



**ENERGY CONTRIBUTION OF THE NOVA FOOD GROUPS & THEIR
ASSOCIATION WITH NUTRITIONAL STATUS OF URBAN DWELLERS IN
ACCRA, GHANA**

BY

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DECLARATION

I, Ms. Winifred Atutor declares that this dissertation is the result of my research work carried out in the Department of Dietetics, School of Biomedical and Allied Health Sciences, University of Ghana, under the supervision of Dr. Anna Amoako-Mensah and neither the whole nor any part of it has been or is being submitted for another degree at this or any other university. All cited references are fully acknowledged.

All references cited have been fully acknowledged.

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INTEGRI PROCEDAMUS

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DEDICATION

This thesis is dedicated to God Almighty for his grace and mercies.

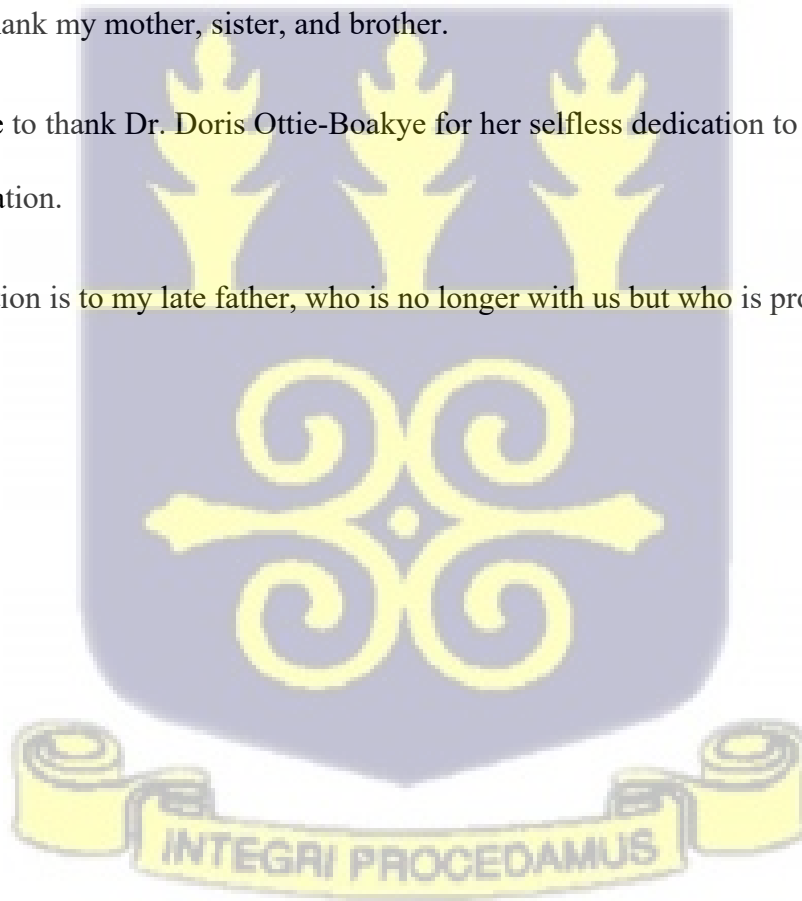
I am incredibly grateful to my husband, Frederick, for his encouragement and support.

I also dedicate this thesis to my daughter Makafui and son Seyram for their contributions to my academic career.

I dedicate and thank my mother, sister, and brother.

I would also like to thank Dr. Doris Ottie-Boakye for her selfless dedication to this work and for being my inspiration.

My final dedication is to my late father, who is no longer with us but who is proud of me.

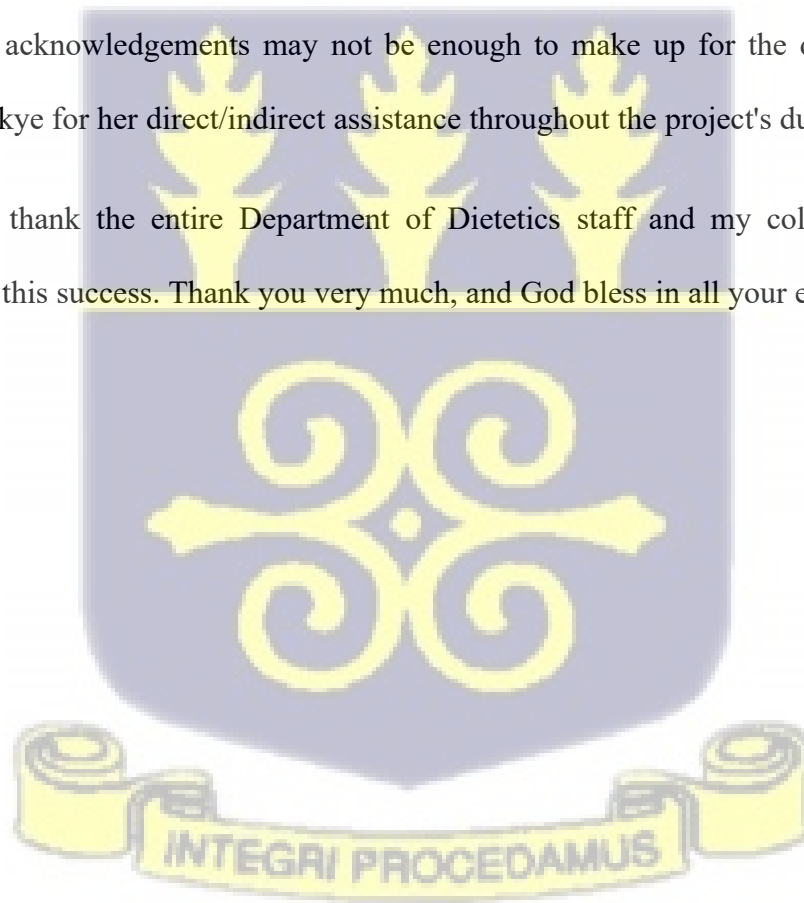


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This study was completed with the assistance and supervision of Dr. Anna Amoako-Mensah. If I do not acknowledge the esteemed scholarly guidance, assistance, and knowledge, then I fail in my duty. More acknowledgements may not be enough to make up for the debt owed to Dr. Doris Ottie-Boakye for her direct/indirect assistance throughout the project's duration.

I'd also like to thank the entire Department of Dietetics staff and my colleagues for their contributions to this success. Thank you very much, and God bless in all your endeavors.



ABSTRACT

Background: NOVA is a food classification system that is based on the type, extent, and purpose of processing of the food. A primary reason for its establishment was to help consumers understand the difference between unprocessed or minimally processed foods and highly processed foods, sensitize them, and guide the development of dietary food guidelines. According to research, Obesity and other associated health conditions have been linked to an increase in the consumption of ultra-processed foods (UPF).

Aim: To estimate the energy and macronutrient contribution of the NOVA food groups consumed in the diet of urban dwellers in Accra and their association with their nutritional status.

Methods: The study employed secondary analysis of a descriptive cross-sectional food consumption survey conducted as part of a research project to develop a photographic food atlas with the portion sizes of commonly consumed animal and plant protein source foods in the Greater Accra Metropolitan Area. The study drew on the information of 700 of the 834 original study participants whose available data satisfied the inclusion criteria for this present study (i.e., age, sex, religion, occupation, educational level, marital status, ethnicity, waist-to-hip circumference, and 3-day 24-hour-dietary recall). The pattern of NOVA food groups consumption was described as frequencies and proportions. and the estimated energy and macronutrient (i.e., Protein, carbohydrate, and fat) contribution of each NOVA food group to the intakes of study participants was also calculated. Additionally, logistic regression models were applied to evaluate the relationship between participants' characteristics and the commonly consumed NOVA food. Lastly, the relationship between the type of NOVA food

groups and the nutritional status (Body Mass Index and Waist-to-Hip ratio) of study participants was assessed using multiple linear regression techniques. Statistical analysis was performed with STATA and level of significance was set at $p\text{-value} \leq 0.05$.

Results: Ultra-processed food was the most frequently consumed by 40.97% of the study population, followed by unprocessed or minimally processed food (35.89%), processed food (20.18%), and processed culinary ingredients (2.96%). However, minimally processed food contributed the most calories (59.9%). This was followed by processed foods which accounted for 38.3% of calorie intake, ultra-processed foods (1.4%) and processed culinary (0.5%). A statistically significant ($p\text{ value} < 0.05$) association was found between educational level ($p\text{ value} = 0.04$) as well as occupation ($p\text{ value} < 0.001$) and consumption of ultra processed food. No significant association ($p > 0.05$) was found between NOVA food types consumed and nutritional status (BMI and WHR) of study participants after controlling for demographic and socio-economic characteristics of study participant. However, age and sex were found to be predictors of nutritional status (BMI and WHR).

Conclusion: Ultra-processed foods were frequently consumed although they contributed only 1.4% of the total caloric intake. Furthermore, educational level and occupation were associated with consumption of ultra-processed food.

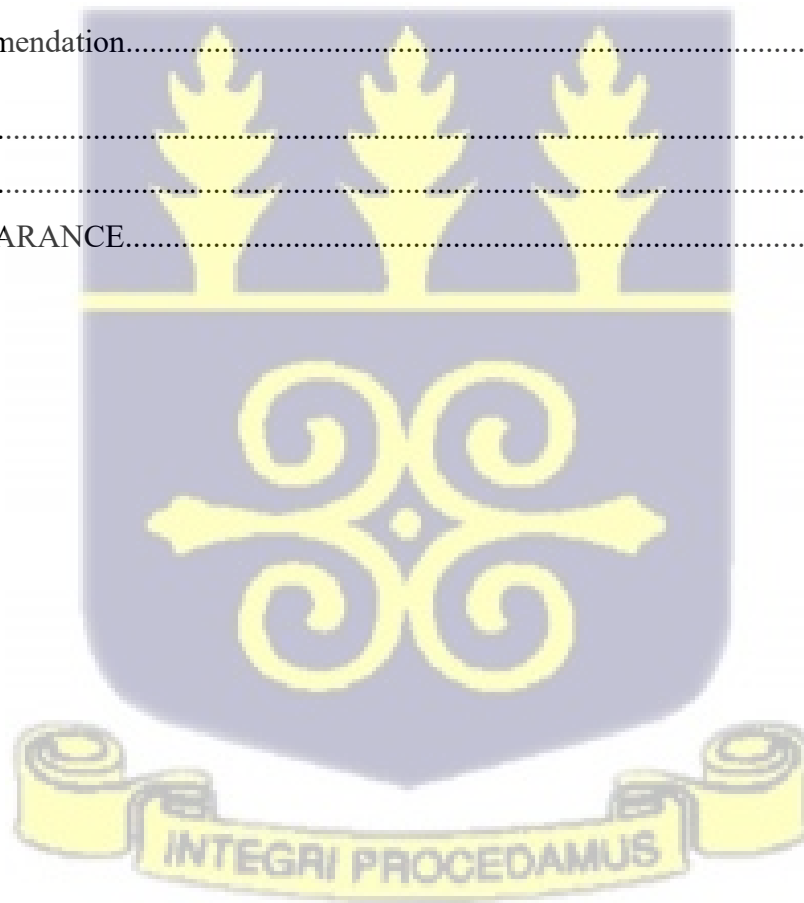
Keywords: NOVA food type, nutritional status, caloric contribution, Urban dwellers, Accra.

TABLE OF CONTENT

DECLARATION.....	2
ACKNOWLEDGEMENTS.....	iii
1.0 INTRODUCTION.....	1
1.1 Background.....	1
1.2 Problem Statement.....	2
1.3 Significance of the Study.....	4
1.4 Aim and Specific Objectives.....	4
2.0. LITERATURE REVIEW.....	6
2.1 Global Focus on Food Processing.....	6
2.2. NOVA Food Groups.....	8
2.3. NOVA Foods and Nutrient Quality.....	11
2.4. NOVA foods and Health Outcomes.....	11
2.5. NOVA Foods and Nutritional Status.....	14
2.6. Socio-demographic Factors Influencing NOVA Foods Consumption.....	17
2.7. Changes in Dietary Patterns in Ghana.....	18
2.8. Conceptual Framework.....	19
CHAPTER THREE.....	21
3.0. METHODOLOGY.....	21
3.1. Study Design.....	21
3. 2. Study Site.....	21
3.2. Study Population.....	22
3.3. Sample Size.....	22

3.4.	Sample Size.....	24
3.5.	Inclusions and Exclusion Criteria.....	24
3.6	Procedure for Data Extracted.....	25
3.7.	Data Management and Statistical Analysis.....	27
3.8.	Ethical Consideration.....	28
CHAPTER FOUR.....		29
4.0.	RESULTS.....	29
4.2	Anthropometric characteristics of study participants.....	32
4.4	Pattern of NOVA Food Consumption Among Study Participants.....	37
4.6	Energy and Macronutrient Contribution of the NOV Food types Consumed by Study 42	
	Participants.....	42
4.7	Sources of Food consumed by Study Participants.....	43
4.8	Influence of Socio-Demographic Characteristics on Nova Food Type Consumed....	44
4.9	Effects of Nova Food Type on Nutritional Status.....	45
4.10	Effects of Nova Food Type on Body Mass Index (BMI) – Unadjusted.....	45
4.11.	Effects of Nova Food Type on Waist-To-Hip Ratio (WHR) – Unadjusted and Unadjusted.....	47
DISCUSSION, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS.....		49
5.0	Discussion.....	49
5.1.	Background Characteristics of Study Participants.....	49
5.2	Nutritional Status of Study Participants.....	50

5.4	Energy and Macronutrients (I.E., Protein, Carbohydrate, and Fat) Contribution of NOVA Foods.....	53
5.6.	Association Between Nutritional Status, Background Characteristics and NOVA....	58
	Food Type Consumed.....	58
5.7	Conclusion.....	59
5.8.	Limitations of The Study.....	60
5.9	Recommendation.....	60
REFERENCES.....		62
APPENDIX I.....		75
ETHICAL CLEARANCE.....		75



List Of Figures

Figure 1: The Double Burden Mortality (DMB) In Low-And Middle-Income Sub-Saharan12

Figure 2: Conceptual Framework Showing The Direct And Indirect Effect Of NOVA Food Types On Nutritional Status After Controlling For The Demographic, Social And Economic Factors Among Urban Dwellers.....16

Figure 3:Map Of Greater Accra Metropolitan Area17

Figure 4.1: Percentage Distribution Of The Most Commonly Consumed NOVA Food By Participants.....31

Figure 4.2: Percentage Caloric And Macronutrient Contribution Of NOVA Food Consumed By Study Participants.....36

Figure 4.3Sources Of Food Consumed By Participants.37



List Of Tables

Table 4.1: Background Characteristics Of Study Participants.....26

Table 4.2 Anthropometric Assessment Of Study Participants28

Table 4.3aFoods Consumed By Participant According To NOVA Classifications.....29

Table 4.3bFoods Consumed By Participant According To NOVA Classifications.....30

Table 4.4a: Mean Energy And Macronutrient Contents Of Unprocessed/Minimally Processed Food Consumed By Study Participants.....32

Table 4.4b: Mean Energy And Macronutrient Contents Of Processed Culinary Ingredient Consumed By Study Participants.....33

Table 4.4c: Mean Energy And Macronutrient Contents Of Processed Food Consumed By Study Participants.....34

Table 4.4d: Mean Energy And Macronutrient Contents Of Ultra- Processed Food Consumed By Study Participants.....35

Table 4.5: Relationship Between Participants Characteristics And Consumption NOVA Food- (Ultra-Processed Foods).....38

Table 4.6: Relationship Between Type Of NOVA Food Group Consumed And Nutritional Status Using BMI Measurement Among Study Participants – Unadjusted & Adjusted Model.....40

Table 4.7: Relationship Between Type Of NOVA Food Group Consumed And Nutritional Status Using WHR Measurement Among Study Participants – Unadjusted & Adjusted (Controlling Their Characteristics) Model.....42

DEFINITION OF TERMS

AMA	-Accra Metropolitan Area
BMI	- Body Mass Index
CC	- Caloric Content
CVDs	- Cardiovascular diseases
FAO	- Food and Agriculture Organization
GAMA	- Greater Accra Metropolitan Area
HC	- Hip circumference
MMDs	- Municipal Metropolitan District
MPF	- Minimally Processed Foods
PCI	- Processed Culinary Ingredients
GAMA	- Greater Accra Metropolitan Area
SDGs	- Sustainable Development Goals
SSA	-Sub-Saharan Africa
UK	- United Kingdom
UPF	- Ultra-Processed Food
US	- United State of America
CC	- Caloric Content
WAFC	- West Africa Food Composition Table
WC	- Waist circumference
WHO	- World Health Organization
WHR	- Waist-to-Hip ratio



CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

All foods consumed daily have undergone some form of processing to preserve them, improve flavor and maintain or supplement quality or color (Amit *et al.*, 2017). While some of these methods date back to prehistoric times, there have also been many advancements in technology and food systems with far-reaching impacts (Amit *et al.*, 2017). One positive impact of this advancement is the substantial reduction in the rate of undernutrition (from 13.1 % in 2001 to approximately 8.8% in 2017) and hunger globally in the past 25 years (Acharya *et al.*,2014).

Obesity and overweight, are considered to play a vital role in the increasing rate of mortality and morbidity worldwide (Advertising & Global marketers, 2013), as well as non-communicable dietary-related diseases such as stroke, cardiovascular diseases, and some cancers. According to research, many of these illnesses result from dietary patterns characterized by ultra-processed foods (UPF) (United Nations, 2019). Rapid changes in the food system, emphasizing quantity rather than quality, have paved the way for consumers to opt for more unhealthy food choices (Scott, 2017). The NOVA food classifications system was initiated to warn customers about the health risks of ultra-processed foods (UPFs), which are often energy dense and high in sugar, saturated fats, and sodium (United Nations, 2019). The system classifies food according to the nature, extent, and purpose of processing (Monteiro *et al.*, 2016a). There are four groups under the NOVA system: unprocessed or minimally processed foods, processed culinary ingredients, processed foods, and ultra-processed foods (Monteiro *et al.*, 2016a). A systematic review of

world food consumption showed marked differences in the intake of UPF across countries. In the United Kingdom (UK) and the United States (US), >50% of food consumed were ultra-processed foods whereas Italy recorded about 10%. Consumption pattern also varied with age, sex, and body mass index (BMI) (Marino *et al.*, 2021).

In sub-Saharan Africa, studies showed that the consumption rate of UPF is between 10-30% (Reardon *et al.*, 2021). These increases are attributed to urbanization, globalization, and the nutritional shift, which has resulted in more women working outside the home, leaving less time to cook. Some studies have also shown a correlation between demographic and socio-economic factors like age, low educational level, and lower household quantile, and UPF consumption (Marchese *et al.*, 2021, Baraldi *et al.*, 2028). Sex, however, did not show any strong correlation (Marchese *et al.*, 2021). Changes in the Ghanaian food system, evidence of rapid urbanization, and the triple burden of malnutrition make it relevant to explore and ascertain the contribution of NOVA food groups to the nutritional status of our urban population.

