
	No	**No Idea**	**Yes**	**No**	**No Idea**			
1. Is the fat/sodium content of your food important to you?	180(72.0%)	64(25.8%)	6(2.4%)		180(72.0%)	64(25.8%)	6(2.4%)	
2. Do you know if there is a recommended amount of fat/sodium per day?	153(61.2%)	97(38.8%)	0(0.0%)		49(19.6%)	191(76.0%)	10(4.0%)	
	182(72.8%)	62(24.8%)	6(2.4%)		159(63.6%)	18(7.2%)	73(29.2%)	
3.Does high fat/sodium intake cause health problems?	**High**	**Average**	**Low**	**N/A**	**High**	**Average**	**Low**	**N/A**
4.IF yes (to Que 3), list some of the health problems (**see table 4.5 for breakdown**)	129(51.6%)	7(2.8%)	46(18.4%)	68(27.2%)	73(29.2%)	10(4.0%)	76(30.4%)	91(36.4%)
	Always	**Sometimes**	**Rarely**	**Not at all**	**Always**	**Sometimes**	**Rarely**	**Not at all**
5.Do you make any conscious effort to monitor /reduce your Fat/Sodium intake levels?	41(16.4%)	93(37.2%)	97(38.8%)	19(7.6%)	44(17.6%)	104(41.6%)	0(0.0)	102(40.8%)

Data presented as proportion with corresponding percentages in parenthesis. High represents at least 70% correct response score, Average, 50-69% correct response score and Low, correct response score of less than 50%. N/A (Not applicable) representing participants who did not make any attempt to list the health problems associated with high fat and sodium intakes

Table 4.5 Common health problems associated with high fat and sodium intakes

Fat		Sodium	
Common Health Problems	**Number**	**Common Health Problems**	**Number**
Atherosclerosis *(Blockage of blood vessels)*	34	Hypertension	105
Obesity (*Big body*)	69	Oedema (*Swollen legs)*	76
Hypertension	64	Fatigue (*Gets tired easily)*	33
Stroke	47	Diabetes*	56
Diabetes	13	kidney problems	27
Fatigue (*Gets tired easily*)	5	Stroke	67
Jaundice	4	Arthritis*(Pains at the knees/ankles)**	4
Fever*	4	Stroke	3
Malaria*	1	Jaundice (*Yellowish coloration of eye whites)**	3
kidney problems	3		
Hyperlipidaemia (*High fat in blood*)	3		
Arthritis *(Pains at the knees/ankles)*	3		

Literal meaning of responses are italicized in parenthesis and *incorrect responses.

With respect to perception, most of the consumers 68.0% strongly agree with the assertion that "what we eat influences our health". A significant proportion 49.6% and 44.4% of the consumers are extremely concerned about the amount of fat and sodium respectively in their food with few of them 0.4% and 0.8%, neither concerned nor unconcerned about the amount of fat and sodium respectively in their food as shown in table 4.6. Also as shown in table 4.6, 71.2% and 6.0% consumers have the perception that their fat and sodium intakes are too much while respectively, 11.2% and 77.6% of consumers are of the perception that they are consuming the right amount of fat and sodium.

Taste influences a significant number of the consumers 31.2% in their choice of street foods from particular joints. Affordability, convenience, and food safety and hygiene are other factors that determine consumers' choice of street foods from specific joints (table 4.6).

Table 4.6 Perception of consumers on fat and sodium

Question	Response Fat	Sodium
1.How concerned are you about the amount of fat/sodium in your food?		
Extremely concerned	124(49.6%)	111(44.4%)
Somewhat concerned	92(36.8%)	99(39.6%)
Not very concerned	28(11.2%)	35(14.0%)
Not at all concerned	5(2.0%)	3(1.2%)
Neither concerned nor unconcerned	1(0.4%)	2(0.8%)
2.How much fat /sodium do you think you consume in a day		
Too much	178(71.2%)	15(6.0%)
Right Amount	28(11.2%)	194(77.6%)
Too little	44(17.6%)	41(16.4%)
3.To what extent do you agree or disagree with the statement that what we eat influences our health?		
Strongly Agree	170(68.0%)	
Strongly Disagree	75(30.0%)	
Somewhat Agree	2(0.8%)	
Somewhat Disagree	3(1.2%)	
Neither Agree nor Disagree	0(0.0%)	
4.What motivates you to buy street foods from a particular joint?		
Convenience	30(12.0%)	
Affordability	68(27.2%)	
Taste	78(31.2%)	
Proximity	25(10.0%)	
Good Customer Relations	19(7.6%)	
Hygiene and Safety	30(12.0%)	

Data was presented in proportions with corresponding percentages in parenthesis

4.1.3 Fat and sodium composition of selected street foods

The amount of sodium (mg), fat (g), energy yield from fat (kcal) and the average weight per 100 g and per serving of the food groups are found in table 4.7 and figure 4.1 respectively. Noodles 'indomie' was found to contain the highest amounts of fat and sodium among the food groups with light soup yielding the least in per 100 g. Noodles 'indomie' yielded 210.23 mg, sodium, 27.75 g fat per 100 g and 862.90 mg sodium, 112.11 g fat per serving. The high yield of fat in noodles 'indomie' gave rise to a corresponding high energy (kcal) in both per 100 g and per serving than the other two food groups, thus fried rice and light soup. The fat in both noodles

'indomie' and fried rice were analysed further for their triglyceride composition (in table 4.8). That of soup could not be done because the amounts of oil extracted were below the limits of quantitation. From figure 4.1, there appears to be a correlation between sodium content and fat composition among the selected foods, thus sodium levels in the selected foods increase with fat content. The number of data points is however too few to establish the significance of this relationship. This apparent correlation is also true for fried rice and light soup. **Table 4.7: Sodium (mg), fat (g) and energy yield of fat per 100g**

Food Group	Sodium(mg)	Fat (g)	Energy from fat(kcal)
Soup	161.28	3.69	33.23
Noodles	210.23	27.75	249.78
Fried rice	186.82	16.48	148.28

