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Household food safety, dietary diversity and malnutrition in an urban context: Evidence from urban Ghana

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Makafui Isaac Dzudzor

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Referent: Prof. Dr. Dr. hc. Joachim von Braun

Korreferent: Prof. Dr. Matin Qaim

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Abstract

Food safety, dietary diversity and malnutrition are significant issues confronting urban households. A nutrition and epidemiological transition is occurring in developing countries, leading to a double burden of malnutrition (DBM) and disease. Due to time constraints urban dwellers face, convenience motives drive households' decisions when allocating time for domestic activities, including food consumption and cooking. Their food consumption decisions manifest in behaviours like where they purchase their food, dietary diversity and time spent cooking. Thus, relying on primary and secondary data from Ghana, this study addresses three critical questions in three analytical chapters.

The first analytical chapter applied Structural Equation Models (SEM) to address the effect of food safety and nutrition knowledge on urban households' food purchasing and cooking behaviour. The results show that although households have some food safety knowledge, it did not translate into appropriate food safety cooking practices. Furthermore, convenience was the primary consideration for urban households in choosing food markets, not food safety. Additionally, most urban households purchased from traditional open-air markets, and supermarket patronage was very low, especially for raw and fresh foodstuffs. We conclude that food safety is a public good, and market failure inhibits its efficient delivery; therefore, public policy and government regulations are required to ensure households are guaranteed safe foods.

In the second analytical chapter, we used two rounds of equal panel household data, fixed effects Poisson and Correlated Random Effects (CRE) Probit models to estimate the effect of weather seasonality on urban households' food safety (incidence of diarrhoea/vomiting), dietary diversity and food expenditure. The results show that food safety is a challenge, and the higher food price of staples positively correlates with the incidence of diarrhoea/vomiting. Some raw foodstuffs tested positive for foodborne pathogens like *E. coli*, *Staphylococcus aureus* and aflatoxins. However, we did not find the effect of seasonality on household dietary diversity score (HDDS) and food expenditure per capita to be significant among sampled urban households.

The final analytical chapter shows the results of the effect of cooking time on household DBM in urban Ghana. We used the three rounds of the Ghana Socioeconomic Panel Survey (GSPS) data and estimated the results using the Cragg hurdle and CRE Probit models. The results show the existence of household DBM in urban Ghana. The most common form of household DBM is an "overweight/obese woman and a stunted child". Households' cooking time has plateaued, although men are increasing their cooking time. Women are the primary food handlers, but women who are employees spend less time cooking than those who are not. Unlike cooking time, household size and wealth status positively affected DBM. Household DBM is complex and the result of multiple factors. Our analysis suggests that factors like cooking time should be assessed in an encompassing context of household structure and consumption patterns.

The study concludes that urban households face systemic food safety issues from the food markets they patronise. However, convenience considerations supersede concerns about food safety; therefore, although households have sufficient knowledge and attitude towards food safety, they only sometimes translate it into appropriate purchasing and cooking practices/behaviour. Households also suffer from DBM, and cooking time has plateaued, but cooking time does not affect many forms of household DBM. Therefore, cooking time only does not guarantee healthy eating outcomes. Therefore, we recommend that the government strengthen policies and regulations on producing and retailing foods to promote compliance by food retailers and households. Also, promote household consumption of nutrient-dense meals so all members can meet their dietary requirements.

Zusammenfassung

Lebensmittelsicherheit, Ernährungsvielfalt und Mangelernährung sind bedeutende Probleme für städtische Haushalte. In Entwicklungsländern vollzieht sich ein ernährungswissenschaftlicher und epidemiologischer Wandel, der zu einer sogenannten „double burden of malnutrition“ (DBM) und Krankheiten führt. Aufgrund des Zeitmangels, mit dem Stadtbewohner konfrontiert sind, werden die Entscheidungen der Haushalte bei der Zuweisung von Zeit für häusliche Aktivitäten, einschließlich Lebensmittelkonsum und Kochen, von Bequemlichkeitsmotiven bestimmt. Diese Entscheidungen zum Lebensmittelkonsum spiegeln sich in Verhaltensweisen wie dem Einkauf von Lebensmitteln, der Ernährungsvielfalt und dem Zeitaufwand für das Kochen wider. Auf der Grundlage von Primär- und Sekundärdaten aus Ghana werden in dieser Studie drei wichtigen Fragestellungen in drei analytischen Kapiteln behandelt.

Im ersten analytischen Kapitel wurden Strukturgleichungsmodelle (SEM) angewandt, um den Einfluss des Wissens über Lebensmittelsicherheit und Ernährung auf das Einkaufs- und Kochverhalten städtischer Haushalte zu untersuchen. Die Ergebnisse zeigen, dass die Haushalte zwar über ein gewisses Wissen über Lebensmittelsicherheit verfügen, dieses aber nicht in angemessene Sicherheitspraktiken beim Kochen umgesetzt wurde. Darüber hinaus war für städtische Haushalte die Bequemlichkeit das wichtigste Kriterium bei der Auswahl der Lebensmittelmärkte, nicht die Lebensmittelsicherheit. Die meisten städtischen Haushalte kauften auf traditionellen Freiluftmärkten ein, während der Besuch von Supermärkten, insbesondere für rohe und frische Lebensmittel, sehr gering war. Wir kommen zu dem Schluss, dass Lebensmittelsicherheit ein öffentliches Gut ist, dessen effiziente Bereitstellung durch Marktversagen behindert wird; daher sind öffentliche Politik und staatliche Vorschriften erforderlich, um den Haushalten sichere Lebensmittel zu garantieren.