1.2 Problem Statement

The food environment, underpinning all forms of malnutrition, influences poor-quality diet choices. Although there has been extensive research into poor dietary choices, the focus on ultra processed foods gained momentum about a decade ago (Heshmat, 2011). Changes in the food environment because of rapid urbanization and increasing income in developed countries have made UPFs which are highly energy-dense and contain excess sugar, readily available, accessible, and affordable (Reardon *et al.*, 2019). Surveys reported high prevalence of household consumption of ultra-processed foods in Brazil (25.2%), the UK (56.8%), the US (57.9%),

Canada (61.7 %%), and Sub-Saharan Africa (SSA) (10-30%) (De Oliveira Da Silva Scaranni et al., 2021); Rauber *et al.*, 2019; Martínez Steele *et al.*, 2016; Moubarac et al., 2017; Reardon *et al.*, 2021) respectively. Unfortunately, there is evidence of strong association of UPFs with an increase. Rise in obesity, overweight, and other diet-related non-communicable diseases (NCDs) such as cardiovascular diseases, diabetes, and certain cancers (Jardim, 2021, Chen *et al.*, 2020).

The increased population exposure to UPFs due to nutritional shifts has become a global problem, and Ghana is no exception. Increased urbanization has given rise to a larger middle class and changing lifestyle in the country (Ameye & Swinnen, 2019), thereby encouraging the demand for highly processed, ready-to-prepare foods (Fox *et al.*, 2019). Some quantitative and qualitative studies have investigated the energy contribution of NOVA foods and its effect on nutritional profile (Cattafesta *et al.*, 2020), diet quality (Andrade *et al.*, 2021 & Moubarac *et al.*, 2017), and nutritional quality of life (Poti *et al.*, 2015). The NOVA classification system classifies food according to the nature, extent, and purpose of processing. The higher categories are associated with excess energy, sugar and sodium intake and increased risk of non-communicable disease morbidity and mortality. The energy contribution of NOVA foods to daily energy intake and its effect on nutritional profile has been studied in some developed countries. There is paucity of data among Ghanaian population even though Ghana, like most countries is experiencing nutritional shift due to growing urbanization. The need identifies the relationship between demographic and socioeconomic characteristics of urban dwellers in Accra and their NOVA food consumption as well as the association with nutritional status formed the rationale for carrying out the study.

1.3 Significance of the Study

Rising population growth, more significant household income growth and working women in Ghanaian society has resulted in significant changes in food habits, culminating in a shift toward a more westernized eating pattern, particularly among urban people (Amugsi *et al.*, 2016). This study establishes the baseline information on the trend of NOVA foods consumed by urban dwellers in Accra. By quantifying the extent of the problem in ways that readily highlight it, this study may help influence the content of health education to create awareness among the populace and encourage positive changes in dietary habits.

The findings can also contribute to policy formulation as stipulated under Sustainable Development Goals, (SDG 12: Curbing the Consumption of Ultra-processed Foods and Beverages Critical to Achieving SDG 12, n.d.-b), to promoting sustainable food systems. It will also contribute to the framework for designing dietary guidelines with urban dwellers in context.

1.4 Aim and Specific Objectives

1.4.1 Aim

To estimate the energy and macronutrient contribution of the Nova food groups in the diet of urban dwellers in Accra and the association with their nutrition status.

1.4.2 Specific Objectives

1. To determine the pattern of consumption of NOVA food groups.

2. To estimate the energy and nutrient (i.e., protein, carbohydrate, and fat) contribution of each NOVA food group to the intakes of study participants.
3. To investigate the relationship between participants' characteristics and the reported commonly consumed NOVA food group.
4. To examine the relationship between type of NOVA food groups consumed and the nutritional status of study participants.



CHAPTER TWO

2.0. LITERATURE REVIEW

2.1 Global Focus on Food Processing

Agricultural production and processing have undergone tremendous modification with modern science and technology. Changes in technology to meet the populace's demand are because of rapid increases in population growth, rapid economic spurt, and subsequent changes to humanity's dietary and cultural practices (Nations, 2019). Food demand has increased globally because of economic and population growth, and urbanization, as well as a shift in dietary preferences toward more resource-intensive foods. Hence the present food systems have introduced an array of complexity and diversity, from subsistence farming to multinational food companies (Ercsey-Ravasz *et al.*, 2012).

As the food industry has grown, these outcomes have improved the advancement of food options farther than regional staples, fulfilling customers' preferences for taste, structure, and quality. However, the concomitant quick structural changes have also led to growing and severe issues that could have far-reaching effects on food security and nutrition. These include the numerous highly processed, calorie-dense, and nutrient-poor food products on the market. Food processing has now become a global issue of great concern and an essential topic of focus, which will help identify its significant association with public health (Monteiro *et al.*, 2017). For example, industrially produced trans-fat significantly correlates with cardiovascular disease CVD (De Souza *et al.*, 2015). Studies also show that some processes used in the food industry may alter

the structural properties of food, which contributes to a high glycemic response and low satiety response (Rich, 2015; Fardet et al., 2016). Study done by Fardet et al. (2017) showed that comparing NOVA group 1 (unprocessed or minimally processed) and group 4 (ultra-processed) foods, the more processed they are, the lower their satiety potential and nutrient density, and the higher their glycemic impact. For instance, fruit in syrup has a higher glycemic index, which is likely due to the highly easily absorbed added sugars. This is because, the overall, thermal and mechanical treatments that destruct the fruit fibrous structure, combined with the incorporation of simple sugars, are the procedures that most degrade the fruit nutritive quality by diluting the nutritional density and attenuating the "matrix" effect (Fardet & Richonnet, 2019).

Over the decades, there has also been drastic global changes concerning the world's food system and supplies, which now determine what consumers purchase and consume (Scott, 2017; Mekouar, 2016). Due to global industrialization, most people cook fewer home foods and seek out more franchised-food products to ease the stress after a long day of work. The rapid spring ups of malls and supermarkets displaying a variety of ready-to-use products, packaged attractive foods, and beverages or drinks are also due to the shift in the food system (McGuire, 2016). Hence the rise in UPFs consumption has been associated with obesity and other diet-related conditions, such as CVDs and diabetes by some public health authorities and other organizations (PAHO/WHO, 2015; Aguayo-Patrón & Calderón, 2017; Martínez Steele, *et al.*, 2016). Increased consumption of UPFs led to the NOVA categorizations by Monteiro and his team (Monteiro *et al.*, 2010).

2.2. NOVA Food Groups

The use of the terms "junk foods," "fast," or "convenient" are not scientifically approved assessment terms in classifying food (FAO, 2019; Monteiro *et al.*, 2010). Hence there was a need to develop a system that would enable foods to be appropriately grouped scientifically for easy identification. Also, the term minimally processed or unprocessed and highly processed foods needed a more explicit definition (Monteiro *et al.*, 2016). The NOVA food classification, developed in Brazil between 2010 and 2016 (Monteiro *et al.*, 2017), addressed these challenges. Despite the several food categorization systems based on the degree of processing, the NOVA classification is the most extensively utilized by researchers worldwide (Batal *et al.*, 2017).

The NOVA classification system categorizes food based on the types, amount, and objectives of the industrial procedures. These are physical, biological, and chemical processes used to remove foods from their original state prior to consumption (FAO, 2019). Some foods can be eaten independently, (Examples are fruit, nuts, and milk). Others eat whole or a portion of prepared foods and meals (grains, vegetables, meat, and eggs are a few examples). Others are food items (such as oils, butter, sugar, and salt) used to prepare dishes and meals. Alternatively, they could be food items prepped to be heated, consumed, or both (examples are bread, cheeses, ham, packaged snacks, soft drinks, and prepared dishes). As outlined below, four main food groups are under the NOVA classification (FAO, 2019).

2.2.1 Group 1: Unprocessed or Minimally Processed Foods (UMPF)

Unprocessed foods are produced and consumed naturally without altering their nature or characteristics, such as leaves, fruits, stem roots, eggs, algae, fungi, and water, after separating

them from nature (Monteiro *et al.*, 2010). Minimally processed foods are single food products that are physically processed to increase shelf life, accessibility, and palatability. Such processes include flaking, grating, removal of inedible portions drying, chilling, freezing, pasteurizing, fermenting, and simple packaging (Monteiro *et al.*, 2010). None of these procedures alter the original food in any way, including by adding salt, sugar, oils, or fats. Rarely, products in Group 1 may include additives that lengthen product shelf life, preserve original qualities, or stop the growth of germs. Finally, all the foods in this group serve as the foundation of a balanced diet when combined in the right amounts (Leffa, 2021).

2.2.2 Group 2: Processed Culinary Ingredients (PCI)

Items in this group are food extracts from group one and used as industrial ingredients, but now also in homes and restaurants to season meals and cook dishes to make food more palatable and add flavor and color (FAO, 2019). They are typically not consumed on their own, but rather used to prepare minimally processed foods. Producing processed food ingredients involves chemical and physical processes like milling, hydrogenation, refining and hydrolysis, and additives (Monteiro *et al.*, 2018). Due to these changes, processed culinary ingredients are durable and lasting. The aim is also to enable the preparation of more diverse dishes from minimally processed foods while enhancing the taste and appearance of such dishes (“Harvard University,” 2022).

2.2.3 Group 3: Processed Foods

They are products containing sugar, oil, salt, or a combination of PCI to MPF. Some of these products may be fermented or have additives added to enhance product shelf-life and prevent microbial activities. Examples include fruits in syrups, tinned or bottled vegetables, cheese, salted/ sugared nuts or seeds, and others. (Jones, 2019; Monteiro *et al.*,2016a). These foods are typically made with at least 2-3 ingredients and can be consumed without further preparation (Monteiro *et al.*, 2010).

2.2.4 Group 4: Ultra-Process Foods (UPFS)

These foods are a combination of several ingredients that have been ultra processed, are often rich in calories and low in nutrient content. They are highly desirable to consumers, palatable, and easy to use, especially the ready-to-use products. Food products in this category are considered unhealthy. Examples of ultra-process foods include protein bars, confectionery, cookies, salty packaged snacks, infant formulas, instant noodles, and soft drinks (WHO, 2018, Rauber *et al.*,2019). It is suggested that these foods are specifically designed to increase cravings so that people will overeat them and buy more. Some of these foods, but not all, are low in fiber and nutrients (“Harvard University”, 2022). A study that used data from the National Health and Nutrition Examination Survey discovered that ultra-processed foods accounted for roughly 60% of total calories in the American diet(Monteiro *et al.*, 2016b).

2.3. NOVA Foods and Nutrient Quality

Food processing is crucial to 'nutritional shifting' and significantly influences human health and disease (Monteiro, 2010). Ultra-processed foods contributed 21.5% of the total energy consumed by Brazil's population from 2008 to 2009 (Popkin & Reardon, 2018). In Canada, the contribution of ultra-processed foods to the population energy intake increased from 28.7% in 1938 to 61.7% in 2011 (Moubarac *et al.*, 2014). However, a steady decline in the nutrient quality of ultra-processed foods has been noted over the years (Popkin & Reardon, 2018; Monteiro *et al.*, 2013). For example, there is indication that ultra-processed foods are high in energy, sodium and free or added sugar but deficient in NCD-protective nutrients such as proteins and fiber (Cediel *et al.*, 2018; Canhada *et al.*, 2019). Thus, increased consumption of ultra-processed foods is shown to have a strong association with higher levels of carbohydrates, added sugar, and saturated fat in the diet, as well as lower levels of potassium, protein, fiber content, phosphorus (<https://wacren.zoom.us/j/61201227280>), Vitamins A, C, D, and E, zinc, magnesium, and calcium (Baraldi *et al.*, 2018).

2.4. NOVA foods and Health Outcomes

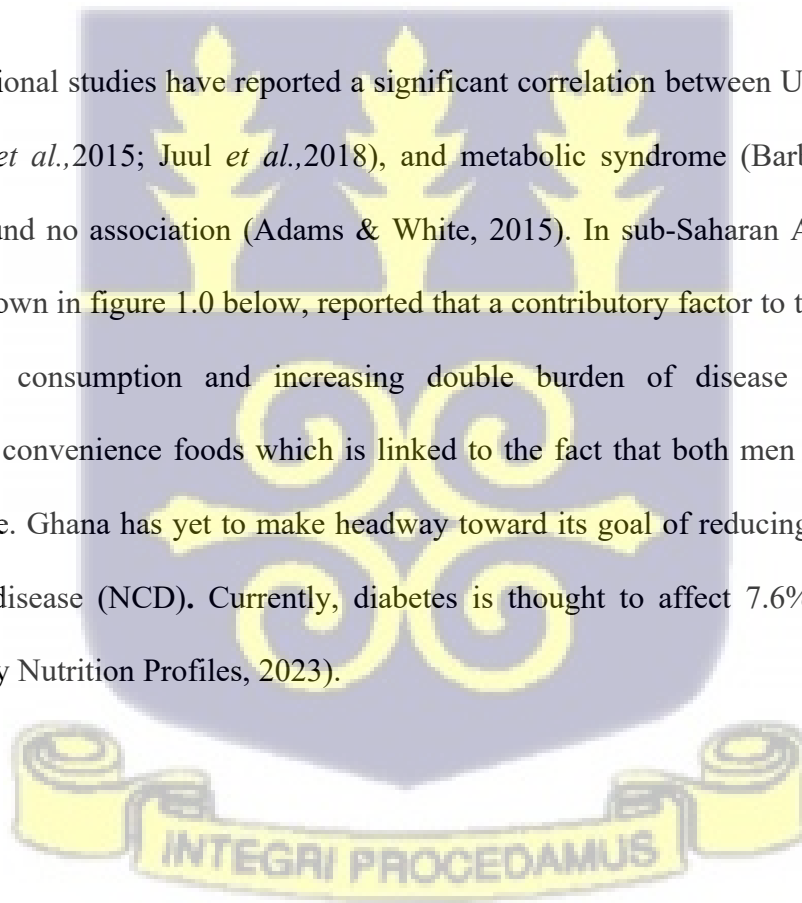
Many domestic kitchens contain at least some processed foods. They can save time when preparing meals, and some processed and enriched foods provide essential nutrients that may not be obtained otherwise in a busy household or one with a constrained food budget (“Harvard University,” 2022). Processed and even ultra-processed foods can provide important nutrients. Some nutrients, such as protein, are naturally retained during processing, while others, such as B vitamins and iron, may be added back if they are lost during processing. The majority of vitamin C can be retained in fruits and vegetables that are quickly frozen after harvesting (Weaver *et al.*,

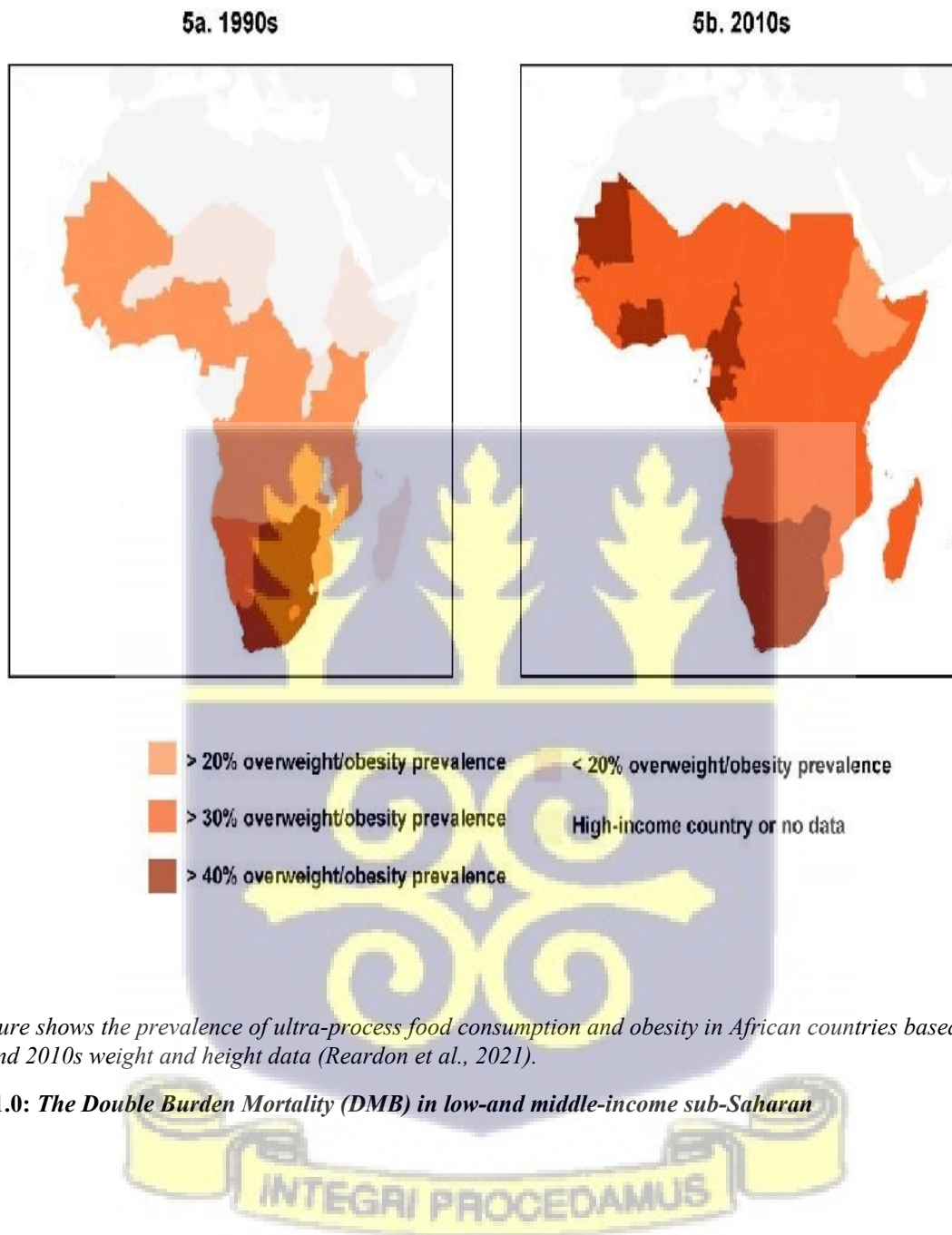
2014, “Harvard University,” 2022). However, there are some disadvantages to food processing. Many nutrients can be destroyed or eliminated depending on the extent of processing. For instance, plant nutrients (phytochemicals) and fiber may be lost when the outer layers of fruits, vegetables, and whole grains are peeled. Certain vitamins and minerals can be destroyed by heating or drying foods. Although food manufacturers can replace some of the nutrients lost, the food cannot be recreated in its original form (Monteiro *et al.*, 2018; “Harvard University,” 2022). The extent to which certain foods are being processed makes it unhealthy and detrimental to health (Monteiro *et al.*, 2018).