Data presented in average per 100 g

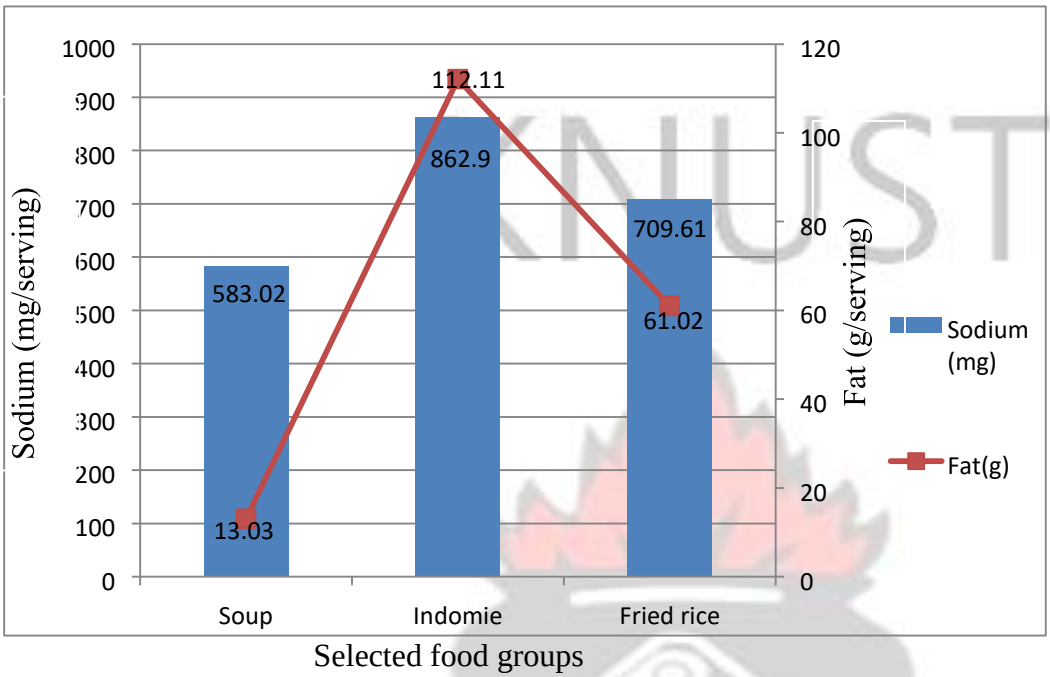


Figure 4.1: Sodium (mg) and fat (g) composition street foods per serving

The individual fatty acids (FAs) constituting the various TAGs are Myristic acid (C14:0), palmitic acid (C16:0), stearic acid (C18:0), oleic acid (C18:1) and linoleic acid (C18:2). Myristic, palmitic and stearic acids are saturated fatty acids (SFAs). Oleic and linoleic are however, unsaturated fatty acids (USFAs). Considering the weights of the fatty acids, linoleic acid is highest followed by oleic acid this is because the vendors use vegetable cooking oils which are polyunsaturated. There was no significant difference (ρ >0.05) in the TAG composition of noodles 'indomie' and fried rice.

Table 4.8: Triglycerides composition of street foods

TAGs	Noodles (*mean±SD*)	Fried rice (*mean±SD*)	*ρ value*	KEY			
		4.52±1.81					
LLL	3.36±0.96	0.25	**LLL**	Linoleic-	Linoleic-	Linoleic	
OLL	10.71±5.82	13.51±5.98	0.48	**OLL**	Oleic-	Linoleic-	Linoleic
PLL	6.53±5.77	5.43±5.06	0.76	**PLL**	Palmitic-	Linoleic-	Linoleic
MOL	2.59±4.97	6.11±5.79	0.33	**MOL**	Myristic-	Oleic-	Linoleic
MLP	10.59±13.29	9.99±13.62	0.95	**MLP**	Myristic-	Linoleic-	Palmitic
MOM	18.69±14.05	12.34±10.92	0.45	**MOM**	Myristic-	Oleic-	Myristic
LOO	22.96±12.00	13.94±12.18	0.27	**LOO**	Linoleic-	Oleic-	Oleic
LLS	4.05±9.05	3.34±7.47	0.9	**LLS**	Linoleic-	Linoleic-	Stearic
POL_MOO	6.42±13.56	7.52±10.39	0.89	**POL**	Palmitic-	Oleic-	Linoleic
MOP	1.65±2.15	2.21±2.67	0.73	**MOP**	Myristic-	Oleic-	Palmitic
PLP	4.27±2.81	2.44±2.26	0.29	**PLP**	Palmitic-	Linoleic-	Palmitic
PPM	2.03±2.68	3.05±2.82	0.57	**PPM**	Palmitic-	Palmitic-	Myristic
OOO	0.12±0.26	0.39±0.54	0.34	**OOO**	Oleic-	Oleic-	Oleic
SLO	0.18±0.19	0.63±0.96	0.34	**SLO**	Stearic-	Linoleic-	Oleic
POO	0.39±0.66	0.21±0.47	0.63	**POO**	Palmitic-	Oleic-	Oleic
PLS	0.36±0.44	0.08±0.17	0.22	**PLS**	Palmitic-	Linoleic-	Stearic
POP	0.50±0.50	0.78±1.09	0.62	**POP**	Palmitic-	Oleic-	Palmitic
PPP	0.03±0.06	0.46±1.02	0.38	**PPP**	Palmitic-	Palmitic-	Palmitic
POS	0.04±0.06	0	0.14	**POS**	Palmitic-	Oleic-	Stearic

Mean concentration of triacylglycerides (TAG) in the street foods shown as mean ± standard deviation; SD, standard deviation M- Myristic acid (C14:0),P-Palmitic acid (C16:0),S-Stearic acid (C18:0), O-Oleic acid (C18:1) and LLinoleic acid (C18:2)