Im zweiten analytischen Kapitel haben wir zwei Runden gleichgewichteter Haushalt Panel Daten, Poisson Regressionen mit fixierten Effekten und Probit-Modelle mit korrelierten Zufallseffekte verwendet, um den Einfluss saisonaler Wettereffekte auf die Lebensmittelsicherheit (Auftreten von Durchfall/Erbrechen), die Ernährungsvielfalt und die Lebensmittelausgaben städtischer Haushalte zu schätzen. Die Ergebnisse zeigen, dass Lebensmittelsicherheit eine Herausforderung darstellt und höhere Preise für Grundnahrungsmittel mit einem höheren Auftreten von Durchfall/Erbrechen korrelieren. Einige rohe Lebensmittel wurden positiv auf lebensmittelbedingte Krankheitserreger wie E. coli, Staphylococcus aureus und Aflatoxine getestet. Wir konnten jedoch keinen signifikanten Einfluss der Saisonalität auf den HDDS-Wert (Score für Ernährungsvielfalt auf Haushaltsebene) und die Pro-Kopf-Lebensmittelausgaben der befragten städtischen Haushalten feststellen.

Das letzte analytische Kapitel zeigt die Ergebnisse des Einflusses der Kochzeit auf die DBM in städtischen Haushalten in Ghana. Wir verwendeten Daten aus den drei Runden des Ghana Socioeconomic Panel Survey (GSPS) und schätzten die Ergebnisse mithilfe von Cragg-Hurdle- und Probit-Modellen mit korrelierten Zufallseffekten. Die Ergebnisse bestätigen das Vorhandensein der DBM in städtischen Haushalten in Ghana. Die häufigste Form von DBM in Haushalten ist eine "übergewichtige/adipöse Frau und ein wachstumsverzögertes („stunted“) Kind". Die Kochzeit der Haushalte hat ein Plateau erreicht, obwohl Männer ihre Kochzeit erhöhen. Frauen sind die Hauptverantwortlichen für die Zubereitung von Lebensmitteln, aber Frauen, die angestellt sind, verbringen weniger Zeit mit dem Kochen als Frauen, die nicht angestellt sind. Im Gegensatz zur Kochzeit wirkten sich die Haushaltsgröße und der Wohlstand positiv auf die DBM aus. Die DBM in Haushalten ist komplex und das Ergebnis mehrerer

Faktoren. Unsere Analyse legt nahe, dass Faktoren wie die Kochzeit in einem umfassenden Kontext von Haushaltsstruktur und Konsumgewohnheiten bewertet werden sollten.

Die Studie kommt zu dem Schluss, dass städtische Haushalte auf den von ihnen besuchten Lebensmittelmärkten mit systematischen Problemen der Lebensmittelsicherheit konfrontiert sind. Bequemlichkeitsmotive haben jedoch Vorrang vor Bedenken hinsichtlich der Lebensmittelsicherheit. Obwohl die Haushalte über ausreichende Kenntnisse und Einstellungen zur Lebensmittelsicherheit verfügen, setzen sie diese nur gelegentlich in angemessene Einkaufs- und Zubereitungspraktiken/ Verhalten um. Haushalte leiden auch unter der DBM, und die Kochzeit hat ein Plateau erreicht, aber die Kochzeit hat keinen Einfluss auf viele Formen der DBM in Haushalten. Daher ist die Kochzeit allein kein Garant für eine gesunde Ernährung. Wir empfehlen daher, dass die Regierung ihre Politik und die Vorschriften für die Herstellung und den Verkauf von Lebensmitteln verschärft, um die Einhaltung der Vorschriften durch Lebensmittelhändler und Haushalte zu fördern. Außerdem sollte der Verzehr von nährstoffreichen Mahlzeiten in Haushalten gefördert werden, damit alle Mitglieder ihre Ernährungsbedürfnisse erfüllen können.

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List of Abbreviations

AFB1	Aflatoxin B1
AGRA	Alliance for a Green Revolution in Africa
AMA	Accra Metropolitan Assembly
BMI	Body Mass Index
CBD	Central Business District
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CPI	Consumer Price Index
CRE	Correlated Random Effects
DALYs	Disability-adjusted life year
DBM	Double Burden of Malnutrition
EAs	Enumeration Areas (EAs)
EFA	Exploratory Factor Analysis
FAO	Food and Agriculture Organisation
FDA	Food and Drugs Authority
GDP	Gross Domestic Product
GLSS	Ghana Living Standard Survey
GHS	Ghana Cedis
GHS	Ghana Health Service
GSS	Ghana Statistical Service
GSPS	Ghana Socioeconomic Panel Survey
HDDS	Household Dietary Diversity
HLPE	High Level Panel of Experts
HLPE-FSN	High Level Panel of Experts on Food Security and Nutrition
IFPRI	International Food Policy Research Institute
ISSER	Institute of Statistical, Social and Economic Research
KAP	Knowledge, Attitude, Practice
KMO	Kaiser-Meyer-Olkin
KMA	Kumasi Metropolitan Assembly
MDGs	Millennium Development Goals
NCDs	Non-Communicable Diseases
NFSP	National Food Safety Policy