Hence the United Nations has designated the years 2016-2025 as the Decade of Nutrition, in support of the UN Sustainable Development Goals as a result threat to the food system, security, and human health (Monteiro *et al.*, 2017). So far, evidence suggests that the substitution of ultra-processed foods for minimally processed foods and freshly prepared dishes and meals is associated with unhealthy dietary nutrient profiles and several diet-related noncommunicable diseases (Monteiro *et al.*, 2017). According to estimates, dietary risk factors are the leading cause of non-communicable disease deaths (NCDs), which accounted for 11 million deaths (22% of all adult deaths) and 15% of lost disability-adjusted life years (DALYs) in 2017, (Leonie *et al.*, 2020). Numerous reviews have revealed the impact of UPFs on health outcomes (Poti *et al.*, 2017; Monteiro *et al.*, 2019). Ever since the creation of the NOVA classification, nutrition researchers from around the world have linked UPFs to poor dietary quality and negative metabolic and health consequences in various populations and national contexts (Leonie *et al.*, 2020).

Five prospective cohort studies involving 183,491 participants studied over a duration of time ranging from three and a half to nineteen years found that increased UPF consumption was associated with an increased risk of mortality (Pagliai *et al.*, 2020). Even though it is widely recognized that UPFs affect dietary quality (Pan American Health Organization, 2019), and therefore has implications for health outcomes, little progress has been made in improving strategies for reducing its consumption (Monteiro *et al.*, 2019).

Some cross-sectional studies have reported a significant correlation between UPF intake, obesity (Costa Lozada *et al.*, 2015; Juul *et al.*, 2018), and metabolic syndrome (Barbosa *et al.*, 2023) while others found no association (Adams & White, 2015). In sub-Saharan Africa, Reardon *et al.*, (2021) as shown in figure 1.0 below, reported that a contributory factor to the 10-30% rate of processed food consumption and increasing double burden of disease is the increased consumption of convenience foods which is linked to the fact that both men and women work away from home. Ghana has yet to make headway toward its goal of reducing diet-related non-communicable disease (NCD). Currently, diabetes is thought to affect 7.6% of adults in the country (Country Nutrition Profiles, 2023).





**The figure shows the prevalence of ultra-process food consumption and obesity in African countries based on the 1990s and 2010s weight and height data (Reardon et al., 2021).*

Figure 1.0: The Double Burden Mortality (DMB) in low-and middle-income sub-Saharan

2.5. NOVA Foods and Nutritional Status

By identifying an entire group of food products with poor nutritional benefits rather than concentrating on individual nutrients or particular dietary items, classification of foods and beverages by extent of food processing can provide novel insight into dietary factors contributing to obesity risk. An increasing body of evidence indicates a high intake of UPF from

the NOVA group is linked to an increase in non-communicable diseases, overweight, and obesity (Poti *et al.*, 2015). Many researchers agree that the rising consumption of ultra-processed foods significantly contributes to the obesity epidemic (Ludwig, 2011; Fardet *et al.*, 2015; Popkin, 2017). Many such studies have looked at the evidence for specific types of ultra-processed foods and discovered that eating more SSBs, fast food, fried potatoes, or candies is linked to a greater likelihood of weight gain or obesity (Nago *et al.*, 2014; Malik *et al.*, 2013; Mozaffarian *et al.*, 2011). This was further demonstrated by Hall *et al.*, 2019, who randomly assigned 20 inpatient adults to ultra-processed versus unprocessed diets for 14 days each. Regardless of being matched for presented calories, sugar, fat, sodium, fiber, and macronutrients, the ultra-processed diet culminated in increased ad libitum energy intake and weight gain.

Unprocessed or minimally processed foods, such as whole grains, fruits, and vegetables, are also linked to weight gain. For instance, fruits and vegetables differ in dietary fiber and glycemic load. High-fiber foods increase satiety (the feeling of being full after eating), which can lead to total energy intake reduction. Low glycemic load foods cause smaller and fewer blood sugar spikes after consumption, which may reduce hunger later (Bertoia *et al.*, 2015, Poti *et al.*, 2017) leading to weight control and management. The above was demonstrated by Hall *et al.*, 2017 who discovered that U/MPFs increased the appetite-suppressing hormone PYY when compared to an ultra-processed diet. Ghrelin, the hunger hormone, was also reduced. The unprocessed diet reduced adiponectin, total cholesterol, hsCRP, and total T3 while increasing free T4 and free fatty acids compared to UPFs. Fasting glucose and insulin levels were significantly lower, as well as triglycerides and HDL cholesterol.

Processed culinary ingredients are durable and lasting with the aim of enabling the preparation of more diverse dishes from minimally processed foods while enhancing the taste and appearance of such dishes (“Harvard University,,” 2022). These consist of Salt, sugar, and fat. All these are energy dense, poor sources of protein, dietary fiber and micronutrients, and the excess usage are suggested to contribute to the obesity epidemic and the rising prevalence of chronic diseases like heart disease and diabetes (Monteiro *et al.*, 2017). For example, among the various types of fatty acids (saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA), and "trans" (TFA), SFA and TFA are frequently associated with adverse impact on population health. Excess consumption of foods high in this type of fatty acid was linked to an increased risk of developing obesity and other NCDs (FAO, 2010).

Furthermore, studies by Meneguelli *et al.* (2021) indicated that consumption of unprocessed or minimally processed foods and culinary ingredients was inversely related to abdominal obesity and hypercholesterolemia, whereas consumption of processed and UPF had a direct relationship. Additionally, when evaluated alone, UPF consumption was associated with excess weight and abdominal obesity.

2.6. Socio-demographic Factors Influencing NOVA Foods Consumption.

According to a cross-sectional survey, socio-demographic characteristics are connected to the energy contribution from UPF intake. The data found that younger ages, urbanization, high socioeconomic class, and a high head of home educational level are socio-demographic variables associated with increasing UPF consumption. (Marrón-Ponce *et al.*, 2017). A study conducted by Livingstone *et al.*, 2017 discovered contrary to Marrón-Ponce *et al.*, 2017, that those with lower socioeconomic class, such as those living in poorer areas with little or no education, had lower

food quality than those with high socioeconomic status. However, the findings of Livingstone *et al.*, 2017 matched with a systematic study by Lewis & Lee, 2020, who discovered a substantial link between poor socioeconomic status and excessive intake of UPF with insufficient amounts of fruits and vegetables.

Further studies confirmed findings previously seen in both developed and developing countries, showing that consumption of UPF has inverse relationships with age and a direct link with living in metropolitan areas (Andrade *et al.*, 2021b; Vandevijvere *et al.*, 201). According to a cross-sectional study conducted by Baraldi *et al.*(2018), ultra-processed food consumption in the United States from 2007 to 2012 was the highest among the participants of lower educational level, younger population, lower-income earners, and American non-Hispanic black and non-Hispanic white strata and increased over time (Baraldi *et al.*, 2018). In Columbia, children and adolescents living in metropolitan regions and households with higher purchasing capacity had the highest consumption of ultra-processed foods in the country (Khandpur *et al.*, 2020). Furthermore, Marino *et al.*, (2021) discovered significant gender, age, and body mass index variation, with men, young adults, and overweight or obese respondents having greater intake than older subjects.

2.7. Changes in Dietary Patterns in Ghana.

Over the last few decades, many emerging countries have undergone tremendous population upheavals (United Nations Human Settlements Programme, UN-HABITAT, 2016; United Nations, 2019). A period between 1950 and 2018, developing world's population increased from 1.72 billion to 6.37 billion, anticipated to reach 8.47 billion by 2050 (United Nations, 2019). Most of the expansion took place in urban settings, with a projected 5.56 billion people

anticipated to reside in developing-country urban setting by 2050 (United Nations, 2019). One of the consequences of this fast urbanization has been drastic changes in the diets of urban people across most of Sub-Saharan Africa (SSA) (Holdsworth *et al.*,2020; Cockx *et al.*,2018). Rapid middle-class development, globalization, and urbanization are shifting global consumption patterns away from fresh plant-based foods and plant proteins and toward increased consumption of animal protein (meat, fish), and ultra-processed foods. The main issue is that these new consumption patterns are not environmentally sustainable (Popkin & Adair, 2012).

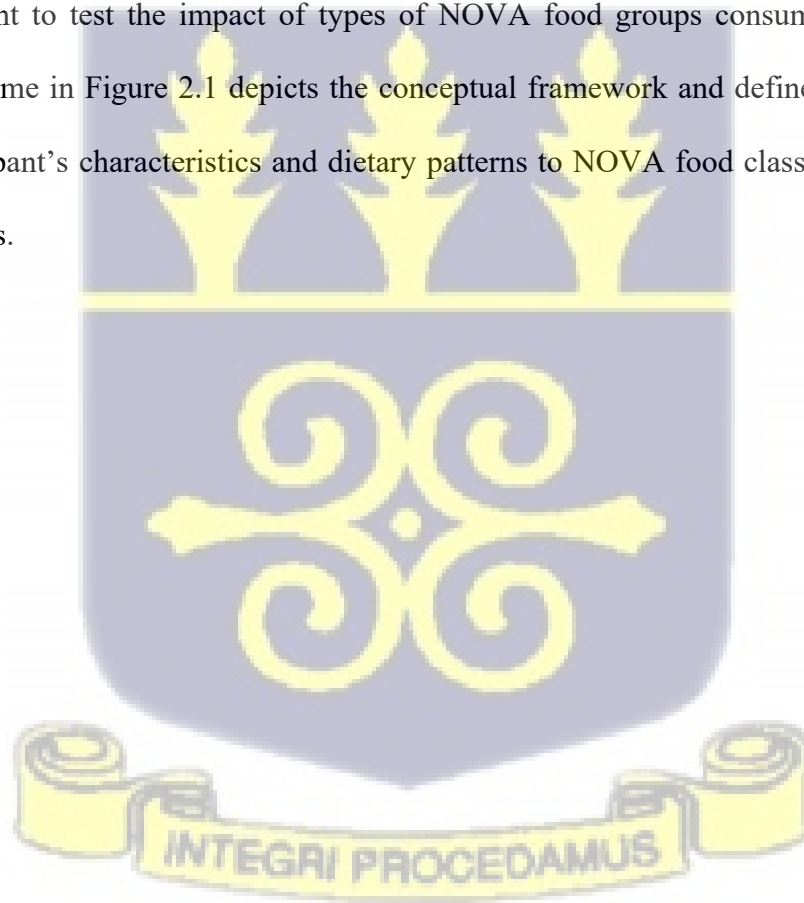
These shifting patterns are more related to the abandonment of traditional foods, largely plant based and less processed, in favor of more convenient foods (including fast and processed foods). The typical Ghanaian dietary pattern relies on starchy roots (cassava, yams, plantain) and cereals, (Maize, rice) with little diversity. These foods provide almost three-quarters of the dietary energy. The share of Protein and lipid dietary energy supply is lower than recommended (Andam *et al.*, 2018). In recent years, rapid urbanization has led to a drastic and dramatic change in the food cape regarding what, where, and how Ghanaian eat (Andam *et al.*, 2018). Evidence of this can be seen on the streets of Accra in the form of high in fat foods like 'tsofi' (turkey tail), sugary beverages, indomi (a form of ramen noodles), and other processed foods introduced in recent years (WHSA, 2011).

A cross-sectional study conducted in Ghana found extensive availability of unhealthy or ultra-processed meals in Greater Accra supermarkets or minimarts. On average, five ultra-processed food products were available at the supermarket or minimart for every unprocessed or minimally

processed food product. On average, there was 5 m² of shelf area for harmful goods for every 1 m² for healthy foods (Adjei *et al.*, 2022).]

2.8. Conceptual Framework

Based on literature linking respondent characteristics to NOVA foods (Andrade *et al.*, 2021), this study sought to test the impact of types of NOVA food groups consumed on nutritional status. The scheme in Figure 2.1 depicts the conceptual framework and defines the relationship between participant's characteristics and dietary patterns to NOVA food classification and their nutritional status.



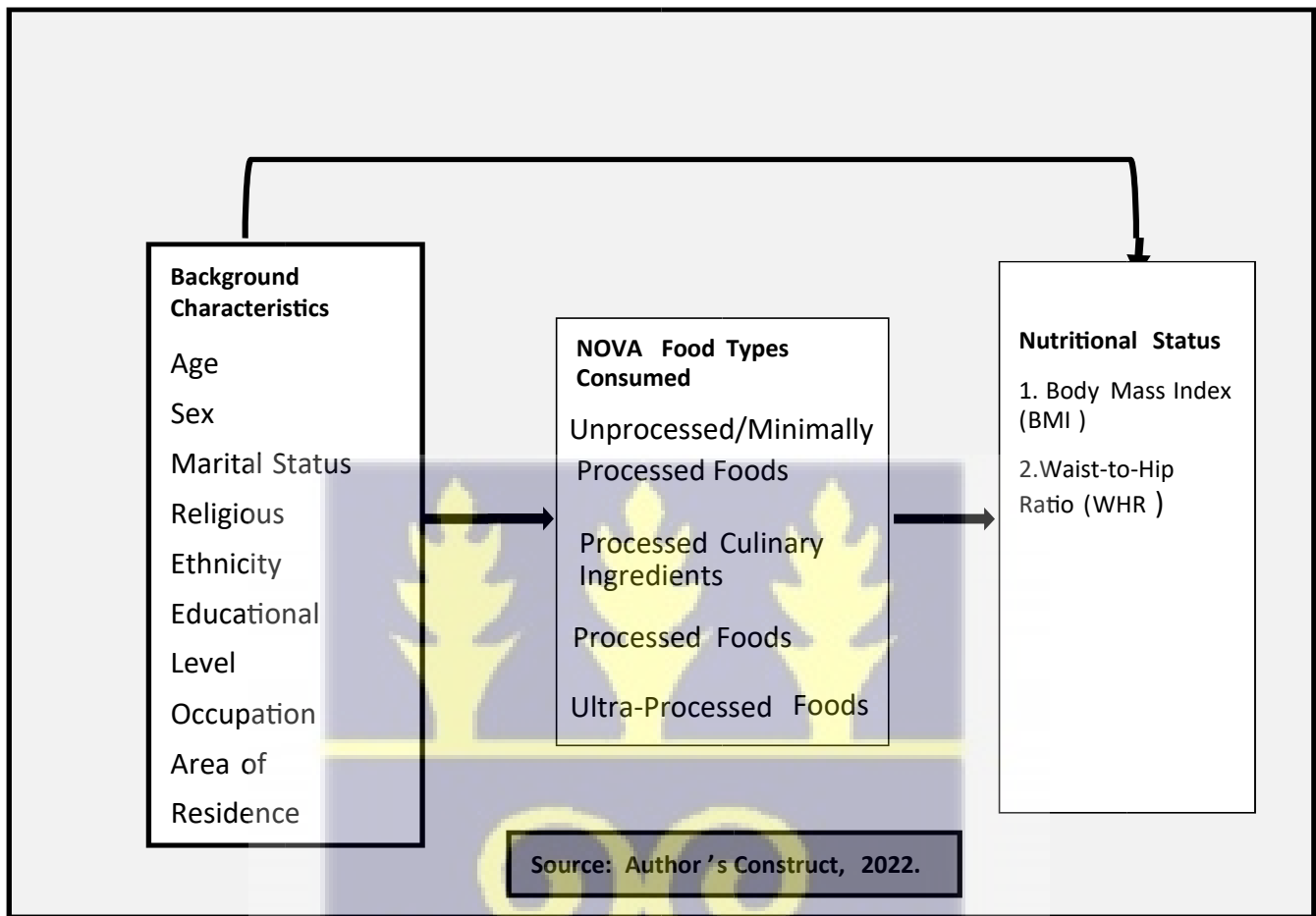


Figure 1.1: Conceptual framework showing the direct and indirect effects of NOVA food types on nutritional status among urban dwellers in Greater Accra Metropolitan Area (GAMA).



CHAPTER THREE

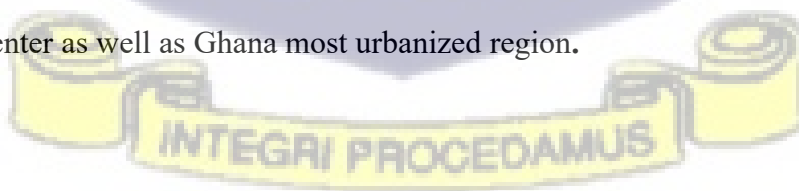
3.0. METHODOLOGY

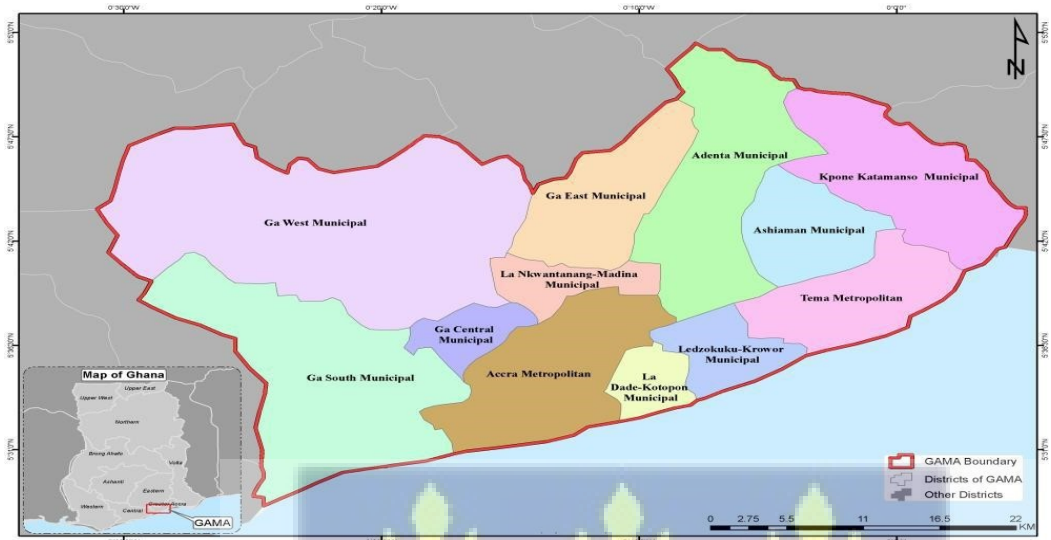
3.1. Study Design

This study analyzed secondary data from a cross-sectional study that was carried out to develop a photographic atlas with portion sizes of commonly consumed animal and plant protein-source foods in the Greater Accra Metropolitan Area (Kuevi, 2020).