4.1.4 Risk Assessment

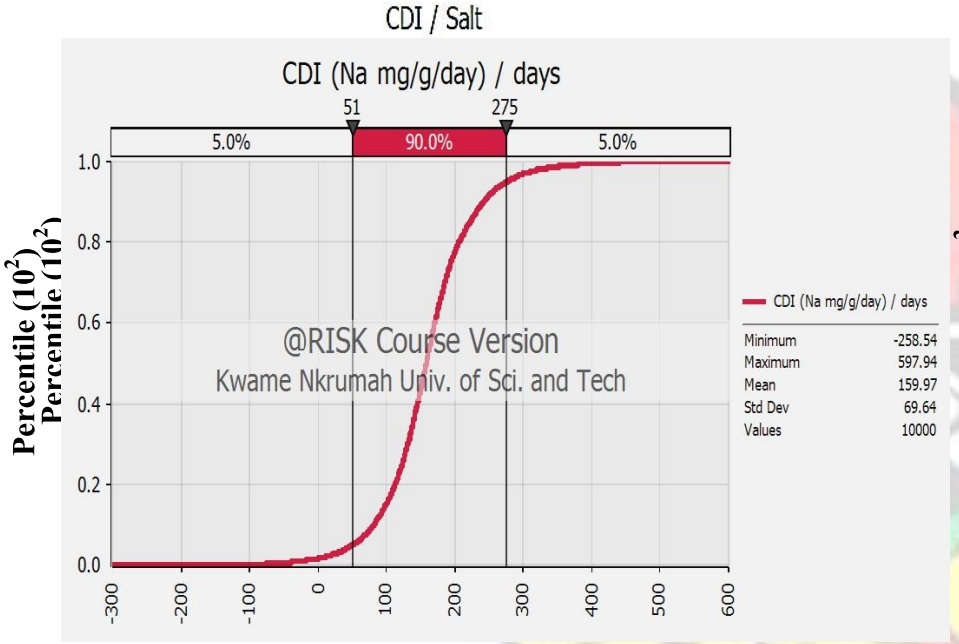


Figure 4.2: Chronic daily intakes of sodium among consumers of 'indomie'

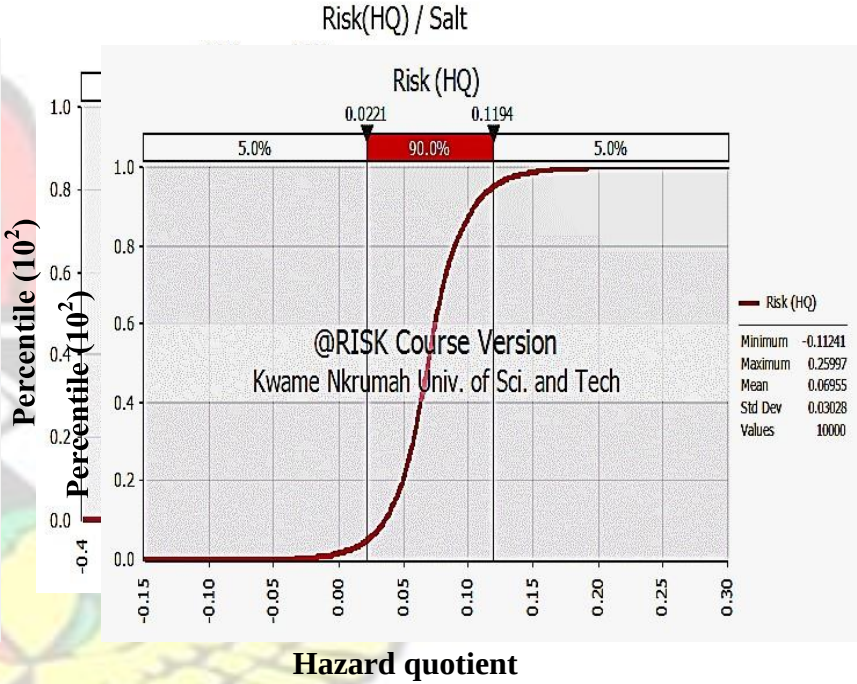
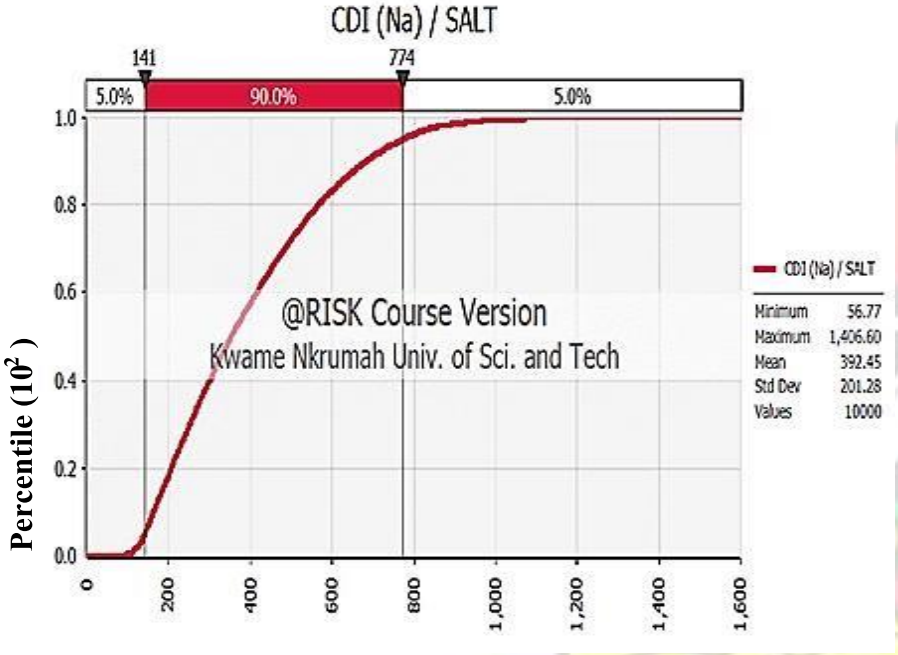