NMIMR	Noguchi Memorial Institute for Medical Research
OECD	Organisation for Economic Cooperation and Development
OLS	Ordinary Least Squares
PCA	Principal Component Analysis
PHC	Population and Housing Census
PPMLHDFE	Poisson pseudo-maximum likelihood estimator with multiple levels of fixed effects
RMSEA	Root Mean Squared Error of Approximation
SDG	Sustainable Development Goals
SEM	Structural Equation Model
SES	Socioeconomic Status
SRMR	Standardised Root Mean Squared Residual
SSA	Sub-Saharan Africa
TaMA	Tamale Metropolitan Assembly
TLI	Tucker-Lewis Index
UN	United Nations
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation

Chapter 1: Introduction

1.1 Research background

There is an intricate and inextricable link between food and nutrition security, food safety and malnutrition (WHO, 2022a; HLPE, 2017). Food security encompasses the availability, accessibility, utilisation and stability of safe food consumed by all people in the right quantity and quality in a hygienic environment to attain a healthy and active life at the individual, household and national levels (FAO, 2017). Food and nutrition security are intrinsically linked, but nutrition security goes beyond the role of food in achieving a healthy and active life. Nutrition security encompasses individual and other systemic factors that affect an individual's health and nutrition status (Ingram, 2020). Food and nutrition security hinges on food safety. There can be no food and nutrition security without food safety (FAO, 2019). The human body cannot optimise the health and nutrient benefits of unsafe food. Food safety is the assurance that there are no adverse health effects from food prepared and/or consumed by an individual (WHO, 2022b; Codex Alimentarius, 2020). Food and nutrition security and food safety are linked to malnutrition because malnutrition is the over and/or under-consumption of nutrients (food) (WHO, 2017c; Soeters et al., 2008). Thus, we can view malnutrition as a manifestation of food safety and food and nutrition security status of individuals and households.

Malnutrition is a function of factors including dietary diversity, economic development and dietary choices (FAO et al, 2018). Malnutrition in all its forms (undernutrition, over-nutrition and micronutrient deficiency) is still a global challenge (InterAcademy Partnership, 2018; FAO et al., 2020). The distribution of the different forms of malnutrition is not uniform and varies across geographical and socio-economic groups and regions (FAO et al., 2020). In the last decade (2010-2020), the number of undernourished people globally has increased from about 601.3 million in 2010 to 675.5 million in 2020. In Sub-Saharan Africa, the prevalence of undernourishment increased from 18.9 percent in 2010 to 22.7 percent in 2020 (FAO et al., 2022). Concurrently, overweight and obesity are rising in both children and adults. Adult obesity increased from 8.7 percent in 2000 to 13.1 percent in 2016. In 2020, about 5.7 percent of children under five years were overweight. Furthermore, micronutrient deficiency continues to be challenging (FAO et al., 2022).

Globalisation, economic development and trade openness are some of the drivers that have contributed immensely to a growing complex food system and dietary diversity (Cockx et al., 2018; Dithmer & Abdulai, 2017), and currently, the difference in eating habits and lifestyles

of developed and developing countries is fading (Cockx et al., 2018; Bhurosy, & Jeewon, 2014). The determinants of food choices can range broadly from biological, physiological, psychological, sociocultural, and natural factors to economic factors (Ergashev, 2017; Leng et al., 2017; Monteleone et al., 2017). Table A.1 presents a summary of some of the classifications of determinants of food choices.

As determinants of food choices grow in complexity, so is the food system. Food and nutrition security strategies are shifting from production-focused programmes to a food systems approach where all facets of the subject are analysed in an all-inclusive manner (Nguyen, 2018). Consumers demand food systems capable of producing more diversified, high-quality, nutritious foods, reducing food waste, and equitably distributing food under sustainable conditions (FAO et al., 2020; von Braun et al., 2023a). Additionally, food systems are growing in complexity because of consumers' food desirability, longer value chains (transborder trade), public health, energy, environmental and ecological sustainability concerns and climate change (AGRA, 2020; Herrero et al., 2020; Béné et al., 2019; HLPE, 2017; Herforth & Ahmed, 2015; Grafton et al., 2015).

Consequently, the literature converges towards addressing food and nutrition issues from a system's perspective. In von Braun et al. (2023b) and HLPE (2017), the authors presented an elaborate conceptual framework within which food systems should be viewed and analysed. Their frameworks showed the interconnectivity among various sub-systems and other systems such as the health, ecology and climate, and economic and governance systems. The heterogeneous nature of the actors in the food system calls for tailor-made solutions to optimise the system's benefits (von Braun et al., 2023b). Furthermore, individuals and households interact with the food system differently. For example, the requirements of urban and rural food systems will vary because of differences in households' characteristics, economic activities and development in these places. Therefore, solutions to household food and nutrition challenges should not be in silos but situated within the local food system of the household and, ultimately, the larger food system. This study aims to situate household malnutrition, food choices and food safety behaviour within the household's local food environment. The complexity of the food choices and food systems makes it tedious to empirically analyse all the dimensions and linkages in a single study. Therefore, most studies focus on a few sub-systems and the mechanisms through which they affect household food choices, food safety and consumption behaviour. This study will focus on specific dimensions of this complex system.