3. 2. Study Site

The original study from which data was analyzed for this present one was carried out in Greater Accra Metropolitan Area (GAMA), with a population of 5,455,693 as of 2021 (*Ghana Statistical Service, Ministry of Finance 2021 Population and Housing Census*, 2022). The metropolitan area has a population density of 1,681 per kilometer square and an annual growth of 2.9% (2010–2021). It comprises Accra metropolis, Tema Metropolis, and ten (10) municipalities. Its inhabitants are mainly urban with no rural characteristics. Also, GAMA is the economic and administrative center as well as Ghana most urbanized region.





(Source: Owusu, 2015)

Figure 3.1: Map of Greater Accra Metropolitan Area

3.2. Study Population

The study population for the original study consisted of adults aged 18 years and above living in GAMA at the time.

3.3. Sample Size

Participants for the original study were selected through a multistage sampling process. This was done in three phases. First, six sub metropolitan areas were randomly selected from the Greater Accra Metropolitan Area using a cluster of 30 to ensure precision according to World Food Programme (WFP); Centers for Disease Control and Prevention (CDC) (2005). Participants were then enrolled from thirty different communities purposively sampled from the six sub metros on the basis of the income class categorization of GAMA (Table 3.1). In the present study, the total

enumeration method was employed such that the data from all participants in the original study, which satisfied the inclusion criteria, were included.

Table 3.1: Number of participants enrolled in selected communities.

<i>Classification</i>	<i>MMDA community</i>	<i>No. of people enrolled</i>	
¹ <i>High class</i>	Tema (community 11)	21	
	Lekma (East Airport, Teshie Nungua Estate)	50	
	Adenta (Adjirigano)	21	
	Ga South (McCarthy Hill)	19	
² <i>Middle class</i>	Accra Metro (Dansoman, Latebiokorshie, Mataheko, North Kaneshie)	134	
	Adenta (Adenta, Ashaley Botwe, New legon)	83	
	Ga south (Gbawe, Weija)	44	
	³ <i>Low class</i>	Accra Metro (Abofo, Abossey Okai, Acrra New-Town, Adabraka, Bubuashie, Korle bu, Manprobi, Nima)	246
Tema Metro (kanewo)		25	
LEKMA (Agblezaa, Twibleo)		60	
Ga South (Bortianor, Obom)		69	
Ga Cental (Palas Town, Santa Maria)		62	
Total number of participants		834	

(Source: Kuevi, 2020).

¹Equivalent to: IZ01 (1st class of AMA four income-levels stratification of residential areas); class 1A &1B property tax rating zones, Local Government Bulletin (2018); and low-density high class (LDHCS)/low density newly developing (LDNDS) sectors (classification of residential areas in GAMA, Songsore et al. (2009).

²Equivalent to: IZ02; class 2A & 2B; low-density middle class (LDMCS)/medium density middle class (MDMCS) sectors.

³ Equivalent to: IZ03 and IZ04; class 3A, 3B and 3C; high-density low-class sector (HDLCS)/high-density indigenous sector (HDIS)/middle density indigenous sector (MDIS)/rural fringe (RF).

3.4. Sample Size

A sample size of 820 was calculated for the original study using the following WFP/CDC (2005)

formula at a 95% confidence level:

$$n = z^2 \times p \times (1-p) \times DEFF / d^2$$

$$\text{Hence} = 738 / 1 - 0.10 = 820 \text{ (taking into consideration, 10\% attrition/incomplete data).}$$

As shown in Table 3.1, a total of 834 were eventually enrolled. However, in this present study 700 out of the total available from the original study satisfied the criteria for inclusion.

3.5. Inclusions and Exclusion Criteria

3.5.1 Inclusion Criteria

Participants were deemed eligible to participate in the original study if they were apparently healthy, above 18 years, resident in GAMA at the time of the study and gave informed consent. In this present study, participants who completed all three 24-hour dietary recalls were included.

3.5.2 Exclusion Criteria

Pregnant women and those on a therapeutically modified diet were excluded from the original study. For this present study, data from participants who were not able to complete the three days 24-hour dietary recalls were excluded.

3.6 Procedure for Data Extracted

The completed questionnaires from the original study were obtained from the researcher via the Department of Dietetics, University of Ghana. Subsequently, the questionnaires were carefully sorted out to identify those that satisfied the inclusion criteria. A total of 700 questionnaires were eventually selected because these contained three completed 24-hour dietary recall information. Specific data extracted for this study are briefly outlined below:

3.6.1 Demographics Information: Information on participants' age, sex, area of residence, ethnicity, marital status, and religion.

3.6.2 Socio-Economic Information: Information on occupation and educational level.

3.6.3 Anthropometric Assessment: Information on weight (kg), height (cm), waist circumference (cm), and hip circumference (cm).

- Data extracted on weight and height was used to calculate BMI (Body Mass Index) as:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

It was then categorized according to WHO (2000) classifications of underweight, (<18.5kg/m²), normal (18.5–24.9kg/m²), overweight (25-29.9kg/m²) and obese (>30kg/m²).

- Waist-to-hip ratio, WHR, was Calculated from waist circumference (cm) and hip measurement (cm) as;

$$\text{WHR} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

The WHR was then further classified per WHO recommendations, where in men, WHR of <0.95, 0.96 – 1.0, and >1.0 indicate lower, moderate, and high health risk, respectively, and in women, WHR of <0.80, 0.8-0.85 and >0.86 indicates lower, moderate, and high health risk respectively (WHO, 2008).

3.6.4 Food Consumption Data Extracted.

Firstly, food consumption data was obtained from the 3-day (2 non-consecutive weekdays and a weekend) 24-hour dietary recall (24HDR) assessment of the original study. The data was extracted separately for each of the three days and food quantities were converted into grams. Next, the nutritional composition (carbohydrate, Protein, and fats) and caloric contents were obtained by inputting the converted grams of food consumed into the West Africa Food Composition table, WAFC (Dahdouh *et al.*, 2019). The resulting data was then inputted into Microsoft Excel3.5.1

3.6.5 Classification of Foods by NOVA According to Degree and Purpose of Processing.

Food consumed by participants in the 3-day 24HDR was listed and grouped under the four NOVA classifications, i.e., unprocessed/minimally processed, processed culinary ingredients, Processed foods, and Ultra-processed foods. The grouping considered the scope and purpose of food processing. Whereas, according to the NOVA definition, food processing is the physical, biological, or chemical process that occurs after harvesting or detaching food from its origin and before it is subjected to culinary preparation in homes or restaurants or consumed when food is a ready-to-eat product (Cattafesta *et al.*, 2020).

3.6.6 Determination of caloric and macronutrient content of NOVA Food Groups.

The energy contribution of each food group (CC) to daily energy consumption was calculated as follows:

$$\text{CC of the food group} = \frac{\text{Calories from food consumption}}{\text{Total gross calories}} \times 100$$

Total gross calories.

(Monteiro, 2012; Costa Lozada *et al.*,2015)

3.7. Data Management and Statistical Analysis

3.7.1 Data Management

Data was entered into MS Excel 365 version 2211 for checking for blanks and inconsistencies, recording of new variables, and others, and then exported into STATA version 14.1.

3.7.2 Statistical Analysis

The data management presented outcomes as charts, graphs, and tables for easy comprehension.

Techniques such as proportion were used to determine the pattern of consumption of NOVA food groups. Mean and frequency was used to estimate the energy and macronutrient (i.e., Protein, carbohydrate, and fat) contribution of each NOVA food group to the daily intakes of study participants. Additionally, multiple linear models were used to assess the relationship between respondents' characteristics and the commonly reported type of NOVA food consumed. Finally, logistic regression models were applied to evaluate the relationship between type of NOVA food groups and the nutritional status of study participants.

Data analysis was at a significant level of p-value $\leq 0.05\%$.

3.8. Ethical Consideration

Ethical approval for this study was granted by the Ethics and Protocol Review Committee of the College of Health Sciences, University of Ghana (CH-Et/M.8-4.7/2018-2019; Appendix 1). The

confidentiality and anonymity of information retrieved from the original study were maintained throughout this research.



CHAPTER FOUR

4.0. RESULTS

Table 4.1 shows the demographic and socioeconomic characteristics of the 700 study participants whose data was included in this research. Their ages ranged from 18 years to 76 years. The mean age of participants was 34.1 years, and most were between 25 and 34 years old (35.1%). A majority of participants were not married (52.3%) and Akan's were the largest tribe (47.4%). Per religious affiliation, 89.1% of respondents were Christians, 7.9% of the Islamic religion, with 1.0% being either traditionalists or spiritually conscious.

In the original study, the area of residents for participants was categorized according to AMA's four income-level stratifications for residential areas. In this present study however, residency was put under two broad groups namely, low income and non-low income. More than half of the participants (53.7%) lived in the low-income area. A majority of participants had attained secondary education or higher. In terms of occupation, service delivery (21.5%), trading (25%), and professionals were the most frequently cited.



Table 4.1: Background Characteristics of Study Participants.

Characteristics	Mean Age:34.1 Background years SD= ±11.925			Socio-economic				
	%	n=700	Religious affiliation	%	n=700	Education level	%	n=700
Age group (years)								
18-24	22.3	156	Christianity	89.	624	Below Secondary Education	42.	297
25-34	35.1	246	Islam	1	7	Above Secondary Education	4	169
35-44	24.3	170	Other	9	7	Secondary Education	1	230
45+	16.9	118	Missing	2	14	Missing	32.	4
Missing	1.4	10					0.6	
Sex			Area of Residence			Occupation status		
Females	47	329	Non-low-income class	28.	199	Service	21.	150
Males	53	371	Low-income class	5	375	Artisanry	5	100
			Missing	7	126	Professional	14.4	134
				18		Trading	1	175
Marital status						Farming	25	15
Not married	52.3	366				Retired/Student/Unemployed	2.2	101
Married	46.4	325				Missing	14.	5
Missing	1.3	9					3.6	25
Ethnicity								
Akan	47.4	332						
Ga-Dangme	23.7	166						
Ewe	17.4	122						
others	11.4	80						

**n=number of participants. *Educational level below secondary are participants who had either primary or Junior high-level education or no education 1-3 years or Tertiary 4 years or number. Marital Status Where married means formally married or informally married (cohabiting). *Not married implies divorced, never married, or widowed. * Ethnicity- Where's others included foreigners, Brong Ahafo, Northerners, Upper East, Upper west, Buem and Krobos.*



4.2 Anthropometric characteristics of study participants

The anthropometric profile of study participants is presented in Table 4.2. According to the BMI classification, 51.1% of participants were normal weight and nearly 44.7% were either overweight or obese. Additionally, the waist-to-hip ration indicated that while 63.3% of the study participants were not at risk of any health condition 14.3% were at moderate risk and 22%at high risk.



Table 4.2 Anthropometric Assessment of Study Participants.

Height	Mean Height = 165.7cm +/-10.152	%	n
69.7 < 165.0		45.1	316
165+		54.3	380
Missing		0.6	4
		100	700
Weight	Mean Weight = 63.3kg +/-13.454	%	n
69.7 to 69.9		57.1	400
70+		42	294
Missing		0.9	6
		100	700
BMI	Mean BMI = 25.6kg/m ² (SD= +/-10.186)	%	n
Underweight		3.3	23
Normal		51.1	358
Overweight		29.7	208
Obese		15	105
Missing		0.9	6
		100	700
WHR	Mean Waist Circumference = 83.0cm +/-10.186 Mean Hip Circumference = 98.0cm +/-14.772	%	n
Normal		63.3	443
Moderate risk		14.3	103
High risk		22	154
Missing		0.4	6
		100	700

* Number of participants * According to WHO categorization guidelines: underweight (<18.5 kg/m²), normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), and obese (≥30.0 kg/m²) (WHO, 2000). * WHO recommendations, where in men, WHR of <0.95, 0.96 – 1.0, and >1.0 indicate lower, moderate, and high health risk, respectively, and in women, WHR of <0.80, 0.8-0.85 and >0.86 indicates lower, moderate, and high health risk respectively (WHO, 2008).

4.3 Food Type Consumed by Study Participants classified by NOVA.

Food consumed by participants was extracted from the 3-days 24-HDR and grouped by degree and purpose of processing according to the NOVA classification. A majority of the 132 different foods identified fell under the unprocessed/minimally processed group (Table 4.3).

Table 4.3a Foods Consumed by Participant According to NOVA Classifications.

Food Groups	NOVA FOOD GROUPS AND SUBGROUPS			
	Group 1 (Unprocessed/Minimally Processed (n=72))	Group 2 Process culinary Ingredients (n=7)	Group 3 Processed Foods (n=31)	Group 4 Ultra-Processed Foods (n=22)
Cereals	Akple, Asaana, Banku, Brukina, Corn Porridge, Flour, Hausa koko, Millet, Oats, Wheat & Rice		Bread, Corn Flakes, Chips, Cream Crackers & Meat Pie	Noodles
White Roots and Tubers	Cassava, Fried Plantain, Roasted Ripped Plantain, Boiled Plantain		Plantain Chips	
Vegetables	Ampesi Kelewele, Potatoes, Beetroots, Cabbage, Carrots, Lettuce, Onions, Tomatoes			Creamed Salad
Fruits	Apples, Banana, Coconut, Grapes, Orange, Pineapple, Watermelon			
Meats Organ Meat	Cow, Goat, Kotodwe, Wele, Cow Intestine & Gizzard			Sausage & Corn Beef
Egg	Chicken Egg			
Fish & Sea Foods	Dried Fish, Smoked Fish, Crabs, Shrimps			Canned Tuna, & Sardine

(Continued)

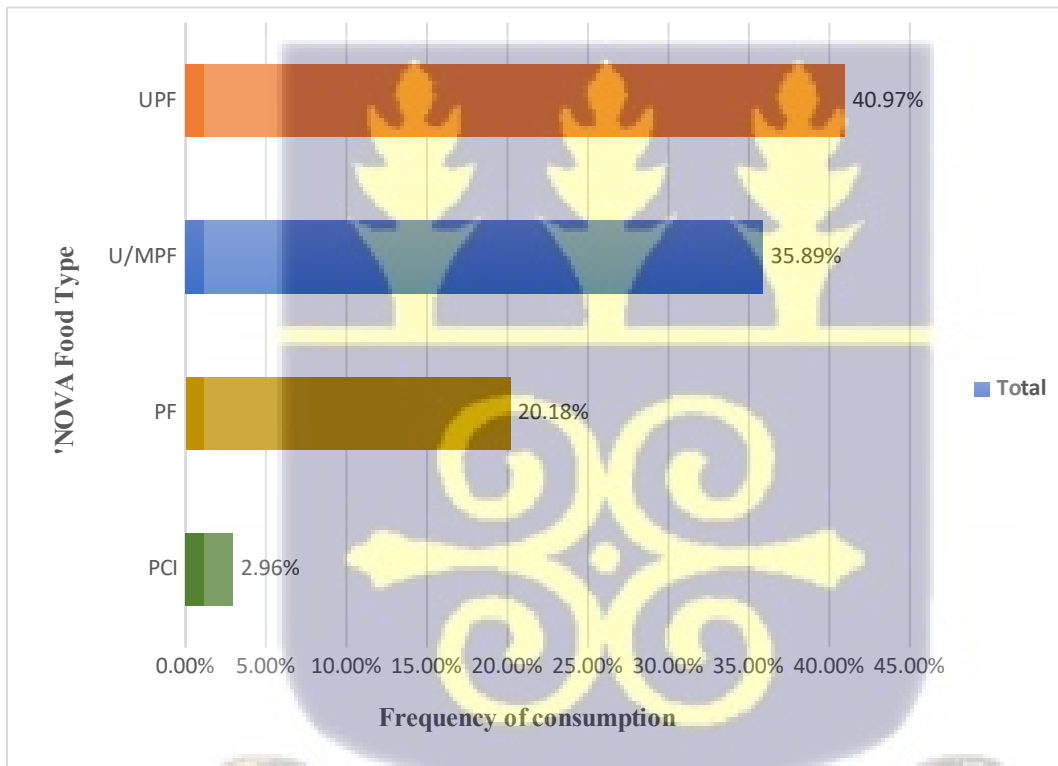
Table 4.3b Foods Consumed by Participant According to NOVA Classifications.

Food Groups	Unprocessed/Minimally Processed	Process culinary Ingredients	Processed Foods	Ultra-Processed Foods
Legumes, Nuts & Seed	Groundnuts, Beans, Bambara Beans		Koose & Pinkaso	
Milk & Milk Products		Cheese, Margarine		Ideal Milk, Carnation Milk, Nunu Milk, Popular Milk, Powdered Milk, Yogurt
Fats and Oil		Frytol & Palm Oil		
Sugar and Sweets		Honey, White & Brown Sugar	Doughnuts,	Cake
Spices, Condiments & Beverages			Milo, Milo Drink	Alvaro, Apple drink, Choco malt, Coke, Fanta, Lipton, Malta Guinness, Multi Fruit drink, Miski Choco, Special Orange Drink,
Soup and Sources			Ayoyo Soup, Carrot Soup, Garden Egg Stew, Groundnut Soup, light Soup, Okra Stew, Palmnut Soup, Tomato Stew, Shito & Vegetable stew	

**Classification by physical, biological, or chemical process, occurring after harvesting or separating food from nature before being subjected to culinary preparation in the home or restaurant kitchens or consumed when food is ready to eat (Cattafesta et al., 2020 & Monteiro et al., 2016). *n = total number of foods consume*

4.4 Pattern of NOVA Food Consumption Among Study Participants.

Figure 4.1 depicts the distribution of food consumption across the four NOVA groups. According to the data, UPF was the most frequently consumed NOVA food group type among the 700 study participants during the 3-day 24-hour recall period. UPFs accounted for 40.97% of the Four NOVA foods, followed by U/MPF, 35.89%, PF, 20.18%, and PCI, 2.96%.



*U/MPF- Unprocessed / Minimally processed food * PCI- Processed culinary ingredients *PF- Processed food *UPF-Ultra-processed food.*

Figure 4.1: Distribution of consumption of a Particular NOVA Food by Study Participants.

4.5 Energy and Macronutrient Contents of the NOVA Food Type Consumed by Study Participants.

Table 4.4a & b displays mean caloric contributions of the various NOVA food type consumed by participants and source of obtaining. The average daily caloric contribution of participants' diet was 2,819.7kcal.

Table 4.4a: Mean Energy and Macronutrient Contents of Unprocessed/Minimally Processed Food Consumed by Study Participants.

FOODS	Energy and macronutrient content (Kcal)			
	ENERGY	CHO	PROTEIN	FAT
Cereals	18032.9	9039.1	13077.3	2240.2
White Roots and Tubers	6588.3	5981.7	360.9	245.5
Vegetables	60.1	52.7	5.4	1.9
Fruits	631.0	134.3	7.5	12.9
Meats & Poultry	1662.7		964.7	631.3
Organ Meat	0.8		0.6	0.2
Egg	1149.3	32.0	331.5	785.8
Fish & Sea Foods	1344.3	66.7	815.7	47.2
Legumes, Nuts & Seed	16.8	1.2	2.8	12.9
Milk & Milk Products				
Fats & Oil				
Sugar & Sweets				
Spices, Pastries, Condiments & Beverages				
Soups & Sauces				

Total	29,493.3	15,313.7	15,567.5	3,978.0
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* CHO= Carbohydrate * Kcal=Kilocalories

Table 4.4b: Mean Energy and Macronutrient Contents of Processed Culinary Ingredients' Consumed by Study Participants.