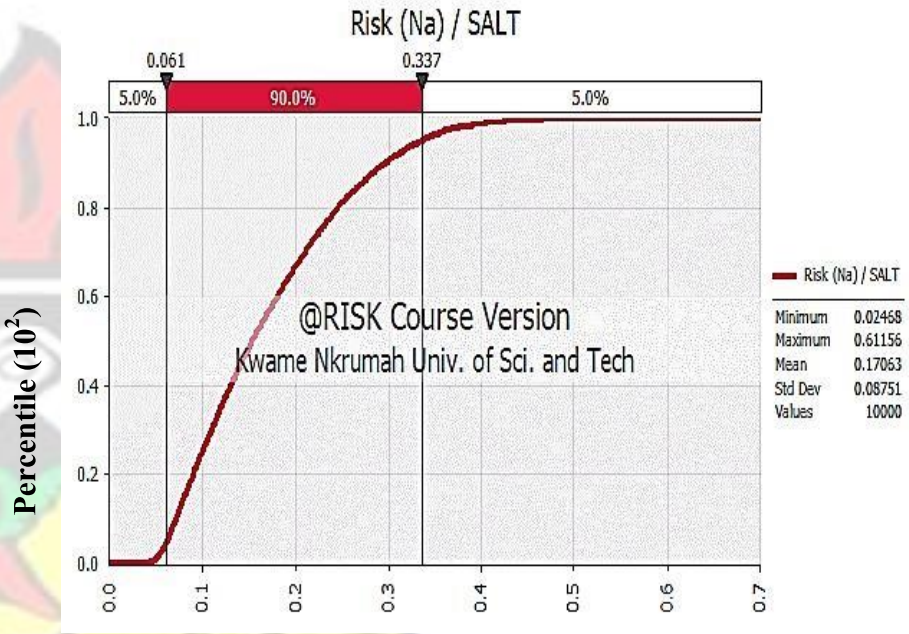
Figure 4.3: Hazard quotient of sodium among consumers of 'indomie'

Figure 4.4: Chronic daily intakes of sodium among consumers of light soup

Figure 4.5: Hazard quotient of sodium among consumers of light soup



Levels of exposure (mg/kg/day)



Hazard quotient

Figure 4.6: Chronic daily intakes of sodium among consumers of fried rice

Figure 4.7: Hazard quotient of sodium among consumers of fried rice

The CDI of sodium is highest (774.0 mg/kg/day) among heavy consumers (95th percentile) of fried rice (figure 4. 6). It is followed closely by noodles (757.0 mg/kg/day) at the same percentile (figure 4.2). Though the CDI is high among heavy consumers of both noodles 'indomie' and fried rice, the consumers are not at risk even at the 95th percentile. The hazard quotients of sodium among consumers of the selected foods is less than 1.0 (figures 4.3, 4.5 and 4.7) for 'indomie', light soup and fried rice respectively

Table 4.9: Chronic daily intakes (CDI) and hazard quotients (HQ) of fat in food samples

	CDI (Percentiles)			HQ (Percentiles)		
Sample	5th	50th	95th	5th	50th	95th
Noodles	12.06	40.21	83.64	0.18	0.60	1.25
Light soup	1.28	3.98	6.99	0.02	0.06	0.10
Fried rice	9.23	23.27	50.49	0.14	0.35	0.75

Chronic daily intakes and hazard quotient of fat from the selected foods presented in percentiles. CDI- Chronic daily intakes and HQ- hazard quotient

The CDI of fat is however highest (83.64mg/kg/day) among the heavy consumers (95th percentile) of noodles 'indomie' followed by fried rice (50.49 mg/kg/day) with light soup being the least (6.99mg/kg/day). The hazard quotient of fat from noodles 'indomie' at the 95th percentile is above 1.0 as shown in Table 4.9 .This implies that intake of fat alone from noodles 'indomie' among the heavy consumers poses a significant risk.

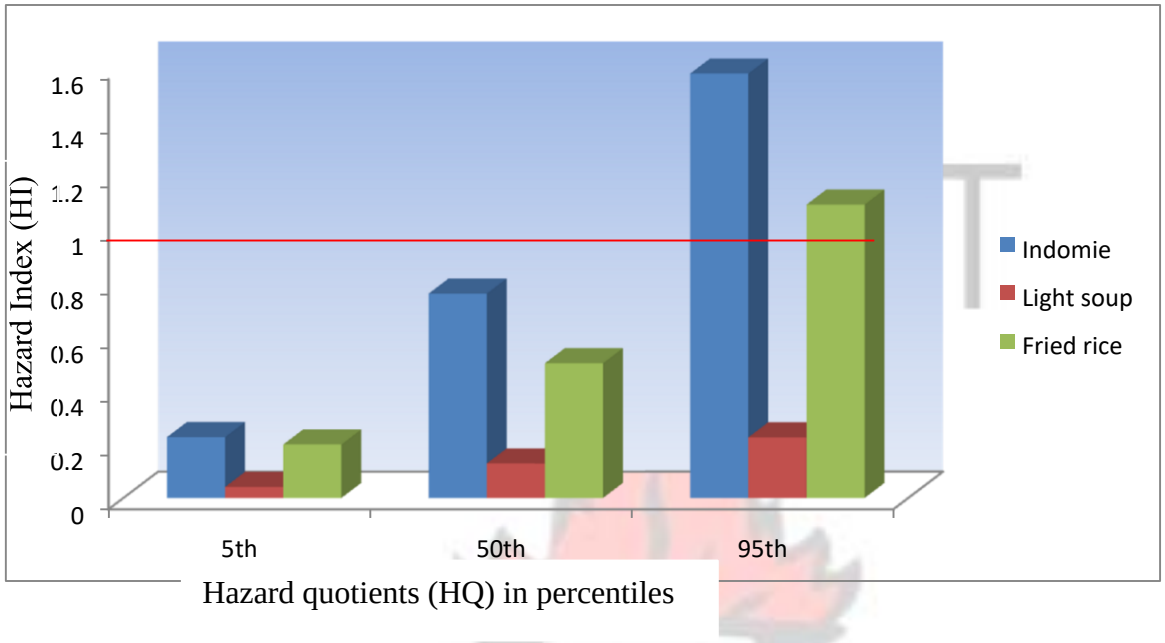


Figure 4.8: Hazard indices of sodium and fat of the selected food samples

The hazard index (HI), addition of the HQs for both sodium and fat in the selected food samples revealed a significant risk for both the consumers of noodles 'indomie' and fried rice at the 95th percentile (figure 4.8)