The study draws on the Ghanaian experience as a proxy for many developing countries, especially African countries. The empirical data used in this study are mostly household and food retail surveys from Ghana. Ghana is a lower-middle-income country in West Africa, with a population of about 31 million (GSS, 2022). It currently has 16 administrative regions. It is bounded to the north by Burkina Faso, to the east by Togo, to the west by Cote d'Ivoire and to the south by the Atlantic Ocean (Figure 1.1). In 2019, the country had a nominal GDP of about US$69 billion (GSS, 2020a). The service sector contributed the largest share at 47.2 percent, followed by industry with 34.2 percent and the agriculture sector with a contribution of 18.5 percent (GSS, 2020a). Although agriculture is the least contributor to GDP, it continues to provide substantial employment opportunities in the economy (GSS, 2019; GSS, 2020b). The agriculture sector remains critical to economic development and serves as the fulcrum for the government's food and nutrition security agenda. Agriculture remains highly dependent on rainfall. The southern and middle belts of the country have two (2) rainfall seasons, while the northern belt has a single rainy season. Ghana's agro-ecological zones influence the economic and agricultural activities that dominate these regions (GSS, 2020b).

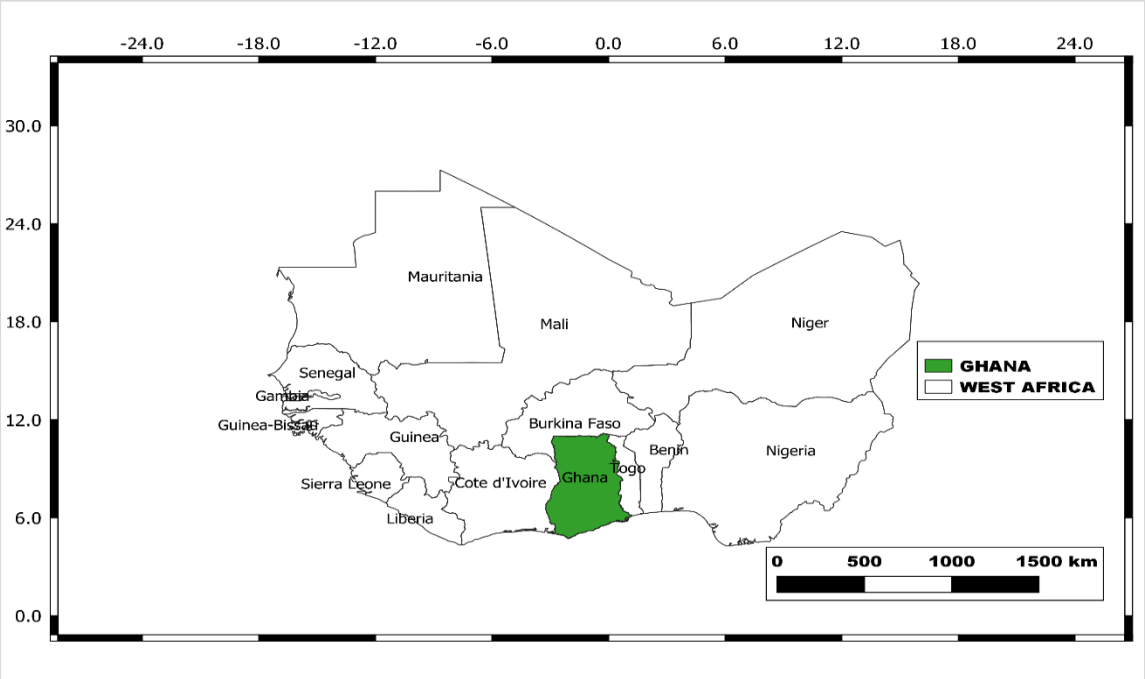


Figure 1.1: A map of Ghana located in West Africa

As a developing country, urbanisation is on the ascendency. The proportion of the Ghanaian population living in urban areas as of 2021 was 57 percent (GSS, 2022). Over the past century (1921-2021), Ghana's urban population has rapidly increased from about 8 percent in 1921 to almost 57 percent of the total population in 2021 (Figure 1.2). A natural increase in population

and internal migration are the main drivers of Ghana's urban population growth (GSS, 2014a). The dominant patterns of migration are rural-urban and north-south migration. Economic consideration is the primary driver of internal migration. The growth in urbanisation has been geographically disproportional. Almost half (47.8%) of the growth in urbanisation between 2010 and 2021 occurred in just the Greater Accra and Ashanti regions (GSS, 2022).

Amidst the rapid urbanisation in Ghana is the issue of infrastructure deficit. The challenges of infrastructure deficit have put pressure on the provision of public services. For example, the housing deficit has led to high rental charges, overcrowded dwellings and homelessness. In addition, there is the unpleasant springing-up of slums in unauthorised parts of towns and cities with its attendant safety and health problems (World Bank, 2015; GSS, 2014a; GSS, 2014b). Street food vending is a popular feature of most cities and urban areas in Ghana (Marras et al., 2016).