FOODS	Energy and macronutrient content (Kcal)			
	ENERGY	CHO	PROTEIN	FAT
Cereals				
White Roots and Tubers				
Vegetables				
Fruits				
Meats & Poultry				
Organ Meat				
Egg				
Fish & Sea Foods				
Legumes, Nuts & Seed				
Milk & Milk Products				
Fats & Oil	199.9	0.9	26	124.
Sugar & Sweets	41.2	40.5		7
Spices, Pastries, Condiments & Beverages				
Soups & Sauces				
Total	241.1	41.4	26	124. 7

* CHO= Carbohydrate * Kcal=Kilocalories

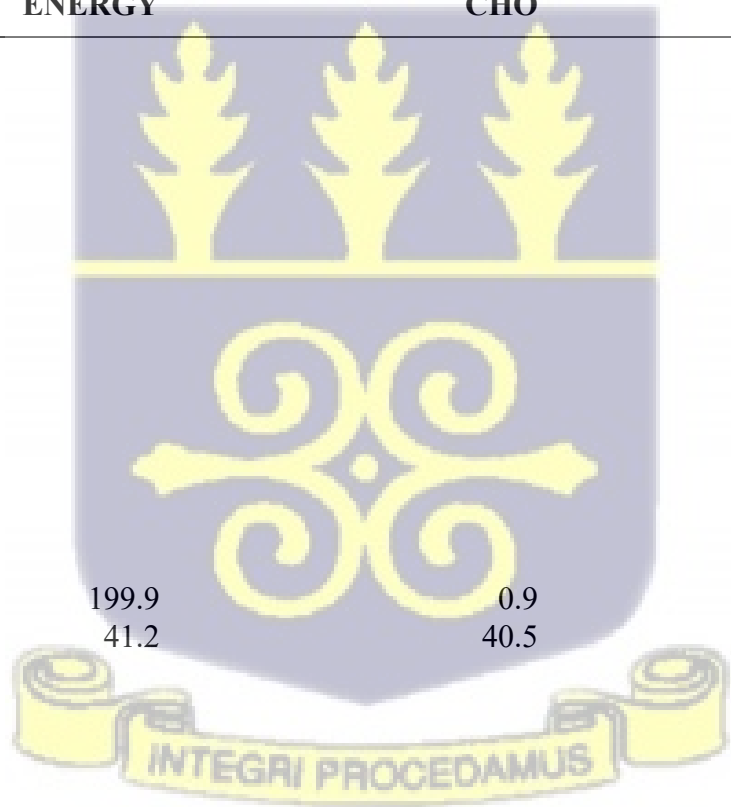


Table 4.4c: Mean Energy and Macronutrient Contents of Processed Food Consumed by Study Participants.

FOODS

Energy and macronutrient content (Kcal)

	ENERGY	CHO	PROTEIN	FA T
Cereals	178.3	167.1	10.9	0.4
White Roots and Tubers	9.7	6.8	0.8	2.0
Vegetables	396.6	280.7	68.8	47.1
Fruits				
Meats & Poultry				
Organ Meat				
Egg				
Fish & Sea Foods				
Legumes, Nuts & Seed	601.4	218.4	7.4	
Milk & Milk Products				4.5
Fats & Oil				
Sugar & Sweets				
Spices, Pastries, Condiments & Beverages	436.3	299.4	28.0	106.9
Soups & Sauces	17212.1	3,747.0	4,449.1	9,016.0

Total	18,840.4	4,720.1	4,565.1	9,176.9
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* CHO= Carbohydrate * Kcal=Kilocalories

Table 4.4d: Mean Energy and Macronutrient Contents of Ultra- Food Consumed by Study Participants.

FOODS	Energy and macronutrient content (Kcal)			
	ENERGY	CHO	PROTEIN	FAT
Cereals	80.6	38.4	15.6	3.6
White Roots and Tubers				0.7
Vegetables	13.8	10.9	2.2	
Fruits				84.6
Meats & Poultry	157.4		50.9	
Organ Meat				
Egg				55.9
Fish & Sea Foods	124.6	5.7	55.9	9
Legumes, Nuts & Seed				46.8
Milk & Milk Products	132.2	56.3	29	
Fats & Oil				21.7
Sugar & Sweets	69.4	43.6	4.2	7
Spices, Pastries, Condiments & Beverages	93.1	92.2	0.8	0.2

Soups & Sauces				<u>213.</u>
Total	671.1	247.1	<u>165.8</u>	<u>5</u>

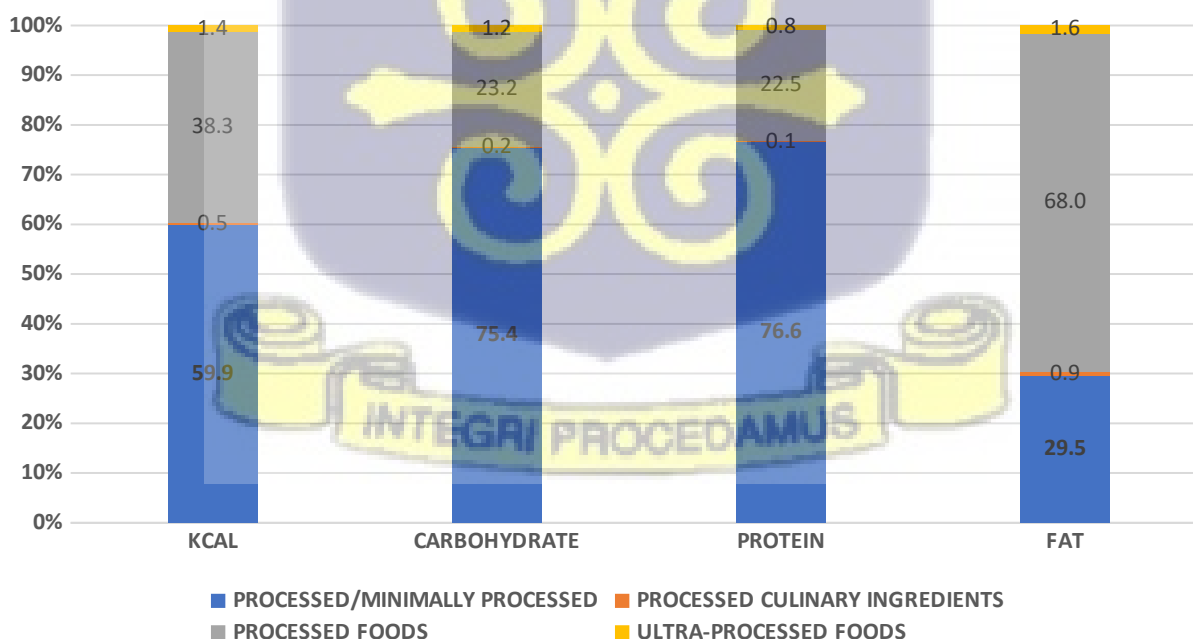
* CHO= Carbohydrate * Kcal=Kilocalories



4.6 Energy and Macronutrient Contribution of the NOV Food types Consumed by Study Participants

Figure 4.2 below shows the percentage of mean caloric and macronutrient contribution of each NOVA food group to the intake of participants. Most of the caloric contribution came from unprocessed/minimally processed foods, which contributed 59.9% (kcal 29,493.3), followed by processed foods, (38.3 %; kcal 18,840.4), ultra-processed foods (1.4 %; kcal 671.4), and processed culinary ingredients (0.5%, kcal 241.1).

Unprocessed/Minimally processed foods contributed the highest carbohydrate(75.4%) and protein (76.6%) content of participants diet, while processed foods contributor the majority of fat content of 68.8% with UP/MPF contributing a little above a quarter thus 29.5% . UPF and PCI contributed the least of all macronutrients. The carbohydrate contribution of PCI was 23.2%, coming from sugar with very little from cheese and margarine.



*UP/MPF- unprocessed or minimally processed food. *PCI-processed culinary ingredients. *PF- processed food.
 *UPF- ultra-processed food.

Figure 4.2: Percentage Caloric and macronutrient contribution of NOVA food Consumed by Study Participants.

4.7 Sources of Food consumed by Study Participants.

Data about the sources of participant's food is captured in Figure 4.3 below. As shown, most of the participants (83.3%) bought and ate food that was prepared away from home.

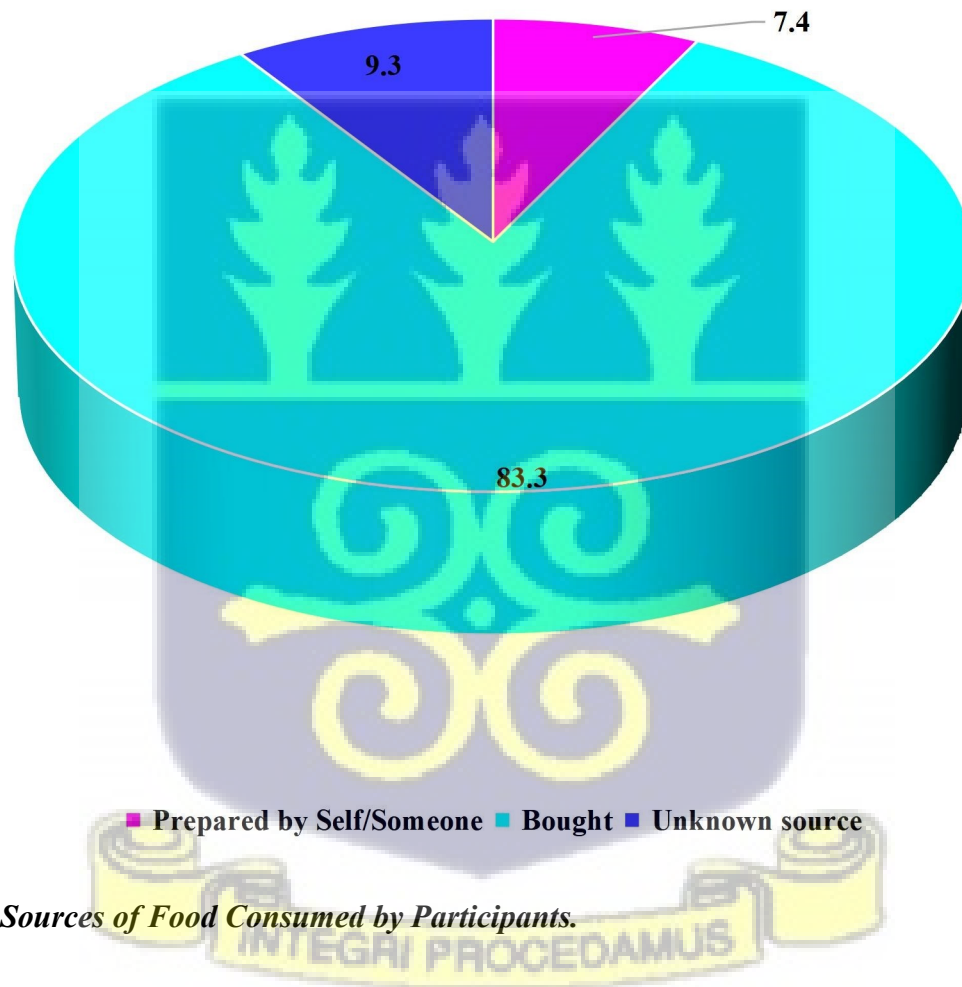


Figure 4.3 Sources of Food Consumed by Participants.

4.8 Influence of Socio-Demographic Characteristics on Nova Food Type Consumed

Table 4.5 shows the multiple logistic regression model results on the relationship between participants' characteristics and the most commonly consumed NOVA food group (Ultra Processed Foods (UPF)).

Educational level ($p < 0.005$) and Occupation ($p\text{-value} < 0.001$) had a significant relationship with ultra-processed food consumption among study participants. The other characteristics had no significant relationship to UPF consumption.

Table 4.5: Relationship Between Participants Characteristics and Consumption NOVA food- (Ultra-Processed Foods).

Variables	Odds Ratio	p-value	95% Conf. interval
Age	0.986	0.137	0.969-1.004
Sex	0.748	0.170	0.494 - 1.133
Union	0.864	0.528	0.585 - 1.361
Ethnic	1.056	0.615	0.854 - 1.303
Religion	1.190	0.612	0.608 - 2.326
Educational level	1.443	0.004	1.128 - 1.846
Occupation	1.168	0.020	1.0251 - 1.331
Residential Area	1.404	0.119	0.9159 -2.151

*RC - Reference category (UP) = 1.000

4.9 Effects of Nova Food Type on Nutritional Status.

To investigate the relationship between types of NOVA food groups consumed and nutritional status measured in terms of body mass index and also waist-to-hip ratio, unadjusted and adjusted models were fitted using linear regression techniques.

4.10 Effects of Nova Food Type on Body Mass Index (BMI) – Unadjusted

Table 4.6 shows the results of the unadjusted linear regression between NOVA food type consumed and nutritional as measured by BMI. The result shows that BMI had no significant correlation with NOVA food type (U/MPF, PF & CPI) consumed by participants. A similar observation was made after controlling for participants characteristics in Table 4.6 using multiple linear regression.

Age and sex of study participants were found to be statistically significant with their BMI. The overall model was significant (Prob F > 0.000), and the R-square showed that 11.1% of the variation in BMI could be explained from participants' characteristics and the type of NOVA food consumed. The adjusted model revealed that age (p-value <0.001) and sex (where $p < 0.001$) were significantly related to participants' BMI respectively, but not the type of NOVA food consumed.

A unit increase in participants' age increases their BMI by 0.102kg/m². Nevertheless, variables such as marital status, ethnicity, religion, educational level, occupation, and area of residence were not statistically significant in the model (Table 4.6).

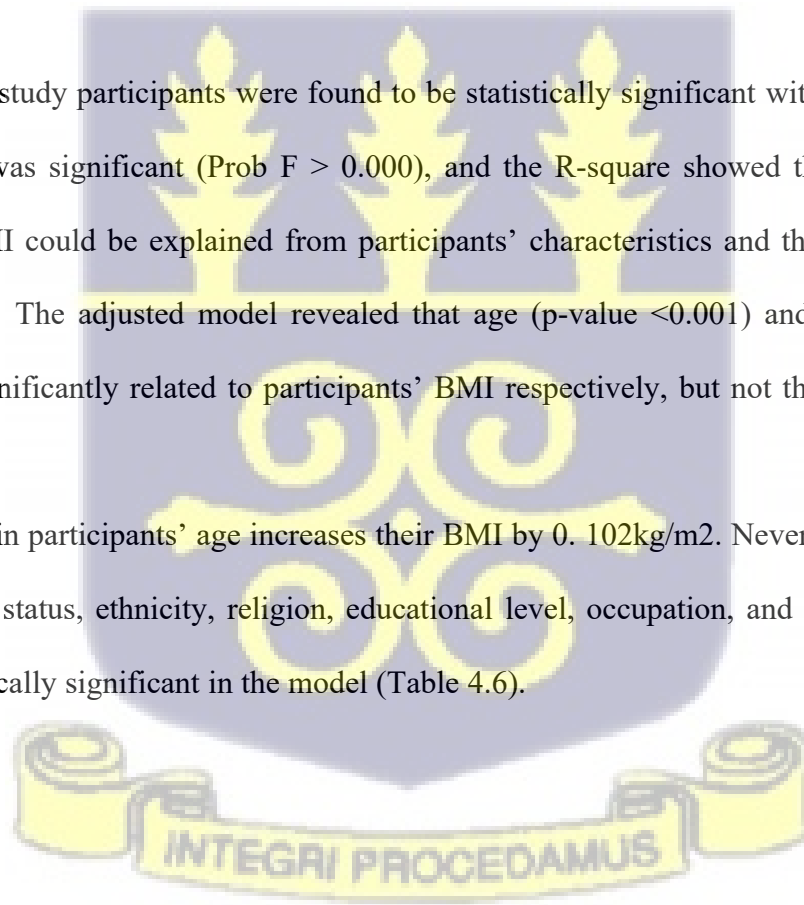


Table 4.6: Relationship Between Type of NOVA Food Group Consumed and Nutritional Status Using BMI Measurement Among Study Participants – Unadjusted & Adjusted Model.

Unadjusted				Adjusted (Controlling their characteristics)			
Variables	Coef.	p-value	95% Conf. interval	Variable	Coef.	p-value	95% Conf. interval
Type of NOVA food group				Type of NOVA Food Consumed			
Ultra-Process Food (RC)	1			UPF (RC)	1.000		
Unprocessed/Minimally food, (U/MPF)	-1.279	0.154	-3.511	Unprocessed/Minimally food	-0.007	0.994	-1.895 - 1.88
Processed culinary ingredient, (PCI)	-0.306	0.7	-3.928	Processed culinary ingredient	0.237	0.775	-1.393 - 1.868
(Processed foods) PF	-1.026	0.149	-2.79	Processed foods	-0.252	0.665	-1.393 - 0.889
				Characteristics			
				Age	0.102	0.000	0.064 - 0.139
				Sex	-3.112	0.000	-3.908 - -2.316
				Marital status	-0.041	0.931	-0.979 – 0.897
				Ethnicity	-1.778	0.315	-0.526 – 0.170
				Religion	-0.556	0.295	-1.598 – 0.489
				Educational level	0.1571	0.499	-0.299 – 0.613
				Occupation	-	0.315	-0.334 – 0.108
				Residential area	0.1131		
					0.2323	0.575	-0.580 – 1.045

*Coef. – coefficient *RC - Reference category *R-square: 0.1115 *WHR- Waist-to-hip ratio *BMI- Body mass index *R-] is adjusted * UPF- Ultra-process foods, Prob F > 0.000 Source:

4.11. Effects of Nova Food Type on Waist-To-Hip Ratio (WHR) – Unadjusted and Unadjusted.

Tables 4.7 below describe the effects of NOVA food type consumed on WHR, which are determinants of weight related health conditions. Unadjusted and adjusted models were also fitted using linear regression techniques. The results of the unadjusted linear regression between NOVA food type consumed and nutritional status measured with WHR showed no significant relation with NOVA food type (U/MPF, PF & CPI) consumed by participants. Similar Observation was made after controlling for participants characteristics in Table 4.7 using multiple linear regression.