4.2 Discussion

4.2.1: General characteristics of street food consumers

In the attempt to investigate the risk of CVDs from street food consumption among street food consumers, some demographic characteristics that have been seen as influential in street food consumption were studied. Some of these characteristics included age, gender, educational level, occupation and marital status. Out of the 250 consumers interviewed, majority (113) representing 45.2% were students. This finding is consistent with a previous finding by Ohiokpehai (2003) in which indicates that students are totally reliant on street foods. The consumers within the age

bracket 21-30yrs dominated in the study and were found to patronize noodles 'indomie' and fried rice. Consumers within this age bracket are relatively young, may have little new information on diet and CVDs, and little physiological changes in their bodies. This accounts for their huge dependence on street foods that are processed by way of frying. The high dependence of consumers within 21-30 years compared to those above 31 years is in line with various studies which assert that age influences consumption decisions (Aidoo, 2009) and that as consumers grow, their consumption pattern is informed by such factors as availability of food, access to new information, past experiences, and changes in the physiology of individuals (Wendt and Kinsey, 2007) which include change in body composition, blood pressure. Fried foods tend to also have improved palatability, favourable organoleptic qualities (Guallar-Castillón *et al.*, 2012; Zhang *et al.*, 2015) which could also be another reason for their high patronage by consumers in the said age bracket.

4.2.2 General characteristics of street food vendors

The street food sector as a source of employment to many people both male and female in Ghana and other parts of the globe has been discussed extensively in other studies (Ohiokpehai, 2003; Tedd *et al.*, 2003; BGDID, 2014). In this study, female vendors (66.7%) dominated their male counterpart (33.3%). This finding is consistent with another study by (Tedd *et al.*, 2003) which states that women are often owners of street food businesses. This same finding however, is different from what happens in countries like Bangladesh where men tend to dominate over their female counterparts (Ohiokpehai, 2003). Women are much involved in the street food vending business than men because it involves a low start up cost, and are generally knowledgeable in food preparation compared to men and can easily be inherited by women from their mothers in a family (Fellows and Hilmi, 2012). The vendors were found to be in the age bracket ranging from

21-40years and most of them attaining at least basic level education except a few 4(26.7%) who had not been to school. The study outcome above regarding age and level of education partly fits into the study of (Gawande *et al.*, 2013) highlighting the socioeconomic profile of vendors of street foods in India. According to Gawande *et al.* (2013), 52.3% of the vendors were in the age range of 25 – 35 years old and had attained various levels of education , 42.8% were of primary school level, while 28.5% attended the high school and 9.5% as graduate.

4.2.3 Knowledge and perception of street food consumers on dietary factors (fat and sodium) and CVDs.

Several studies have touched on the influence of knowledge, attitudes and perception on dietary fat and sodium intakes (Sarmugam *et al.*, 2013). Although consumers displayed an overall high level of knowledge (80.8%) on the problems associated with high intakes of sodium and fat, the knowledge was biased towards fat. Thus proportion of consumers with high knowledge on fat was higher (51.6%) compared to that of sodium (29.2%). They (consumers) mentioned more health problems associated with high intakes of fat with ease than sodium (Table 4.5). The finding of high knowledge level on fat than sodium among the consumers is not different from a study among women in the urban areas of Senegal aimed at examining their knowledge on diet and related behaviours that are linked to disease (Holdsworth *et al.*, 2006) . The knowledge of the women on dietary fat– NCD relationship was ranged between 49.8 and 81.4% while their knowledge regarding salt and diseases was in the range of 26.3–56.3% (Holdsworth *et al.*, 2006).

The above study outcome is also partly consistent with a study conducted by (Diekman and Malcolm, 2009) in 16 countries among 6426 subjects where fat ranked consistently at the top of the list of consumer nutrition concerns though there were some misunderstanding among consumers on fat quality.

The difference in knowledge on fat and sodium could be attributed to more public education (in the media and other platforms) on fat than sodium. With respect to perception, 68.0% of the

participants interviewed were of the opinion that "what we eat influences our health". Consumers showed extreme concern about their fat and sodium intakes (table 4.6). With the high level of knowledge on fat and sodium among the consumers, less than 50% of them do make conscious effort to monitor or reduce their fat and sodium intake levels as in table 4.4. This suggests that the consumers have the declarative knowledge "what is" or "know that" but do not have the procedural knowledge "know how" but consumers need both knowledge to make a choice or change a behavior (Worsley, 2002).

The knowledge - behavior gap in this study can also be attributed to the environment in which the consumers live. According to (Sligo and Jameson, 2000), environment structures people's ability to effectively use information, accept and interpret new knowledge. Food availability and accessibility differ from one environment to the other and consumers will always eat what is available, accessible and affordable within their environs.

The consumers probably also did not perceive any threats and internal 'cue to action' such as symptoms of cardiovascular diseases. These factors (perceived threats and cue to action) are necessary for behavior change as in the Health Belief model postulated by (Becker, 1974).

Taste and affordability were the major factors that influenced consumers to buy food at specific joints. Other motivating factors which consumers also consider in their choice of food at particular joints are convenience, and hygiene and safety. These findings found in this study motivating consumers to buy food from joints of their choice reiterates the findings in other studies by (Rheinländer *et al.*, 2008; Farhana and Islam, 2011).

4.2.4 Sodium content and fat composition of selected street foods

The sodium and fat contents of the selected street foods varied substantially by food type both in per 100 grams and per serving (table 4.7 and figure 4.1 respectively). The average sodium in the foods per 100 grams were 161.28, 210.23, 186.82 mg and fat 3.69, 27.75, 16.48 g respectively for light soup, noodles (Indomie) and fried rice. Also light soup, noodles (Indomie) and fried rice respectively yielded 583.02, 862.90, 709.60 mg of sodium and 13.03, 112.11, 61.02 g of fat per serving. The variability in sodium and fat among the three street foods is due to the amount of ingredients used and the method of processing/preparation. Sodium occurs naturally (12%) in foods (Jacobson *et al.*, 2013). The sodium content of soup is lowest because it was analysed without the starch (*fufu*) which is the usual accompaniment. In the case of fried rice and the noodles (Indomie), the values include the natural sodium in the cereal/grains and the sodium (salt) added during cooking. The high fat content of noodles (Indomie) and fried rice is due to the frying during their preparation as frying changes the nutritional content of food (Pokorn *et al.*, 2003). During frying, the food loses water and takes up more fat in the process (Pokorn *et al.*, 2003). The results in (table 4.7 and figure 4.1) though are high, they compare well with the findings of other studies on street food. In Calcutta, 500 g of an average street food meal contains 12-15 g fat (Steyn *et al.*, 2013). Another study (Nazni and Jaganathan, 2014) in the Salem District of India, a street food (Panipoori) contains 70-120 g fat by proximate analysis. In

Australia, the mean sodium in a fast food product is 471mg/100 g and 605 mg per serving (Garcia *et al.*, 2014).