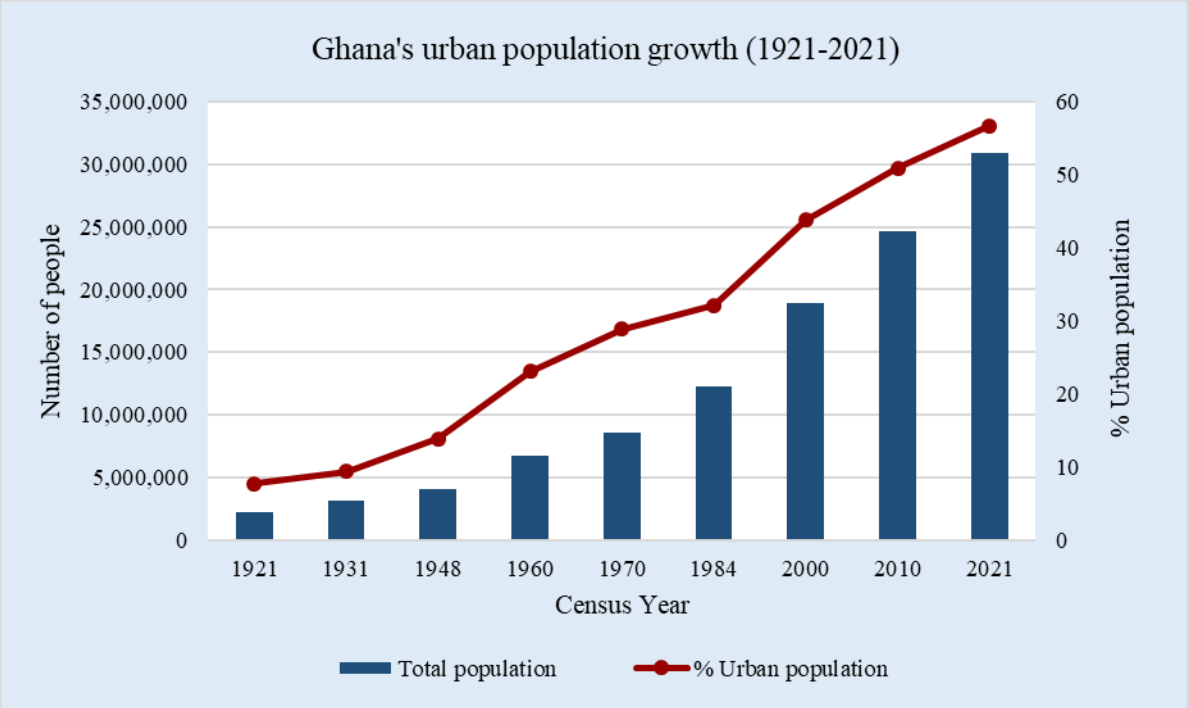


Figure 1.2: Ghana's urban population growth (1921-2021)
Source: Data extracted from GSS, (2014a) and GSS, (2022)

1.2 Problem statement

Like other African countries, Ghana, a lower-middle-income country, is experiencing rapid urbanisation. The proportion of the population living in urban areas was about 51 percent in 2010 (GSS, 2013) and increased to about 57 percent in 2021 (GSS, 2022). Urban lifestyles and pressures have made eating outside the home and living a sedentary life a common

phenomenon. Also, urban dwellers are driven by convenience motives to optimise their time between the labour market and food consumption (Reardon et al., 2021).

There is a positive correlation between urbanisation and the prevalence of overweight and obesity in Ghana (Ofori-Asenso et al., 2016). About 43 percent of adults are overweight (25.4%) or obese (17.1%). The most urbanised regions-Greater Accra and Ashanti, have a prevalence rate of about 55 and 43 percent, respectively, of adults who are either overweight or obese. Most of these people are women in towns and cities (Ofori-Asenso et al., 2016). At the same time, undernutrition has not been completely eradicated. For example, the 2014 Ghana Demographic and Health Survey indicated that 19, 5 and 11 percent of children under five years were stunted, wasted and underweight, respectively. Also, about 66 and 42 percent of children under five years and women between 15-49 years were anaemic, respectively (GSS et al., 2015)—an indication of the double burden of malnutrition among the population.

Ghana also has an infrastructure deficit in urban areas (GSS, 2014a; GSS, 2014b; World Bank, 2015). The infrastructure deficit has resulted in overcrowding and pressure on public services and amenities. There is pressure on the food system in West Africa, where food safety and healthy diet concerns have been raised, especially in the distribution and retailing stages of the food system (Staatz & Hollinger, 2016). Open markets are still a core feature of the food system in Ghana (Gonzalez et al., 2014), and sanitary and safety conditions in these markets are not optimal ("Joy Clean Ghana campaign", 2019). Food safety is a public good inefficiently delivered by the private sector in the absence of government interventions due to market failure. Consequently, households are at a high risk of exposure to unsafe foods if public policy and government regulations do not regulate the sector. Practising proper food handling behaviour, including food safety cooking practices at home, will safeguard the household against some foodborne diseases but will also require adequate time to prepare home-cooked food. Households are also gradually turning to supermarkets as an alternative to domestic open markets (Meng et al., 2014).

Regarding urban households' exposure to unsafe foods coupled with urbanisation and nutrition transition in Ghana, a robust food system cannot be over-emphasised, especially an urban food system that can adequately supply consumers with stable and timely food in the correct quantity and quality. In other words, in Ghana, food safety and healthy diets are interlinked with purchasing behaviour, time allocation decisions (food preparation, work, and leisure), and consumers' food-related health status. Therefore, this study aims to investigate the challenges

in the local urban food system, focusing on household food consumption decisions relative to food safety, dietary diversity and cooking time. There is limited empirical research in Africa on food safety, especially households' food safety cooking decisions and choice of food markets. Food safety is partly an unobservable quality characteristic of food and can result from market failures and, therefore, needs market failure correcting policies and regulations to safeguard consumers.