Age and sex of study participants were found to be significantly associated with their WHR. The overall model was significant (Prob F > 0.000), and the R-square showed that 15.9% of the variation in WHR could be explained from participants' characteristics and the type of NOVA food consumed. The adjusted model revealed that age (p-value < 0.001) and sex (where p = 0.004) were significantly related to participants' WHR respectively, but not the type of NOVA food consumed. A unit increase in participants' age increases their WHR by 0.003. Additionally, being a male increase one's WHR by 0.28. Nevertheless, variables such as marital status, ethnicity, religion, educational level, occupation, and area of residence were not statistically significant in the model (Table 4.7).

Table 4.7: Relationship Between Type of NOVA Food Group Consumed and Nutritional Status Using WHR Measurement Among Study Participants – Unadjusted & Adjusted (Controlling their characteristics) Model.

Variables	Unadjusted			Adjusted (Controlling their characteristics)			
	Coef.	p-value	95% Interva l	Variable	Coef .	p- value	95% Conf. interval
Type of NOVA food group				Type of NOVA food			
ULTRA Processed Food (RC)	1.000			UPF (RC)	1.00 0		
Unprocessed/Minimally food	0.008	0.755	-0.105	Unprocessed/ Minimally food	- 0.03 8	0.134	-0.012-1.880
Processed culinary ingredient	- 0.015	0.488	-0.087	Processed culinary ingredient	0.01 3	0.51	-0.053-1.868
Processed foods	0.006	0.782	-0.08	Processed foods	- 0.00 6	0.717	-0.04 - 0.889
				Characteristics			
				Age	0.00 3	0.000	0.017- 0.139
				Sex	0.02 8	0.004	0.009 - -2.316
				Marital status	0.00 3	0.82	-0.027-0.897
				Ethnicity	0.00 4	0.348	-0.013-0.170
				Religion	0.00 4	0.712	-0.039-0.486

Educational level	0.00	0.171	-0.022-0.613
	9		
Occupation	0.00	0.585	-0.044-0.108
	2		
Residential area	0.00	0.426	-0.012-1.045
	8		

**Coef. – coefficient *WHR- Waist-to-hip ratio *Coef. – coefficient *RC - Reference category * R-square: 0.1115 *WHR- Waist-to-hip ratio *BMI- Body mass index 2003 *R-] is adjusted * UPF- Ultra-process foods, Prob F > 0.000 Source:*



CHAPTER FIVE

DISCUSSION, CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

5.0 Discussion

5.1. Background Characteristics of Study Participants.

The mean age of participants in this study was 34.1 years, and most were between 25 and 34 years old (35.1%). Although the participants were sampled from Greater Accra Metropolitan Area, which is traditionally a Ga domicile, Akan's were the largest tribe (47.4%) represented. This reflects the cosmopolitan nature of the Metropolis and the fact that it has been the home for many who have come from other parts of the country to pursue various socioeconomic activities.

Per religious affiliation, 89.1% of respondents were Christians. According to the Ghana Statistical Service (2014), almost three in every four persons in Ghana are Christians. Also, in the Ghana Demographic and Health Survey report of 2015, a vast majority (79.2%) of the respondents interviewed said they were Christians.

More than half of the participants (53.7%) lived in a low-income area and approximately 52.3% were not married. Most participants had attained secondary education or higher. In terms of occupation, more than half of the study participants were either employed or self-employed where service delivery (21.5%), trading (25%), and professionals were the most frequently cited.

The present study is aligned with a previous study done on urbanization in Ghana, where the majority (86%) of the populace of age greater than 11 years were literate, more than half were not married, and 82% were either self-employed/employed (Ghana Statistical Service, 2014).

5. 2 Nutritional Status of Study Participants

Nutritional status is the balance of nutrients consumed and nutrients expended in growth, reproduction, and health maintenance. Due to its highly individualized and complex nature, nutritional status assessment can focus on various aspects— from body’s nutrient levels to its metabolic by-products and the functional processes they modulate or control. There are various methods for assessing nutritional status, but for this study, body mass index (BMI) and waist-to- hip ratio (WHR) were used.

The present study revealed that more than one-third (44.7%) of study participants were overweight or obese using BMI. Obesity and overweight are terms used to describe abnormal or excess fat build-up that has the potential to harm one's health. Obesity/overweight is identified as a growing public health issue in Ghana, with significant implications for national resources (Ofori-Asenso *et al.*, 2016). Obesity and overweight are risk factors for non-communicable diseases, including cardiovascular diseases, diabetes, hypertension, musculoskeletal disorders, and some cancers. Both conditions significantly impact physical, psychological, and health-related quality of life (Amu *et al.*, 2021). According to a report by WHO, as of 2016, approximately 13% of the world's adults were obese. Its reports further stated that overweight and obesity, once considered a high-income issue, are now public health issues in low- and middle-income countries, mainly urban areas, due to their rise (WHO Fact sheet, 2021 1c). A systematic and meta-analysis review conducted in Ghana also

confirmed the findings, where the prevalence of overweight and obesity at the national level was 25.4% (95% confidence interval [CI]: 22.2-28.7%) and 17.1% (95% CI: 14.7-19.5%), respectively. The proportion of urban residents who were overweight (27.2%) and obese (20.6%) was significantly higher than the proportion of rural residents who were obese (8.0%) and overweight 16.7%. (Ofori-Asenso *et al.*, 2016).

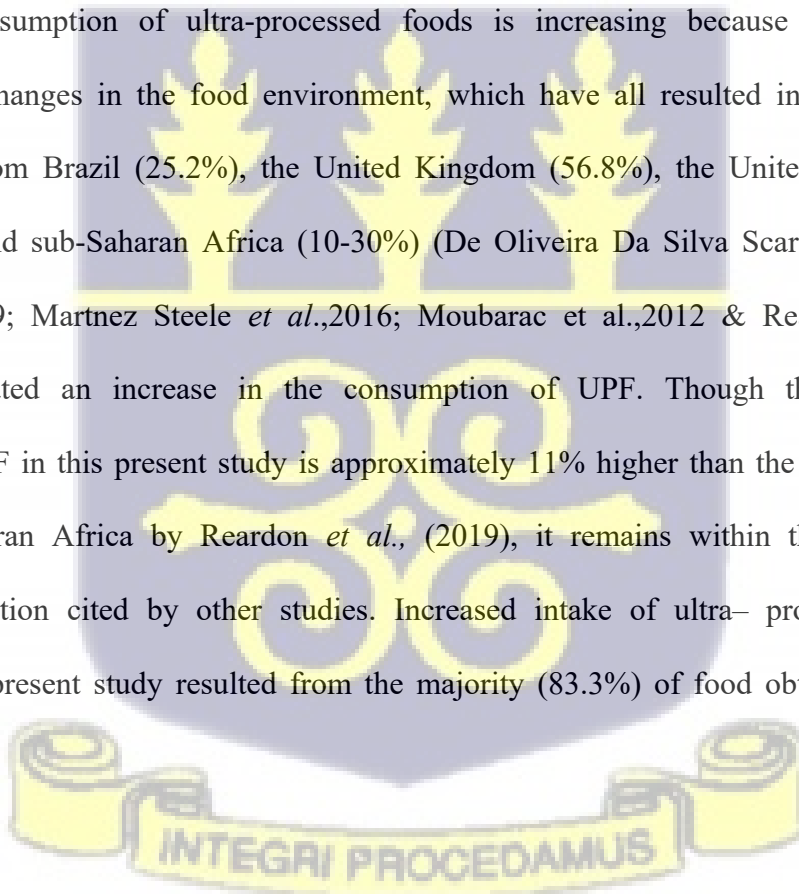
According to Ofori-Asenso *et al.* (2016), the variation resulted from cultural and tribal differences and urbanization influencing higher obesity prevalence in cities compared to rural areas. The further variation observed among ethnic groups was the differences in work patterns, meal preparation methods, and body size perception. In Ghana, plus body size is considered ideal since it signifies wealth and good health, as cited by other studies (Neupane, 2016; Ofori-Asenso *et al.*, 2016). According to the study, four out of every five people in Accra were physically inactive, with women having a higher rate (94.7%) than men (70.5%). The study also discovered that most participants lead sedentary lives, particularly tabletop traders.

Additionally, in the present study, the results of the waist-to-hip ratio assessment of a little above one-third of participants (36.3%) were at risk of health conditions such as diabetes and CVDs. Higher waist-to-hip ratios may indicate an accumulation of abdominal fat. Higher WHR may put people at risk for heart disease or diabetes. Several studies have suggested that WHR is a better tool for predicting one risk for myocardial infarction than BMI because muscle mass and bone mass do not influence WHR as compared to BMI (Zhang *et al.*, 2022; Darbandi *et al.*, 2020; Elsayed *et al.*, 2008).

5.3. Pattern of Consumption of Unprocessed/Minimally Processed Food, Processed

Culinary Ingredient, Processed Food and Ultra-Processed Food Among Study Participants.

The study revealed that UPF was the most frequently consumed NOVA food group type among the 700 study participants during the 3-day 24-hour recall period. UPFs accounted for 40.97% of the Four NOVA foods, followed by U/MPF, 35.89%, PF, 20.18%, and PCI, 2.96%. A number of studies show that the consumption of ultra-processed foods is increasing because of globalization, urbanization, and changes in the food environment, which have all resulted in a transition. For instance, reports from Brazil (25.2%), the United Kingdom (56.8%), the United States (57.9%), Canada (61.7%), and sub-Saharan Africa (10-30%) (De Oliveira Da Silva Scaranni *et al.*, 2021; Rauber *et al.*, 2019; Martnez Steele *et al.*, 2016; Moubarac *et al.*, 2012 & Reardon *et al.*, 2021 respectively) indicated an increase in the consumption of UPF. Though the percentage of consumption of UPF in this present study is approximately 11% higher than the rate of 10%-30% cited for Sub-Saharan Africa by Reardon *et al.*, (2019), it remains within the minimum and maximum consumption cited by other studies. Increased intake of ultra-processed foods by participants in the present study resulted from the majority (83.3%) of food obtained away from home.



The findings of the study agreed with those of previous research, which showed that alterations to the food system had led to an increase in the consumption of UPF not only in rich countries but also developing nations like Sub-Saharan Africa (Popkin *et al.*, 2012; Reardon *et al.*, 2021). In the present study, 83.8% of participants consumed their meals outside the home, while only 7.4% consumed meals prepared at home. Reardon *et al.* (2020) speculated that the shift from home to processed foods might be due to decades of rising numbers of men travelling for urban employment

and off-farm employment in rural areas, as well as more women outside the home in both urban and rural areas.

In this present study as majority of the study participants were employed and work outside the home, hence most of their foods consumed throughout the day were bought. It also saves time since they must leave home early for work as well as beat traffic or avoid the early rush hour. Additionally, other factors, such as the rise of the middle class, preferences or availability of food, sex, education, and ethnicity, may influence consumer dietary patterns, eventually altering lifestyles.

5.4 Energy and Macronutrients (I.E., Protein, Carbohydrate, and Fat) Contribution of NOVA Foods.

The participants' diets provided an average of 2,819.68 calories per day, with minimally processed foods accounting for more than half (59.9%) of those calories, processed foods contributing 38.3%, ultra-processed foods 1.4%, and processed culinary ingredients accounting for 0.5%. The higher caloric contribution of minimally processed foods came from staple, grains, and cereal, which forms the bulk of the normal Ghanaian diet and mostly consumed in large quantities than other food groups. This distribution is not typical of the majority of research carried out in industrialized countries, where UPF is known to contribute significantly to calories (Baraldi *et al.*, 2018 & Dauber *et al.*, 2020). Furthermore, even though the majority of study participants (40.97%) often consumed UPF, they did so in smaller amounts, resulting in a lower caloric contribution. Ghanaians eat primarily staples rather than animal or plant-based protein, with little or no vegetables. According to Andam *et al.* (2018), a typical Ghanaian dietary pattern relies on starchy roots (cassava, yams,

plantain) and cereals (Maize, rice) with little diversity, providing nearly three-quarters of the dietary energy with a lower share of protein and lipid dietary energy than recommended.

In contrast to these findings, studies carried out in developed western countries show a high caloric contribution from ultra-processed foods, as seen in the United States of America (60.0%) (Baraldi *et al.*, 2018), the United Kingdom (54.3%) (Rauber *et al.*, 2019), and Canada (45.0%) (Moubarac *et al.*, 2017). On the other hand, in developing countries like Mexico (29.8%) (Marion-Ponco *et al.*, 2018), and Brazil (20.4%), (Louzada, 2018), the rate is significantly lower. This was attributed to the fact that UPF is cheaper in developed countries and costly in developing countries. In a study on 'the energy contribution of NOVA food and the influence of sociodemographic characteristics on UPF consumption in the Mexican population,' Marion-Ponco *et al.* (2017) discovered that MPF had the highest caloric contribution, which is consistent with the current study, but in contrast to UPF being the second highest and PF being the one with the lowest caloric contributor. Another study conducted among Brazilian farmers on the energy contribution of NOVA food groups and the nutritional profile of their diets backed up his findings (Cattafesta *et al.*, 2020).

In the current study, however, PF was the second highest contributor of calories, accounting for 38.3%. This pattern differs from what has been found in other populations (Baraldi *et al.*, 2018; Calixto Andrade *et al.*, 2021; Cattafesta *et al.*, 2020; Monteiro *et al.*, 2016a; Moubarac *et al.*, 2014; Marion-Ponco *et al.*, 2017). The variation in findings with other studies was due to soups and stews accounting for a portion of the food subgroup contributions (of the 38.3% of energy contributed by PF, soups and stews accounted for 32.4%). Soups and stews almost always accompany traditional Ghanaian main dishes (staples, grains, and cereals), which account for a large portion of their diet. As a result, it is the second largest calorie contributor. The soups and Stews are a combination of U/

MPF and PCI. The majority of the stews and soups (86%) were purchased. For food purposes of palatability, most foods sold outside the home contain additives such as monosodium glutamate.

Macronutrients are essential nutrients that the body requires in large quantities on a regular basis to function properly. Proteins, carbohydrates, and fats make up their composition. All three types of macronutrients play important roles in the body, and a balanced diet should include adequate amounts of each. The recommended acceptable Macronutrient Distribution Ranges (AMDR) for adults include 45-65% of daily calories from carbohydrate, 10-35% from protein and 20-35% from fat (Manore, 2005). The WHO (2020) healthy eating fact sheet also reiterates the need to keep consumption of fat at less than 30% of total energy intake to avoid unhealthy weight gain.

Unprocessed/Minimally processed foods contributed the most carbohydrate (75.4%) and protein (76.6%) content of the participants' diet, while processed foods contributed much of the fat content (68.8%), with UP/MPF contributing slightly more than a quarter of the total (29.5%). Of all macronutrients, UPF and PCI contributed the least. The nutritional profile of this study's findings revealed that UP/MP foods had a higher nutritional macronutrient content than the other NOVA sub-food groups, particularly UPF (Carbohydrate, 1.2%, and Protein, 0.8%). This finding is consistent with Cattafesta et al., 2020 and Louzada, 2018, which found that MP foods had higher nutritional content than UPFs but lower content of all macro and micronutrients.

PFs contributed significantly despite having less than 30% carbohydrate and protein content. As a result, it is critical to recognize that processed foods are not the problem, but rather the nature, extent of processing, and quantities consumed (Cattafesta *et al.*, 2020; Monteiro *et al.*, 2019). PF's protein content was within the recommended range, but its fat content, at 68%, was higher than

recommended. The soups provided the majority of the fat content in PF (68% of the various sub-foods under PF, 56.9% of fat was from soup). Participants ate either palm nut soup, groundnut soup, wrewre soup, okra soup, or light soup. The ground nut and palm nut soup provided 49% of the fat.

Though groundnut and palm nut soups are high in iron content, according to a study conducted by Annor *et al.*, (2016) on the minerals and phytate content of some prepared popular Ghanaian meals,' these foods should still be consumed in moderation due to their high-fat content, especially for individuals with obesity and high cholesterol. True, consuming a lot of oil is not a good dietary practice, but it is not entirely bad, especially when the right type and amount per recommendation is consumed, as it is required to make food balanced in nutrients and energy.

5.5 Influence of Background Characteristics on NOVA Food Type Consumed

This research found that the educational level and occupation of the people who participated in the study had a strong correlation with the amount of ultra-processed foods (UPF) that they consumed. The participants' educational level was found to significantly increase their intake of ultra-processed food by 44%, while their occupation was found to increase consumption by 17%. Several studies have demonstrated that there has been an increase in the consumption of UPF as a result of increased urbanization (Ameje & Swinnen, 2019, & McGuire, 2016), rising influence in industrialized nations, and increased number of individuals working outside the home (Reardon *et al.*, 2019)

In contrast to the results of this study, which showed a significant correlation between UPF and occupation, the findings of Rauber *et al.*, (2020) showed that consumption of UPF varied with age and sex, but not with occupation or social level. The increasing number of people who had jobs outside the home may explain the high association of this present study. In addition, Marion-Ponco

et al. (2017) and Baraldi *et al.* (2018), who looked at NOVA foods and the sociodemographic characteristics, found a significant association between education and ultra-processed food consumption. While Marion-Ponco *et al.* (2017) indicated that heads of households with higher educational backgrounds influenced increased UPF consumption, Baraldi *et al.* (2018) also revealed higher educational level had a positive relationship with increase UPF consumption in the adult population and negative in children.

The present study therefore agreed with Marion-Ponco *et al.* (2017), which showed that the educational level of participants increased ultra-processed food intake by 44%. One may expect that those with some level of education will opt for healthier food choices, but the results showed otherwise. People may be knowledgeable in some areas, such as academic and social life, but they may be nutrition-knowledge deficit. The kind of foods that a person eats can also be influenced by elements that are unique to that person, such as their cultural heritage, dietary preferences, and personal attitudes towards food. For instance, people who come from cultures in which a particular style of cooking is traditional may opt to consume that style of food, whereas people who prefer diets that are based more on plants may opt to consume more meals that are based on plants.

5.6. Association Between Nutritional Status, Background Characteristics and NOVA

Food Type Consumed

According to the findings of the research, the nutritional status of the individuals, as measured by their BMI and WHR, did not have a significant association with the NOVA food kinds (U/MPF, PF,

and CPI) that they consumed. In contrast to the findings of a five-year cohort research carried out in the United States (US), which indicated a link between the consumption of UPFs and nutritional status, and more especially obesity (Crimarco *et al.*, 2021), this study found no such association. This study only used three days 24-hour dietary recall, in contrast to a cohort study, which tracks participants' dietary intake over the course of the entire study. This could be the reason for the discrepancy. It also contradicts the findings of earlier research that found a link between a person's nutritional status and the amount of ultra-processed food they ate (Dicken & Batterham, 2021 & Shim *et al.*, 2023). In addition, because it is dependent on memory, capacity for cooperation, and the ability to communicate, it is possible that three days twenty-four hours recall are insufficient to represent a regular diet, which could affect the results of research.