The average amount of sodium per serving from all the food groups in this study is above 400 mg. These selected foods can therefore be described as high in sodium according to (Centre, 2016). The amount of sodium per serving exceeds the WHO recommended daily intake of 2000 mg

(2g/day), and the US joint 2010 *Dietary Guidelines* which recommends intakes not more than 1500 mg/d in African- Americans, people of 51 years of age, and people with hypertension, diabetes mellitus, or chronic kidney disease, and no more than 2300 mg/d in all others.

The levels of fat/oils in the noodles 'indomie' and fried rice were not only high, they had more saturated fatty acids (SFAs) than unsaturated fatty acids in the their TAG constituents (Table 4.8) possibly because of their method of preparation. A study with similar findings describing the changes resulting from the method of food preparation is (Carlos and Ribeiro, 2013) which indicates that fatty acid chain and cholesterol are influenced by the method of food preparation, and may increase the levels of most saturated fatty acids, such as palmitic and myristic fatty acids. In their study, boiled salmon was compared with fried salmon, the latter showed doubled fat content, regardless of the type of oil used.

In effect, the saturated fatty acids will increase low density lipoproteins ('bad' cholesterol) and decrease high density lipoproteins ('good' cholesterol) levels in the blood (Hu *et al.*, 2001). The blood cholesterol-raising properties of saturated fats are attributable to SFAs with more than 12 carbons such as lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0) and Stearic acid (18:0) which were common among the selected food samples (WHO, 2007c). This makes noodles 'indomie' and fried rice per the study results, diets with the potency of raising blood cholesterol levels, blood pressure and subsequently raising the chances of developing NCDs among consumers (Buidhean and Inbhe-Bidhe, 2014) . The usual dietary energy intakes per person per day among Ghanaians is 2900 kilocalories (FAO, 2005). Available evidence suggests that, the contribution of fat to total daily energy consumption should not exceed 30% to avoid unhealthy weight gain (WHO, 2003b; FAO, 2010; Hooper *et al.*, 2012). Thirty percent (30%) of the usual consumption

of Ghanaians (2900kcal) is about 870 kilocalories which is approximately 97 g of fat. The usual fat intakes is about 48 grams according to (FAO, 2005). This implies that the fat in street foods especially, noodles 'indomie' contribute more than the 30% of the daily energy intakes of its consumers.

It should be recognized that the high sodium and energy(as a result of the high fat) from street foods would be added to that obtained from regular home meals, and in the long run will increase both sodium and energy intakes, which will detrimentally impact on weight status (Steyn *et al.*, 2013) and blood pressure (Vollmer *et al.*, 2001; He and MacGregor, 2002).

4.2.5 Risk Assessment

In this cross-sectional study of consumers of selected street foods, intake of noodles (Indomie) and fried rice at the 95th percentile was associated with significant risk (Hazard Index > 1.0) (EPA, 1993; Gerba *et al.*, 1996). With the exception of noodles (Indomie), neither sodium nor fat either in fried rice or light soup independently pose a risk to the consumers even at the 95th percentile. This suggests that the chronic intakes (CDIs) of sodium and fat among consumers from fried rice and light soup is not equal to or above the daily reference dose. Comparing the chronic daily intakes of sodium and fat with their reference dose among consumers of light soup, there was no risk. Both the hazard quotient and hazard index were less than 1.0 (Table 4.9 and figure 4.8). This implies that the intakes of sodium and fat from light soup alone are not likely to exceed their daily thresholds among consumers. However, the hazard indices of sodium and fat in fried rice and noodles 'indomie' were above 1.0 (figure 2.0). Inference from the hazard index means that consuming fried rice or light soup alone on daily basis may not pose a health risk.

However, if they are eaten severally on daily basis along side home meals, the nutrients will add up posing a risk to consumers (Steyn *et al.*, 2013) .

Both noodles 'indomie' and fried rice are processed by way of frying and are frequently consumed. The above finding is consistent with other findings (Cahill *et al.*, 2014) and confirms the association of frequent intakes of fried foods and high significant risk of CVDs.

A study in China showed that the intake of fried food with a frequency of 1.3 ±2.1 versus 1.1±1.8 per week was significantly higher ($p = 0.025$) in patients with acute myocardial infarction than in their control counterparts (Guo *et al.*, 2013).

Another study in India involving 165 coronary heart disease patients and 199 controls found that the coronary heart disease patients had higher intakes of both deep fried and shallow fried foods (Panwar *et al.*, 2011).

Unsaturated vegetable oils as well as their products at high temperatures between 150 ^{o}C and 200 ^{o}C deteriorates because they are susceptible to oxidation (Taraka *et al.*, 2015). Oxidation takes place during frying and it increases the amounts of trans- fatty acids (Wang *et al.*, 2010) and poses a substantial CHD risk (Mozaffarian *et al.*, 2009). The substantial risk of consumers of fried foods according to Mensink *et al.* (2003), could be arising from the mediating role of the trans-fatty acids in fried foods.

Although this finding may be alarming, it must be recognised that fried foods' quality and the fatty acid composition of fried food products depend to a larger extent on several factors (Sanchez-Muniz, 2006; Minihane and Harland, 2007). These factors are the oil used, the composition of the food being fried, and other conditions of frying such as temperature and the duration of frying (Sanchez-Muniz, 2006; Minihane and Harland, 2007). Consuming foods fried with the right type of oil with more polyunsaturated fatty acids and at lower temperatures may present a lower risk.