1.3 General research questions

Based on the background and problem statement of this study, the general research questions to be addressed are:

1. What is the effect of food safety and nutrition knowledge on urban households' food purchasing and cooking behaviour?
2. What is the effect of seasonality on household dietary diversity and food safety related short-term health status?
3. What is the effect of time used for household food preparation on the prevalence of household double burden of malnutrition (DBM) in urban Ghana?

1.4 Summary of study data

We use multiple data sources to address the objectives of the study. In chapters 2 and 3, we use primary data from the NOURICITY project—household, market and food microbial data. The household data covered socioeconomic indicators, household dietary diversity, knowledge, attitude and practices (KAP) of food safety and determinants of choice of food markets. The market data covered socioeconomic indicators, type of retailers and structure of retail outlets, food products sold, and retailers' level of knowledge on food safety and hygiene. The microbial data covered the levels of selected food microbes and aflatoxins present in tomatoes, cabbage, maize and ground purchased from the Agbogbloshie market in Accra. Chapter 4 uses three rounds of the Ghana Socioeconomic Panel Survey (GSPS) data. It is nationally representative, covering many socioeconomic indicators, development indicators, agriculture information, anthropometric information and time-use modules.

1.5 Relevance of the study

The study contributes to a better understanding of where consumers in urban areas get their information about food safety, the food markets they shop at, and households' food safety cooking practices, thus helping explain how behaviour can be influenced to be receptive to safe and healthy diets. Food safety is a public good, but food safety delivery, which is embedded in

food delivery, is mostly by private sector and, thus, inefficiently delivered, resulting from market failure (Kerr & Hobbs, 2022; Horne, 2019). Therefore, government interventions and regulations are needed to correct these inefficiencies and imperfections (Henson & Traill, 1993) and protect consumers. Also, some food safety issues occur within the household, for example, unhygienic food handling (Langiano et al., 2012). Therefore, food safety is a shared responsibility (FAO & WHO, 2021).

The study also shows the prevalence of malnutrition and the double burden of malnutrition in urban Ghana. This study is relevant for policymakers because although there are still challenges in addressing undernutrition in developing countries, there is a growing prevalence of overweight and obesity. Severe undernutrition among children can cause brain damage that leads to permanent cognitive impairment (Galler et al., 2021; Kar et al., 2008; Ivanovic et al., 2000). Cognitive impairment affects children's educational abilities and, ultimately, their productivity in the labour market during adulthood (Hoddinott, 2016). In addition, undernutrition increases the vulnerability and susceptibility of children and adults to infectious diseases. In Sub-Sahara Africa, undernutrition costs between 3 and 16 percent of GDP annually (Hoddinott, 2016). The cost of overweight and obesity can be high, as observed in developed countries (OECD, 2019). Being overweight and obese are closely associated with non-communicable diseases (NCDs), such as cardiovascular diseases and cancers. The global burden of disease shows that NCDs are a leading cause of disability-adjusted life years (DALYs) in Sub-Saharan Africa (SSA), accounting for about 29.8 percent of the total burden of disease (Gouda et al., 2019). Undernutrition studies dominate most academic research and policies on food and nutrition security in Africa. However, the growing challenge of the double burden of malnutrition calls for more scientific research and evidence-based policies to tackle the issues holistically, given the under-resourced health system in most African countries.

The study also provides an understanding of the effect of seasonality on food safety concerns in an urban environment and the food consumption behaviour of households in three (3) cities in Ghana. Much of the food security literature focuses on rural agriculture households and concludes that households are more food secure during harvest or soon after harvesting (Brander et al., 2021; Gelli et al., 2017). Given the growing share of people living in urban areas and engaged in non-agriculture activities, the study will determine the effect of seasonality on dietary diversity and food expenditure in urban areas. Further, the study determines the association between seasonality and household food safety status.

1.6 Conceptual framework

Figure 1.3 presents the general conceptual framework of the study. It shows the focus of all three analytical chapters. The conceptual framework will help address the issue of household food safety, dietary diversity, food expenditure and the household DBM in urban Ghana. Specifically, for this research, the role of household-level factors, including food safety knowledge, attitude and practice (KAP), employment type, time spent cooking, dietary diversity, malnutrition status, food retailers' food safety knowledge and behaviour, and seasonality, will be explored.

The study draws inspiration from a more detailed food system framework as presented in von Braun et al. (2023b) and HLPE (2017). The HLPE framework emphasises the linkage between food system and diet and nutrition. The framework shows how diets produced by the food system influence health outcomes. The HLPE framework also highlights how consumer food choices should be sustainable to produce an economically, socially and environmentally sustainable food system. The framework by von Braun et al. (2023b) highlights not only the interconnectivity of subsystems of the food system but also the interlinkage of the food system with other systems like health, ecology and climate, economic and governance, and science and innovation systems. The authors also point to challenges and the dilemma of developing overly complex systems that could become unsolvable or too narrow a system that excludes critical components of the system (von Braun et al., 2023a).

This study will focus on the linkages presented in the conceptual framework in Figure 1.3. The linkages within the food system that are analysed are (i) the linkage among food safety knowledge, dietary behaviour, and food expenditure per capita, (ii) the linkage among seasonality, household incidence of foodborne disease and dietary diversity, and (iii) the links among household head and spouse employment status, time usage for food preparation and household DBM.