On the other hand, the results of this study showed that intake of UPFs was not connected with either general or abdominal obesity (BMI/WHR), even after considering potential confounding factors (Haghighatdoost *et al.*, 2022). This was reinforced by the results of the research, which revealed no significant change even after controlling for the characteristics of the participants. However, after taking the participants' ages and other characteristics into account, this study found a significant correlation between the participants' nutritional status (WHR and BMI) and their sex and age. This was consistent with the findings of a study carried out by Haghighatdoost *et al.*, (2022), in which the researchers concluded that there is significant correlation between sex and nutritional status (BMI and WHR), and more specifically, obesity, but not with age. It is possible for there to be a complicated and intertwined relationship between the background features of a person, their nutritional status, and the kinds of foods that they consume. For instance, persons who are overweight may consume unhealthy food due to a lack of information about healthy food choices or

restricted access to healthy options, whereas individuals with a higher income may have greater access to options for healthy eating.

5.7 Conclusion

The study revealed that ultra processed foods were frequently consumed by study participants and had a significant association with educational level and occupation. Furthermore, no association was found between ultra processed foods and nutritional status (BMI and WHR). Though UPF was consumed frequently by a large proportion of the participants, its caloric contribution was low, since it was consumed in very small quantities. Hence it can be said that ultra processed food has become more accessible for consumption because of nutritional transition and globalization as stated by several literatures in both developing and developed countries.

High consumption of ultra-processed and processed foods is linked to a higher risk of chronic diseases, including obesity; type 2 diabetes, cardiovascular diseases, and certain cancers. These diseases have substantial public health implications, leading to increased healthcare expenses and decreased quality of life. The prevalence of ultra-processed and processed foods in urban areas reflects an obesogenic food environment.

In conclusion, addressing this issue requires comprehensive public health interventions that target factors like food marketing, food labeling, and the availability of healthier food options. These interventions aim to promote healthier eating behaviors and create an environment that supports healthier food choices, particularly in urban areas where the majority of participants resided.

5.8. Limitations of The Study

There were difficulties in placing some local Ghanaian foods appropriately within the NOVA food groupings. This could increase the chances of misclassifying some foods. Furthermore, although the food composition table used provided adequate information for a majority of the foods, this was not so in a few instances. Foods not found in the composition table were entered into food groups assumed to be closely related.

5.9 Recommendation

- Based on the results from this study, is recommended that public health campaigns and interventions by **Ghana health Service** be developed to address the problem of unhealthy diets and promote healthy eating habits among the general population.
- In view of the difficulties in placing some of our local foods, example, composite dishes in an appropriate NOVA food group, studies to help properly classify Ghanaian food according to the NOVA system is required.



REFERENCES

Acharya, T., Fanzo, J., Gustafson, D., Ingram, J. & Schneeman, B. (2014).

Assessing Sustainable Nutrition Security: The Role of Food Systems. Washington, DC: ILSI, CIMSANS.

Adams, J., White, M. Characterisation of UK diets according to degree of food processing and associations with socio-demographics and obesity: cross-sectional analysis of UK National Diet and Nutrition Survey (2008–12). *Int J Behav Nutr Phys Act* **12**, 160 (2015). <https://doi.org/10.1186/s12966-015-0317-y>

Adjei, A. P., Amevinya, G. S., Quarpong, W., Tandoh, A., Aryeetey, R., Holdsworth, M., Agyemang, C., Zotor, F., Laar, M. E., Mensah, K., Addo, P., Laryea, D., Asiki, G., Sellen, D., Vandevijvere, S., & Laar, A. (2022, November 9). Availability of healthy and unhealthy foods in modern retail outlets located in selected districts of Greater Accra Region, Ghana. *Frontiers in Public Health*, **10**. <https://doi.org/10.3389/fpubh.2022.922447>

ADVERTISINGAGE & Global Marketers (2013). Accessed 16 February 2016.

<http://adage.com/datacenter/globalmarketers2013#302>

Aguayo-Patrón, S. V., & Calderón de la Barca, A. M. (2017). Old Fashioned vs. Ultra-Processed-Based Current Diets: Possible Implication in the Increased Susceptibility to Type 1 Diabetes and Celiac Disease in Childhood. *Foods (Basel, Switzerland)*, **6**(11), 100. <https://doi.org/10.3390/foods6110100>.

Ameye, H. & Swinnen, J. (2019). Obesity, income, and gender: The changing global relationship. *Global Food Security*, **23**: 267-281

Amit, S. K., Uddin, M. M., Rahman, R., Islam, S. K., & Khan, M. S. (2017). A review on mechanisms and commercial aspects of food preservation and processing. *Agriculture & Food Security*, **6**(1). <https://doi.org/10.1186/s40066-017-0130-8>

Amu H, Osei E, Kofie P, Owusu R, Bosoka SA, Konlan KD, Kim E, Orish VN, Maalman RS, Manu E, Parbey PA, Saah FI, Mumuni H, Appiah PK, Komesuor J, Ayanore MA, Amenuvegbe GK, Kim S, Jung H, Adjuik M, Tarkang EE, Alhassan RK, Donkor ES,

Zottor FB, Kweku M, Amuna P, Kim SY, Gyapong JO. (2021). Prevalence and predictors of depression, anxiety, and stress among adults in Ghana: A community-based cross-sectional study. *PLoS One*. ;16(10):e0258105. doi: 10.1371/journal.pone.0258105. PMID: 34624044; PMCID: PMC8500438. Schlomer, B. J., & Copp, H. L. (2014). Secondary Data Analysis of Large Data Sets in Urology: Successes and Errors to Avoid. *Journal of Urology*, 191(3), 587–596. <https://doi.org/10.1016/j.juro.2013.09.091>

Annor, G. A., Tano Debrah, K., & Essen, A. (2016). Mineral and phytate contents of some prepared popular Ghanaian foods. *SpringerPlus*, 5, 581. <https://doi.org/10.1186/s40064-016-2202-9> Amugsi, D. A., Lartey, A., Kimani, E., & Mberu, B. U. (2016). Women's participation in household decision-making and higher dietary diversity: findings from nationally representative data from Ghana. *Journal of health, population, and nutrition*, 35(1), 16. <https://doi.org/10.1186/s41043-016-0053-1>

Andrade, G. C., Julia, C., Deschamps, V., Srour, B., Hercberg, S., Kesse-Guyot, E., Allès, B., Chazelas, E., Deschasaux, M., Touvier, M., Monteiro, C. A., & Levy, R. B. (2021). Consumption of Ultra-Processed Food and Its Association with Sociodemographic Characteristics and Diet Quality in a Representative Sample of French Adults. *Nutrients*, 13(2), 682. <https://doi.org/10.3390/nu13020682>

Andam, K. S., Tschirley, D., Asante, S. B., Al-Hassan, R. M., & Diao, X. (2018). The transformation of urban food systems in Ghana: Findings from inventories of processed products. *Outlook on Agriculture*, 47(3), 233–243.

Baraldi, L. G., Martinez Steele, E., Canella, D. S., & Monteiro, C. A. (2018, March). Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: evidence from a nationally representative cross-sectional study. *BMJ Open*, 8(3), e020574. <https://doi.org/10.1136/bmjopen-2017-020574>

Barbosa, L.B., Vasconcelos, N.B.R., dos Santos, E.A. *et al.* (2023). Ultra-processed food consumption and metabolic syndrome: a cross-sectional study in Quilombola communities of Alagoas, Brazil. *Int J Equity Health* 22, 14 (<https://doi.org/10.1186/s12939-022-01816-z>)

- Batal, M., Johnson-Down, L., Moubarac, J., Ing, A., Berti, P. R., Sadik, T., Tikhonov, C., Chan, L., & Willows, N. D. (2017). Quantifying associations of the dietary share of ultra-processed foods with overall diet quality in First Nations peoples in the Canadian provinces of British Columbia, Alberta, Manitoba and Ontario. *Public Health Nutrition*, 21(1), 103–113. <https://doi.org/10.1017/s1368980017001677>
- Bertoia, M. L., Mukamal, K. J., Cahill, L. E., Hou, T., Ludwig, D. S., Mozaffarian, D., Willett, W. C., Hu, F. B., & Rimm, E. B. (2015). Changes in Intake of Fruits and Vegetables and Weight Change in United States Men and Women Followed for Up to 24 Years: Analysis from Three Prospective Cohort Studies. *PLOS Medicine*, 12(9), e1001878. <https://doi.org/10.1371/journal.pmed.1001878>
- Bray, G. A., Heisel, W., Afshin, A., Jensen, M. C., Dietz, W. H., Long, M., Kraus, W. E., Daniels, S. R., Wadden, T. A., Tsai, A. G., Hu, F. B., Jakicic, J. M., Ryan, D. H., Wolfe, B. M., & Inge, T. H. (2018). The Science of Obesity Management: An Endocrine Society Scientific Statement. *Endocrine Reviews*, 39(2), 79–132. <https://doi.org/10.1210/er.2017-00253>
- Canhada, S., Luft, V. C., Giatti, L., Duncan, B. B., Chor, D., Fonseca, M. J. M., Matos, *et al.*, (2019). Ultra-processed Foods, Incident Overweight and Obesity, and Longitudinal Changes in Weight and Waist Circumference? The ELSA-Brasil Study. [Accepted in Public Health Nutrition]
- Cattafesta, M., Petarli, G. B., Zandonade, E., De Paula Alves Bezerra, O. M., De Abreu, S. E. A., & Salaroli, L. B. (2020). Energy contribution of NOVA food groups and the nutritional profile of the Brazilian rural workers' diets. *PLOS ONE*, 15(10), e0240756.
- Cediel, G., Reyes, M., da Costa Louzada, M. L., Martinez Steele, E., Monteiro, C. A., Corvalán, C., & Uauy, R. (2018). Ultra-processed foods and added sugars in the Chilean diet (2010). *Public health nutrition*, 21(1), 125–133. <https://doi.org/10.1017/S1368980017001161>
- Chen, X., Zhang, Z., Yang, H., Qiu, P., Wang, H., Wang, F., Zhao, Q., Fang, J., & Nie, J. (2020). Consumption of ultra-processed foods and health outcomes: a systematic review of

epidemiological studies. *Nutrition journal*, 19(1), 86. <https://doi.org/10.1186/s12937-020-00604-1>

Cockx, L., Colen, L., & De Weerd, J. (2018). From corn to popcorn? Urbanization and dietary change: Evidence from rural-urban migrants in Tanzania. *World Development*, 110, 140–159. <https://doi.org/10.1016/j.worlddev.2018.04.018>

Costa Louzada, M. L., Martins, A. P., Canella, D. S., Baraldi, L. G., Levy, R. B., Claro, R. M., Moubarac, J. C., Cannon, G., & Monteiro, C. A. (2015). Ultra-processed foods and the nutritional dietary profile in Brazil. *Revista de saude publica*, 49, 38. <https://doi.org/10.1590/S0034-8910.2015049006132>

Country Nutrition Profiles. (2023). Global Nutrition Report | Country Nutrition Profiles - Global Nutrition Report. Retrieved January 23, 2023, from <https://globalnutritionreport.org/resources/nutrition-profiles/africa/western-africa/ghana/>

Crimarco, A., Landry, M. J., & Gardner, C. D. (2021). Ultra-processed Foods, Weight Gain, and Comorbidity Risk. *PubMed*, 11(3), 80–92. <https://doi.org/10.1007/s13679-021-00460-y>

Dahdouh, S., Grande, F., Espinosa, S. M. G., Vincent, A. I., Gibson, R. S., Bailey, K. G. D., King, J. C., Rittenschöber, D., & Charrondiere, U. R. (2019). Development of the FAO/INFOODS/IZINCG Global Food Composition Database for Phytate. *Journal of Food Composition and Analysis*, 78, 42–48. <https://doi.org/10.1016/j.jfca.2019.01.023>

Darbandi, M., Pasdar, Y., Moradi, S., Mohamed, H. J. J., Hamzeh, B., & Salimi, Y. (2020). Discriminatory Capacity of Anthropometric Indices for Cardiovascular Disease in Adults: A Systematic Review and Meta-Analysis. *Preventing Chronic Disease*, 17. <https://doi.org/10.5888/pcd17.200112>

De Oliveira Da Silva Scaranni, P., De Oliveira Cardoso, L., Chor, D., Melo, E. C. P., Matos, S. M. A., Giatti, L., Barreto, S. M., & De Jesus Mendes Da Fonseca, M. (2021). Ultra-processed foods, changes in blood pressure and incidence of hypertension: the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil). *Public Health Nutrition*, 24(11), 3352–3360. <https://doi.org/10.1017/s136898002100094x>

De Souza, R. J., Mente, A., Maroleanu, A., Cozma, A. I., Ha, V., Kishibe, T., Uleryk, E., Budylowski, P., Schünemann, H. J., Beyene, J., & Anand, S. S. (2015). Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and

type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ*, h3978. <https://doi.org/10.1136/bmj.h3978>

- Dicken, S. N., & Batterham, R. L. (2021). The Role of Diet Quality in Mediating the Association between Ultra-Processed Food Intake, Obesity and Health-Related Outcomes: A Review of Prospective Cohort Studies. *Nutrients*, 14(1), 23. <https://doi.org/10.3390/nu14010023>
- Elsayed, E. F., Tighiouart, H., Weiner, D. E., Griffith, J., Salem, D., Levey, A. S., & Sarnak, M. J. (2008). Waist-to-hip ratio and body mass index as risk factors for cardiovascular events in CKD. *American journal of kidney diseases : the official journal of the National Kidney Foundation*, 52(1), 49–57. <https://doi.org/10.1053/j.ajkd.2008.04.002>
- Ercsey-Ravasz, M., Toroczka, Z., Lakner, Z., & Baranyi, J. (2012). Complexity of the international agro-food trade network and its impact on food safety. *PloS one*, 7(5), e37810. <https://doi.org/10.1371/journal.pone.0037810>
- Fardet, A., Rock, E., Bassama, J., Bohuon, P., Prabhasankar, P., Monteiro, C. A., Moubarac, J., & Achir, N. (2015). Current Food Classifications in Epidemiological Studies Do Not Enable Solid Nutritional Recommendations for Preventing Diet-Related Chronic Diseases: The Impact of Food Processing. *Advances in Nutrition*, 6(6), 629–638. <https://doi.org/10.3945/an.115.008789>
- Fardet A. (2016). Minimally processed foods are more satiating and less hyperglycemic than ultra-processed foods: a preliminary study with 98 ready-to-eat foods. *Food & function*, 7(5), 2338–2346. <https://doi.org/10.1039/c6fo00107>
- Fardet, A., Méjean, C., Labouré, H., Andreeva, V. A., & Feron, G. (2017). The degree of processing of foods which are most widely consumed by the French elderly population is associated with satiety and glycemic potentials and nutrient profiles. *Food & function*, 8(2), 651–658. <https://doi.org/10.1039/c6fo01495j>
- Fardet, A., & Richonnet, C. (2019). Nutrient density and bioaccessibility, and the antioxidant, satiety, glycemic, and alkalinizing potentials of fruit-based foods according to the degree of processing: a narrative review. *Critical Reviews in Food Science and Nutrition*, 60(19), 3233–3258. <https://doi.org/10.1080/10408398.2019.1682512>
- Food and Agriculture Organization of the United Nations (FAO), Rome, Italy (2010). *Fats and Fatty Acids in Human Nutrition: Report of an Expert Consultation*. Volume 91. [(accessed on 3 August 2022)]. 166p. Food and Nutrition Paper. Available online: <https://www.fao.org/3/i1953e/I1953E.pdf>

- Food and Agriculture organization of United Nation. (FAO), Rome. (2019). Ultra-processed foods, diet quality and health using the Nova food classification system. <http://www.fao.org>
- Fox, A. M., Feng, W., & Asal, V. (2019). What is driving global obesity trends? Globalization or “modernization”? *Globalization and Health*, 15(1). <https://doi.org/10.1186/s12992-019-0457-y>
- Ghana Statistical Service (2014) 2010 Population and Housing Census. District Analytical Report. Kumasi Metropolitan. Ghana Statistical Service, Accra. https://www2.statsghana.gov.gh/docfiles/2010_District_Report/Ashanti/KMA.pdf
- Ghana Statistical Service. (2022). Ministry of Finance 2021 Population and Housing Census: SYUDY DOCUMEMT. (2022, October 10). Retrieved December 6, 2022, from <https://www2.statsghana.gov.gh/nada/index.php/catalog/110/download/459>
DDI-GHA-GSS-2021PHC-2021-v1.0
- Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF International. (2015). Ghana Demographic and Health Survey 2014. Rockville, Maryland, USA: GSS, GHS, and ICF International.
- Haghighatdoost, F., Atefi, M., Mohammadifard, N., Daryabeygi-Khotbehsara, R., Khosravi, A. R., & Mansourian, M. (2022). The relationship between ultraprocessed food consumption and obesity indicators in Iranian adults. *Nutr Metab Cardiovasc Dis* ., 32(9), 2074–2085. <https://doi.org/10.1016/j.numecd.2022.05.019>
- Hall, K. D., Ayuketah, A., Brychta, R. J., Cai, H., Cassimatis, T. M., Chen, K. Y., Chung, S. T., Costa, E. T., Courville, A. B., Darcey, V. L., Fletcher, L. A., Forde, C. G., Gharib, A. M., Guo, J., Howard, R. J., Joseph, P. V., McGehee, S., Ouwkerk, R., Raising, K., . . . Zhou, M. (2019). Ultra-Processed Diets Cause Excess Calorie Intake and Weight Gain: An Inpatient Randomized Controlled Trial of Ad Libitum Food Intake. *Cell Metabolism*, 30(1), 67-77.e3. <https://doi.org/10.1016/j.cmet.2019.05.008>
- HARVARD UNIVERSITY. (2022, December 11). *The Nutrition Source: Processed Foods and Health*. Retrieved June 24, 2023, from <https://www.hsph.harvard.edu/nutritionsource/processed-foods>. Kresge Building, Room 1005, 677 Huntington Avenue. Boston, Massachusetts 02115
- Heshmat, S., PhD. (2011). *Eating Behavior and Obesity: Behavioral Economics Strategies for Health Professionals*. Springer Publishing Company.