Although the food samples are high sodium foods according to the USFMC bench mark (≥400 mg/100g), sodium independently did not pose any risk to consumers after comparing the CDIs with the RfDs. Consumers cannot however be assured of 'risk free' throughout their life time if strategies are not put in place to reduce their daily sodium intakes from both street foods and regular home meals. Several studies (Poulter *et al.*, 1990; He and MacGregor, 2002) have demonstrated the linkage that exist between intake so sodium and hypertension. High intakes from all sources can also result in oxidative stress, albumin excretion, and renal damage independent of blood pressure (Matavelli *et al.*, 2007; Susic *et al.*, 2011). Among consumers of the selected foods who are hypertensive, the efficacy of hypertensive drugs amongst them may be reduced because of the levels of their sodium contents (Heerspink *et al.*, 2012).

In summary, though the consumers are at risk, the risk factors/causal pathway of CVDs is diverse including genetic predisposition, lifestyle, physical activity, nutrition (Stoner *et al.*, 2013). This suggests that though the consumers health is at risk, they may not experience signs/symptoms of CVDs if they are not genetically predispose, live a lifestyle devoid of smoking, alcohol, engage in physical activities as recommended and consume diets rich in vegetables and fruits.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The overall knowledge level of respondents on the harmful effects of high sodium and fat intakes is 80.8%. The overall level of knowledge though high among respondents, is skewed towards fat.

Thus 61.2% of the respondents could mention more health problems associated with high intake of fat than sodium (19.6%). Taste was found to be the most influential factor in the choice of street food from particular joints. Other factors that consumers considered include affordability, convenience, food safety and hygiene.

'Indomie' was found to contain the highest amounts of both fat and sodium per 100g followed by fried rice and light soup. 'Indomie' contains 210.23mg sodium and 27g of fat per 100g while fried rice contains 186.82mg sodium and 16.48g fat per 100g. Light soup however contains the least of 161.28 mg sodium and 3.69g fat per 100g. Most of the individual fatty acids making up the triglycerides in the oil extracted from the selected street foods are saturated thus Myristic acid (C14:0), Palmitic acid (C16:0), Stearic acid (C18:0). The only unsaturated fatty acids found are Oleic acid (C18:1) and Linoleic acid (C18:2).

Higher intake of 'indomie' and fried rice was associated with a significant risk, Hazard Index greater than one (HI > 1.0). With the exception of 'indomie', neither sodium nor fat either in fried rice or light soup independently pose a risk to the consumers even at the 95th percentile. However the Hazard Index (HI) of sodium in both fried rice and 'indomie' poses a significant risk to consumers.

5.2 Recommendations

Based on the findings of the study, the following recommendations have been suggested to individuals, agencies, organisations, ministries in the street food sector and government for their attention and action.

1. Public education on air and in the print and electronic media regarding diet and risk of cardiovascular diseases (CVDs) should place much emphasis on dietary sodium. The emphasis should be on physiological/toxic effects of sodium on the human body and practical strategies that can be adopted to minimise salt/sodium content in food by vendors and intake by consumers.

2. Natural ingredients such as garlic, onion and ginger should be used instead of the artificial spices which are high in sodium and monosodium glutamate to improve the

   taste of street foods.

3. Standard easy- to- use equipments for measuring oil and sodium should be manufactured, made accessible to vendors and the vendors trained on how to use them. This will reduce the discretionary salt and oil use among vendors during cooking and further cut down the high sodium and fat contents of street foods as a result of their discretionary use.

4. New and improved methods of cooking such as boiling, toasting, broiling are associated with low levels of fat and sodium and should be adopted by vendors. 'Must fry foods' should however be fried at lower temperatures (<120 degrees Celsius), reduced quantity of oil, use polyunsaturated vegetable oils, shorten frying duration and avoid oil re-use.
   These conditions if ensured will prevent acrylamide and free radicals formation and subsequently,prevent the change in configuration of fatty acids from "Cis to Trans" which are necessary risk for atherosclerosis

5. Consumers of street foods should ccontinue to enjoy street foods but in moderation especially the street foods that processed by way of frying ‘fried rice and the noodles” due to the significant risk they pose to the consumers.

6. To better determine the risk associated with sodium and fat intake and cardiovascular disease, future research should involve a prospective cohort study of detailed dietary assessment of a relatively large sample size of both consumers of street foods and regular home meals for at least two (2) years. Total fat and sodium levels and risk markers for cardiovascular disease are then determined at the end of the study.

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APPENDIX

Appendix I: Questionnaire for Street Food Consumers

Introduction

Good Morning/Afternoon Sir/Madam

Please I am a Post graduate student of the Kwame Nkrumah University of Science and Technology (KNUST). My research is on the analyses of FAT/OIL AND SALT /SODIUM contents of street foods in the Kumasi Metropolis. I would be glad if you spare me few minutes of your time for a brief discussion. I promise your responses in this discussion will be kept secret and confidential. Thank you for your consent.

Demographics

1. Gender

a) Male

b) Female

2. What is your age in years? ……

3. Please indicate the highest level of formal education attained. (Circle one) a) None

b) Basic education /middle school

c) Senior High School/ Technical /Vocational

d) Post Secondary (Bachelor degree, HND, Diploma etc)

e) Post graduate degree

4. What is your marital status?

a) Married

b) Single

c) Divorced

d) Widow/widower

5. What is your occupation? ……

Consumer's knowledge and perception on street vended foods

6. To what extent do you agree or disagree with the statement that food influences our health? a) Strongly agree

b) Strongly disagree

c) Somewhat agree

d) Somewhat disagree

e) Neither agrees nor disagrees

7. What motivated you to order this food from this particular joint? (List any 3 key reasons in order of importance)

……

……

8. Please is the SALT/ FAT content of the foods you eat important to you?

Yes No

If **yes,** why?.....

Fat consumption

9. How concerned are you about the type of FATS you consume

a) Extremely concerned

b) Somewhat concerned

c) Not very concerned

d) Not at all concerned

e) Neither concerned nor unconcerned **(If concerned, skip to QUE 12)**

10. Do you know if there is a recommended amount of FAT to be eaten per person per day?

Yes

No

If **yes,** please indicate the amount.....