1.7 Organisation of the study

The rest of the thesis is organised as follows: Chapter 2 addresses the first research question on food safety knowledge and its effect on household cooking practice/behaviour and dietary diversity. Chapter 3 examines the effect of agricultural seasonality on household dietary diversity and food safety (incidence of food-related diarrhoea). Chapter 4 addresses the question of the effect of cooking time on household DBM in urban Ghana. This chapter also

investigates the existence of household DBM. Finally, chapter 5 presents the study's general conclusions and policy implications.

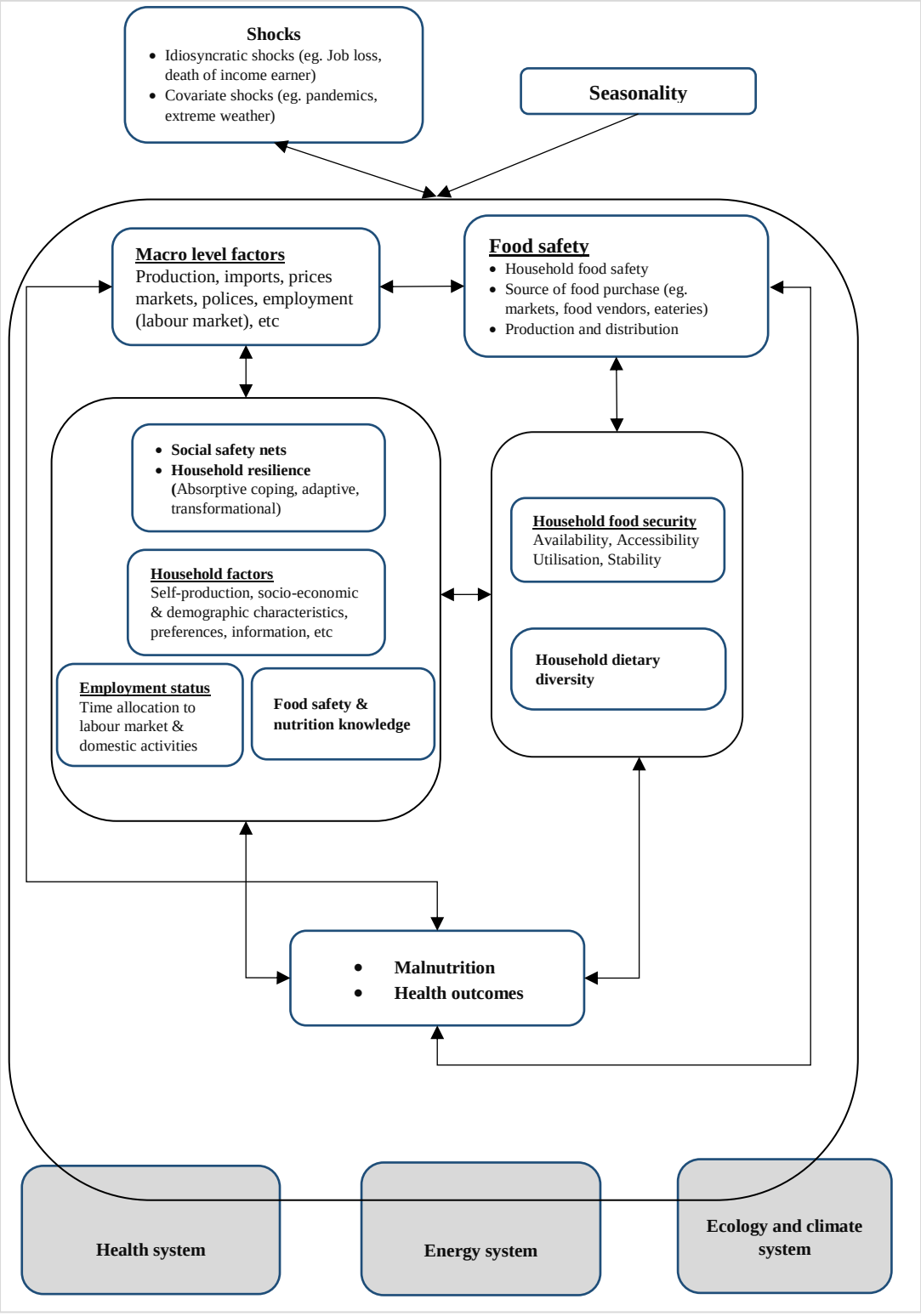


Figure 1.3: Conceptual framework showing the linkage among household food safety knowledge and behaviour, seasonality, food consumption, time spent cooking and malnutrition
Source: Modified based on von Braun et al., (2023b)

Chapter 2: Analysis of food safety and nutrition knowledge, and household food purchasing and cooking behaviour

2.1 Introduction

Food safety is fundamental to food and nutrition security and health (WHO, 2022b). Unsafe food has the potential to create a vicious cycle of food and nutrition insecurity, malnutrition and poor health (WHO, 2022b). Food safety issues can affect everybody and are of concern at every stage of the food system (Gizaw, 2019; HLPE, 2017). Food safety is the assurance that food prepared or consumed by an individual for an intended purpose will not cause harm or adverse health effects (Codex Alimentarius, 2020). Unsafe foods can result from a wide range of microbial and chemical contaminants. The sources of these contaminants can be pathogens, pesticides and heavy metal residues, food adulteration, use of unapproved hormones in animal production, misuse of additives, mislabelling and expired products (Thakali & MacRae, 2021; Gizaw, 2019; Rather et al., 2017; WHO, 1999).