- Holdsworth M, Pradeilles R, Tandoh A *et al.*, (2020) Unhealthy eating practices of city-dwelling Africans in deprived neighbourhoods: evidence for policy action from Ghana and Kenya. *Glob Food Sec* 26:100452. <https://doi.org/10.1016/j.gfs.2020.100452>
- Jardim, M. Z., Costa, B. V. L., Pessoa, M. C., & Duarte, C. K. (2021). Ultra-processed foods increase noncommunicable chronic disease risk. *Nutrition research (New York, N.Y.)*, 95, 19–34. <https://doi.org/10.1016/j.nutres.2021.08.006>
- Jones J. M. (2019). Food processing: criteria for dietary guidance and public health?. *The Proceedings of the Nutrition Society*, 78(1), 4–18. <https://doi.org/10.1017/S0029665118002513>
- Juul, F., Martinez-Steele, E., Parekh, N., Monteiro, C. A., & Chang, V. W. (2018). Ultra-processed food consumption and excess weight among US adults. *The British journal of nutrition*, 120(1), 90–100. <https://doi.org/10.1017/S0007114518001046>
- Khandpur, N., Cediel, G., Obando, D. A., Jaime, P. C., & Parra, D. C. (2020). Sociodemographic factors associated with the consumption of ultra-processed foods in Colombia. *Revista de saude publica*, 54, 19. <https://doi.org/10.11606/s1518-8787.2020054001176>
- Krakauer, NY. & Krakauer, JC. (2012). A new body shape index predicts mortality hazard independently of body mass index. *PLoS One*. 7: e39504.
- Kuevi A.D. (2020) “The development of photographic food atlas with the portion sizes of commonly consumed animal and plant protein source foods”. PhD Thesis, University of Ghana, Legon
- Lee, M., Jebb, S. A., Oke, J., & Piernas, C. (2020). Reference values for skeletal muscle mass and fat mass measured by bioelectrical impedance in 390 565 UK adults. *Journal of Cachexia, Sarcopenia and Muscle*, 11(2), 487–496. <https://doi.org/10.1002/jcsm.12523>
- Leffa, P. D. S. (2021). Ultra-processed foods. In *Elsevier eBooks* (pp. 653–662) <https://doi.org/10.1016/b978-0-12-821848-8.00009-3>
- Leonie, E., Machado, P., Zinöcker, M., Baker, P., & Lawrence, M. (2020, June 30). Ultra Processed Foods and Health Outcomes: A Narrative Review. *Nutrients*, 12(7), 1955. <https://doi.org/10.3390/nu12071955>

- Lewis, M., & Lee, A. J. (2020). Dietary inequity? A systematic scoping review of dietary intake in low socio-economic groups compared with high socio-economic groups in Australia. *Public Health Nutrition*, 24(3), 393–411. <https://doi.org/10.1017/s1368980020003006>
- Louzada, M. L. D. C., Ricardo, C. Z., Steele, E. M., Levy, R. B., Cannon, G., & Monteiro, C. A. (2018). The share of ultra-processed foods determines the overall nutritional quality of diets in Brazil. *Public health nutrition*, 21(1), 94–102. <https://doi.org/10.1017/S1368980017001434>
- Livingstone KM, Olstad DL, Leech RM, Ball K, Meertens B, Potter J, Cleanthous X, Reynolds R, McNaughton SA. Socioeconomic Inequities in Diet Quality and Nutrient Intakes among Australian Adults: Findings from a Nationally Representative Cross-Sectional Study. *Nutrients*. 2017 Oct 4;9(10):1092. doi: 10.3390/nu9101092. PMID: 28976927; PMCID: PMC5691709.
- Ludwig, D. S. (2011). Technology, Diet, and the Burden of Chronic Disease. *JAMA*, 305(13), 1352. <https://doi.org/10.1001/jama.2011.380>
- Malik, V. S., Pan, A., Willett, W. C., & Hu, F. B. (2013). Sugar-sweetened beverages and weight gain in children and adults: a systematic review and meta-analysis. *The American Journal of Clinical Nutrition*, 98(4), 1084–1102. <https://doi.org/10.3945/ajcn.113.058362>
- Manore M. M. (2005). Exercise and the Institute of Medicine recommendations for nutrition. *Current sports medicine reports*, 4(4), 193–198. <https://doi.org/10.1097/01.csmr.0000306206.72186.00>
- Marchese, L., Livingstone, K. M., Woods, J., Wingrove, K., & Machado, P. P. (2021). Ultra-processed food consumption, socio-demographics and diet quality in Australian adults. *Public Health Nutrition*, 25(1), 94–104. <https://doi.org/10.1017/s1368980021003967>
- Marino, M., Puppo, F., Del Bo, C., Vinelli, V. S., Riso, P., Porrini, M., & Martini, D. (2021). A Systematic Review of Worldwide Consumption of Ultra-Processed Foods: Findings and Criticisms. *Nutrients*, 13(8), 2778. <https://doi.org/10.3390/nu13082778>
- Marrón-Ponce, J. A., Sánchez-Pimienta, T. G., Da Costa Louzada, M. L., & Batis, C. (2017). Energy contribution of NOVA food groups and sociodemographic determinants of ultra-processed food consumption in the Mexican population. *Public Health Nutrition*, 21(1), 87–93. <https://doi.org/10.1017/s1368980017002129>
- Martínez Steele, E., Baraldi, L. G., Louzada, M. L., Moubarac, J. C., Mozaffarian, D., & Monteiro, C. A. (2016). Ultra-processed foods and added sugars in the US diet: evidence

from a nationally representative cross-sectional study. *BMJ open*, 6(3), e009892. <https://doi.org/10.1136/bmjopen-2015-009892>

McGuire S. (2013). WHO, World Food Programme, and International Fund for Agricultural Development. 2012. The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition. Rome, FAO. *Advances in nutrition (Bethesda, Md.)*, 4(1), 126–127. <https://doi.org/10.3945/an.112.003343>

McGuire, S. (2016). Scientific Report of the 2015 Dietary Guidelines Advisory Committee. Washington, DC: US Departments of Agriculture and Health and Human Services, 2015. *Advances in Nutrition*, 7(1), 202–204. <https://doi.org/10.3945/an.115.011684>

Mekouar, M. A. (2016). 15. United Nations Food and Agriculture Organization (FAO). *Yearbook of International Environmental Law*, 27, 488–506. <https://doi.org/10.1093/yiel/yvx070>

Meneguelli, T. S., Juvanhol, L. L., Da Silva Leite, A., Bressan, J., & Hermsdorff, H. H. M. (2021). Minimally processed versus processed and ultra-processed food in individuals at cardiometabolic risk. *British Food Journal*, 124(3), 811–832. <https://doi.org/10.1108/bfj-12-2020-1087>

Monteiro, C. A., Levy, R. B., Claro, R. M., Castro, I. R., & Cannon, G. (2010). A new classification of foods based on the extent and purpose of their processing. *Cadernos de saude publica*, 26(11), 2039–2049. <https://doi.org/10.1590/s0102-311x2010001100005>

Monteiro, C. A., Moubarac, J. C., Cannon, G., Ng, S. W., & Popkin, B. (2013). Ultra-processed products are becoming dominant in the global food system. *Obesity reviews : an official journal of the International Association for the Study of Obesity*, 14 Suppl 2, 21–28. <https://doi.org/10.1111/obr.12107>

Monteiro CA, Levy RB, Claro RM, de Castro IR, Cannon G. (2016a). Increasing consumption of ultra-processed foods and likely impact on human health: evidence from Brazil. *Public Health Nutr* 2011; 14:5–13.

Monteiro, C. A., Baraldi, L. G., Da Costa Louzada, M. L., Moubarac, J., & Mozaffarian, D. (2016b). Ultra-processed foods and added sugars in the US diet: evidence from a nationally representative cross-sectional study. *BMJ Open*, 6(3), e009892. <https://doi.org/10.1136/bmjopen-2015-009892>

- Monteiro, C. A., Cannon, G., Moubarac, J. C., Levy, R. B., Louzada, M. L. C., & Jaime, P. C. (2017). The UN Decade of Nutrition, the NOVA food classification, and the trouble with ultra-processing. *Public Health Nutrition*, 21(1), 5–17.
- Monteiro C, Cannon G, Moubarac JC *et al.*, (2018) The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr* 21,5 –17.
- Monteiro, C. A., Cannon, G., Levy, R. B., Moubarac, J. C., Louzada, M. L., Rauber, F., Khandpur, N., Cediel, G., Neri, D., Martinez-Steele, E., Baraldi, L. G., & Jaime, P. C. (2019). Ultra-processed foods: what they are and how to identify them. *Public health nutrition*, 22(5), 936–941. <https://doi.org/10.1017/S1368980018003762>
- Moubarac, J. C., Batal, M., Martins, A. P., Claro, R., Levy, R. B., Cannon, G., & Monteiro, C. (2014). Processed and ultra-processed food products: consumption trends in Canada from 1938 to 2011. *Canadian journal of dietetic practice and research : a publication of Dietitians of Canada = Revue canadienne de la pratique et de la recherche en dietetique : une publication des Dietetistes du Canada*, 75(1), 15–21. <https://doi.org/10.3148/75.1.2014.15>
- Moubarac, J., Batal, M., Louzada, M. L., Steele, E. M., & Monteiro, C. A. (2017). Consumption of ultra-processed foods predicts diet quality in Canada. *Appetite*, 108, 512–520. <https://doi.org/10.1016/j.appet.2016.11.006>
- Mozaffarian, D., Hao, T., Rimm, E. B., Willett, W. C., & Hu, F. B. (2011). Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men. *The New England Journal of Medicine*, 364(25), 2392–2404. <https://doi.org/10.1056/nejmoa1014296>
- Nago, E., Lachat, C., Dossa, R., & Kolsteren, P. (2014). Association of Out-of-Home Eating with Anthropometric Changes: A Systematic Review of Prospective Studies. *Critical Reviews in Food Science and Nutrition*, 54(9), 1103–1116. <https://doi.org/10.1080/10408398.2011.627095>
- Nations, F. a. a. O. O. T. U. (2019). *Ultra-processed foods, diet quality and human health*. Food & Agriculture Org.
- Neupane, S., Prakash, K. C., & Doku, D. T. (2016). Overweight and obesity among women: analysis of demographic and health survey data from 32 Sub-Saharan African Countries. *BMC public health*, 16, 30. <https://doi.org/10.1186/s12889-016-2698-5> Obesity and Overweight: Factsheet. <http://www.who.int/mediacentre/factsheets/fs311/en/>. Accessed 12 Aug 2016.


- Ofori-Asenso, R., Agyeman, A. A., Laar, A., & Boateng, D. (2016). Overweight and obesity epidemic in Ghana-a systematic review and meta-analysis. *BMC public health*, *16*(1), 1239. <https://doi.org/10.1186/s12889-016-3901-4>
- Pagliai, G., Dinu, M., Madarena, M. P., Bonaccio, M., Iacoviello, L., & Sofi, F. (2021). Consumption of ultra-processed foods and health status: a systematic review and meta-analysis. *The British journal of nutrition*, *125*(3), 308–318. <https://doi.org/10.1017/S0007114520002688>
- Pan American Health Org. PAHO/WHO. Noncommunicable Diseases and Mental Health (2015) Ultra-processed food and drink products in Latin America: Trends, impact on obesity, policy implications http://iris.paho.org/xmlui/bitstream/handle/123456789/7699/9789275118641_eng.pdf (accessed September 2016).
- Piché, M. E., Tchernof, A., & Després, J. P. (2020). Obesity Phenotypes, Diabetes, and Cardiovascular Diseases. *Circulation research*, *126*(11), 1477–1500. <https://doi.org/10.1161/CIRCRESAHA.120.316101>
- Popkin, B. M. (2017). Relationship between shifts in food system dynamics and acceleration of the global nutrition transition. *Nutrition Reviews*, *75*(2), 73–82. <https://doi.org/10.1093/nutrit/nuw064>
- Popkin, B. M., & Reardon, T. (2018). Obesity and the food system transformation in Latin America. *Obesity Reviews*, *19*(8), 1028–1064. <https://doi.org/10.1111/obr.12694>
- Popkin, B. M., & Adair, L. S. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, *70*(1), 3–21. <https://doi.org/10.1111/j.1753-4887.2011.00456.x>
- Poti, J. M., Mendez, M. A., & Popkin, B. M. (2015). Is the degree of food processing and convenience linked with the nutritional quality of foods purchased by US households?., *The American Journal of Clinical Nutrition*, *101*(6), 1251–1262. <https://doi.org/10.3945/ajcn.114.100925>
- Poti, J. M., Braga, B., & Qin, B. (2017). Ultra-processed Food Intake and Obesity: What Really Matters for Health-Processing or Nutrient Content?., *Current obesity reports*, *6*(4), 420–431. <https://doi.org/10.1007/s13679-017-0285-4>
- Rauber, F., Louzada, M. L. D. C., Martinez Steele, E., Rezende, L. F. M. D., Millett, C., Monteiro, C. A., & Levy, R. B. (2019). Ultra-processed foods and excessive free sugar

- intake in the UK: a nationally representative cross-sectional study. *BMJ Open*, 9(10), e027546. <https://doi.org/10.1136/bmjopen-2018-027546>
- Rauber, F., Steele, E. M., Louzada, M. L. D. C., Millett, C., Monteiro, C. A., & Levy, R. B. (2020). Ultra-processed food consumption and indicators of obesity in the United Kingdom population (2008-2016). *PloS one*, 15(5), e0232676. <https://doi.org/10.1371/journal.pone.0232676>
- Reardon, T., Echeverría, R. G., Berdegúe, J. A., Minten, B., Liverpool-Tasie, S., Tschirley, D. L., & Zilberman, D. (2019). Rapid transformation of food systems in developing regions: Highlighting the role of agricultural research & innovations. *Agricultural Systems*, 172, 47–59. <https://doi.org/10.1016/j.agsy.2018.01.022>
- Reardon, T., Tschirley, D. L., Liverpool-Tasie, L. S. O., Awokuse, T. O., Fanzo, J., Minten, B., Vos, R., Dolislager, M., Sauer, C., Dhar, R., Vargas, C., Lartey, A., Raza, A., & Popkin, B. M. (2021). The processed food revolution in African food systems and the double burden of malnutrition. *Global Food Security*, 28, 100466. <https://doi.org/10.1016/j.gfs.2020.100466>
- Rich, K. M. (2015). Comment on: ‘Ultra-processed foods have the worst nutrient profile, yet they are the most available packaged products in a sample of New Zealand supermarkets’ by Luiten et al. *Public Health Nutrition*, 19(3), 564–569. <https://doi.org/10.1017/s1368980015002815>
- Scott, P. (2017). Global panel on agriculture and food systems for nutrition: food systems and diets: facing the challenges of the 21st century. *Food Security*, 9(3), 653–654. <https://doi.org/10.1007/s12571-017-0678-y>
- SDG 12: Curbing the consumption of ultra-processed foods and beverages critical to achieving SDG 12.* (n.d.). 2030 Spotlight. <https://www.2030spotlight.org/en/book/1730/chapter/sdg-12-curbing-consumption-ultra-processed-foods-and-beverages-critical-achieving>
- Shim, J., Ha, K. H., Kim, D. J., & Kim, H. C. (2023). PS-P09-5: DIET QUALITY PARTIALLY MEDIATES THE ASSOCIATION BETWEEN ULTRA-PROCESSED FOOD CONSUMPTION AND OBESITY. *Journal of Hypertension*, 41(Suppl 1), e431. <https://doi.org/10.1097/01.hjh.0000917240.88023.9b>
- United Nations Human Settlements Programme, UN-HABITAT. (2016). World Cities Report 2016, urbanization, and development: emerging futures. In: United Nations Human Settlements Programme, Nairobi. *UN-HABITAT*. Retrieved January 23, 2023, from <https://unhabitat.org/world-cities-report-2016>

- United Nations (2019) World Urbanization Prospects 2018 Highlights. New York. (P.19).
<https://population.un.org/wup/publications/Files/WUP2018-Highlights.pdf>. 9789211483185
9789210043137 (e-ISBN). Accessed 25th September,2019.
- Vandevijvere, S., De Ridder, K., Fiolet, T., Bel, S., & Tafforeau, J. (2018, December 3). Consumption of ultra-processed food products and diet quality among children, adolescents, and adults in Belgium. *European Journal of Nutrition*, 58(8), 3267–3278.
<https://doi.org/10.1007/s00394-018-1870-3>
- Weaver, C. M., Dwyer, J. T., Fulgoni, V. L., King, J. C., Leveille, G. A., MacDonald, R. S., Ordovas, J. M., & Schnakenberg, D. D. (2014). Processed foods: contributions to nutrition,. *The American Journal of Clinical Nutrition*, 99(6), 1525–1542.
<https://doi.org/10.3945/ajcn.114.089284>
- World Food Programme (WFP); Centers for Disease Control and Prevention (CDC). (2005). A Manual: Measuring and Interpreting Malnutrition and Mortality. *World Food Programme (WFP)*, 231 p.(WFPWFP214). <https://wfp.tind.io/record/6917?ln=en>
Updated on 1 January 2014. Accessed 10th June, 2023.
- WHS-2 Writing T. Team. (2011). Final report Women’s health study of Accra. WAVE II conducted. The Institute For Statistical, Social And Economic Research, University Of Ghana, Legon, Accra, Ghana 2011
[in.https://geog.sdsu.edu/Research/Projects/IPC/publication/WHS-91.PDF](https://geog.sdsu.edu/Research/Projects/IPC/publication/WHS-91.PDF). ISBN: 9964-75-033-8
- World Health Organization. (2008). Waist Circumference and Waist-Hip Ratio Report of a WHO Expert Consultation GENEVA. ISBN 978 92 4 150149 1 (NLM classification: QU 10
- World Health Organization (WHO). (2021, June 9). Obesity and overweight. *World Health Organization*. Fact sheet Retrieved December 11, 2021, from <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>
- Zhang, S., Fu, X., Du, Z., Guo, X., Li, Z., Sun, G., Zhou, Y., Yang, H., Yu, S., Zheng, L., Sun, Y., & Zhang, X. (2022). Is waist-to-height ratio the best predictive indicator of cardiovascular disease incidence in hypertensive adults? A cohort study. *BMC Cardiovascular Disorders*, 22(1). <https://doi.org/10.1186/s12872-022-02646-1>

APPENDIX I

ETHICAL CLEARANCE

 **UNIVERSITY OF GHANA**

COLLEGE OF HEALTH SCIENCES
ETHICAL AND PROTOCOL REVIEW COMMITTEE

EPRC/OCT/2022
October 27, 2022.

Ms. Winifred Atutor
Department of Dietetics
School of Biomedical and Allied Health Sciences
Korle Bu

ETHICAL CLEARANCE
Protocol Identification Number: *CHS-Et/M.3 – P 5.7/2022-2023*

FWA: 000185779 IORG: 0005170 IRB: 00006220

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) on October 27, 2022 reviewed and approved your re-submitted research protocol.

Title of Protocol: **“Energy Contribution of the NOVA Food Groups and their Association with Nutritional Status of Urban Dwellers in Accra, Ghana”**

Principal Investigator: Ms. Winifred Atutor

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

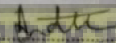
Please note that any significant modification(s) to this project/study must be submitted to the Committee for review and approval before its implementation.

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

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

This ethical clearance is valid till, October 26, 2023.

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

Signed: 
Professor Andrew Anthony Adjei
Chair, Ethical and Protocol Review Committee

cc: Provost, CHS
Dean, SBAHS
Head, Dietetics

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