11. How much FAT do you think you consume in a day?

a) Too much

b) Right amount

c) Too little

12. To what extent, do you make a conscious effort to monitor how much FAT you consume in a day?

a) Always

b) Sometimes

c) Rarely

d) Not at all (If **Rarely/Not at all** skip to Question 14**)**

13. What specifically do you do to limit the amount of FAT you consume from street foods?

……

14. Does a high FAT consumption cause health problems?

Yes

No

No Idea

If **yes**, what problems?

……

15. Which of the following sources of FATS/FATTY ACIDS do you consider to be healthful?

(Select all that apply) a) Fish oils

b) Vegetable oil

c) Animal fats

d) Nuts and seeds

e) None of the above

16. Which foods in your opinion are very high in fat? (Rank from **Highest** to **Lowest**)

……

……

Salt/sodium consumption

17. How concerned are you, about the amount of SALT/SODIUM in your food?

a) Extremely concerned

b) Somewhat concerned

c) Not very concerned

d) Not at all concerned

e) Neither concerned nor unconcerned

18. Do you know if there is a recommended amount for SALT/SODIUM to be eaten per person per day? Yes

No

No Idea

If **yes,** please indicate the amount**.....**

19. How much SALT/SODIUM do you think you consume in a day?

a) Too much

b) Right amount

c) Too little

20. To what extent, do you make a conscious effort to monitor how much SALT/SODIUM you consume in a day ?

a) Always

b) Sometimes

c) Not at all

d) Rarely **(**IF **Rarely/Not at all,** Skip to Question 22**)**

21. What specifically do you do to limit the amount of SALT/SODIUM you consume from street foods?

a) Do not add salt at table

b) Avoid canned/processed foods

c)Others(specify)……

……

22. Does a high SALT/SODIUM diet cause health problems?

Yes

No

No Idea

If **yes**, what problems?

……..

23. What are the sources of SALT/SODIUM in street foods?

……

……

24. Which foods in your opinion are very high in SALT? (Rank from **Highest** to **Lowest**)

……

Frequency and quantity consumed

25. In a week, how many times do you consume this food of your choice?

……

26. How much (Price/Quantity) do you often buy /eat?

……

Appendix II: Questionnaire for Food Vendors

Introduction

Good Morning/Afternoon Madam,

I am a Postgraduate student of the Kwame Nkrumah University of Science and Technology. My research is on the analyses of oil and salt (sodium) contents of street foods in the Kumasi Metropolis. I would be grateful if you could please spare me few minutes of your time for a brief discussion. I promise your responses in this discussion will be kept secret and confidential.

Thank you for your consent.

Vendor Code:……

Food sold:……

Location:…….....

Demographics of vendors

1. Gender

    a) Male

    b) Female

2. What is your age in years? ……

3. Please indicate the highest level of formal education attained. (Circle one) a) None

    b) Basic education /middle school

    c) Senior High School/ Technical /Vocational

    d) Post Secondary (Bachelor degree, HND, Diploma etc)

    e) Post graduate degree

4. What is your marital status?

    a) Married

    b) Single

    c) Divorced

    d) Widow/widower

Food vending practices

5. How long have you been in this business?.....

6. Have you ever had any formal training on food preparation?

Yes

No

If **yes** how many times…… and by whom? … ……..

7. How many plates/quantity approximately do you serve in a day?……

8. What time in a day do you have a peak sale?

……

Knowledge and perceptions on salt/fat

9. To what extent do you agree or disagree with the statement that the food we eat influences our health?

a) Strongly agree
b) Strongly disagree
c) Somewhat agree
d) Somewhat disagree
e) Neither agrees nor disagrees

10. What do you think are the motivating factors that drive people to your joint?

(List them in order of importance)

……

11. With respect to healthier foods, do you see it as your responsibility to prepare or the responsibility of the consumer to ensure that what he/she eats is healthy?

……

12. In your opinion what are the most SALTY/FATTY ingredients you use?

Salty ingredients……

Fatty ingredients……....

13. Please is the SALT/ FAT content of the foods you prepare important to you?

Yes.....

No.....

No Idea.....

If **yes,** why?

Salt……

Fat…….....

14. How do you measure the amount of SALT/FAT you need/use during food preparation?

Salt:.....

Fat: .....

15. Does a high SALT/FAT diet cause health problems?

Salt

Yes

No

No Idea

if **yes**, what problems?……

Fat

Yes

No

No idea

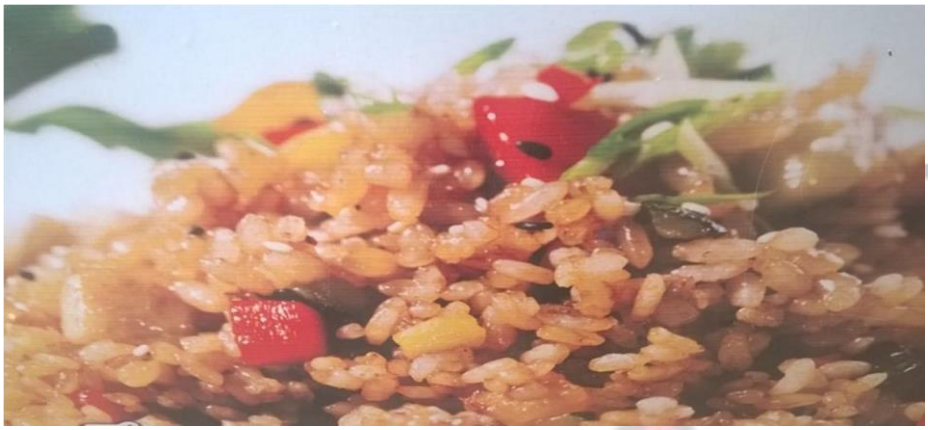
If **yes**, what problems?……

Appendix III: Work in Pictures

Plate 1: Fish in Light soup

Indomie

Fufu



Fried rice

Plate 2: Serving sizes of selected foods

Plate 3: Food samples (soup, noodles and fried rice) in the Lab pending blending

Plate 4: Blended food samples (soup, noodles and fried rice)

Plate 5: Weighed blend samples in crucibles ready for ashing

Plate 6: Soxhlet apparatus

Plate 7: Extracted oil in round bottom flask

Plate 8: HPLC apparatus

Plate 9: Nutrition information of indomie