The consequences of unsafe food are enormous, especially in developing countries. Foodborne diseases caused by food contaminants cause productivity loss of about US$ 95.2 billion annually in low- and middle-income countries. Sub-Saharan Africa accounts for about US$16.7 billion of this total productivity loss (Jaffee et al., 2018). Moreover, within the household, children bear the brunt of foodborne diseases. Children under five years account for about 40 percent of the global burden of foodborne diseases, mostly found in low- and middle-income countries (WHO, 2015).

Food safety is a collective and shared responsibility from farm (production) to fork (consumption) (WHO, 2022b; FAO & WHO, 2021). For example, at the production stage of the food value chain, aflatoxins are a significant food safety challenge, especially in developing countries, because of their toxicity and carcinogenic properties (Fouché et al., 2020; WHO, 2018a; Marchese et al., 2018) and they can linger in food if not adequately dried, processed and stored (Udomkun et al., 2017; Gong et al., 2002). Monitoring and testing food products in the local markets to check their safety are limited in developing countries (Shephard, 2018), thus compromising consumers' health. Furthermore, urban households are exposed to high risks of foodborne disease transmission because most urban households rely on traditional open-air markets to meet their food consumption needs: traditional open-air markets are prone to unsanitary and unhygienic conditions, which are fertile grounds for the spread of foodborne pathogens (WHO, 2022b; WHO, 2006c; IFPRI, 2017).

The home can also be an avenue for the spread of food pathogens and foodborne diseases (Langiano et al., 2012). However, it can also be the final barrier to preventing and transmitting foodborne diseases (Soon et al., 2020). The home provides an effective eating food environment for promoting healthy eating behaviour. Parental food and feeding habits shape a child's eating habits and behaviours (Scaglioni et al., 2018; Asakura et al., 2017). Maternal food safety and healthy diet knowledge influence children's food behaviour (Campbell et al., 2013). Tabbakh and Freeland-Graves (2016) showed a positive relationship between a mother's nutritional knowledge and the diet of her adolescent child. A mother with higher nutritional knowledge positively affected her adolescent child's total fruit, whole grain, seafood and plant protein, and general diet quality consumption: this is due to the mother's controlling influence and her role as the primary food handler in the home (Tabbakh & Freeland-Graves, 2016; Campbell et al., 2013). Men's nutritional knowledge can also improve the nutritional status of households (Ambikapathi et al., 2021; Ochieng et al., 2017). Ambikapathi et al. (2021) found that men's dietary knowledge and household dietary diversity correlate positively. The men's Vitamin A knowledge and children's dietary diversity are positively correlated, unlike women's knowledge of Vitamin A.

Therefore, household food handlers are essential in implementing safe and hygienic cooking practices in the home (Jevšnik et al., 2008). Food handlers' food decisions depend on factors like the source of food purchases and whether to opt for home-cooked food or food away from home. Households are urged to eat healthier home-cooked meals instead of food away from home (Glanz et al., 2021; Smith et al., 2013). Inherent in this statement is that the food handler in the home is knowledgeable in food safety and healthy food preparation and has the tools and the environment to act according to their knowledge. However, appropriate knowledge only sometimes translates into appropriate behaviour (Kenkel, 1991; McCluskey & Lovarini, 2005). For example, a food handler with enough purchasing power and the proper knowledge of food safety and healthy diets only sometimes translates this knowledge into purchasing safe and healthy diets. In an experimental study by List and Samek (2015), they found that educational messages on healthy diets can have a more significant short- and long-term impact on food choices among school children if combined with an incentive.

A review of the existing literature on household food safety behaviour shows a paucity of empirical evidence on food safety knowledge, attitude and practice (KAP) in Ghanaian urban homes. The existing literature has focused on institutional food handlers like restaurants, food

outlets, and food sellers and vendors (Rheinländer et al., 2008; Akabanda et al., 2017). Thus, this chapter aims to explore the knowledge level of household food handlers on safe foods; and the effect of food safety and nutrition knowledge in determining households' food purchases and food safety cooking behaviour. The study answers the questions: What are the main factors that influence urban households' choice of food market; does food safety knowledge affect cooking and food purchasing behaviour, and what is the effect of household wealth status on food safety behaviour? Our study is unique because, to the best of our knowledge, there is currently a need to study Ghanaian urban household food safety knowledge and cooking practices using the methods applied in this study.

The structure of the remainder of the chapter is as follows: Section 2.2 provides a literature review on food safety and nutrition knowledge and household dietary diversity. Section 2.3 presents the study's conceptual framework, while section 2.4 covers the study area, source of data and sampling design used in data collection. Section 2.5 presents the empirical strategy used to address the research questions. Finally, sections 2.6 and 2.7 present the study's empirical results and discussion, and conclusions, respectively.

2.2 Literature review

2.2.1 Link between food safety and nutrition knowledge and behaviour

There is no convergence in the literature on food-related knowledge translating into appropriate food behaviour change (Spronk et al., 2014; Asakura et al., 2017; Soon et al., 2020; De Vriendt et al., 2009). However, food safety and nutrition knowledge is a necessary but insufficient factor in a positive food safety and nutrition behavioural change (Worsley, 2002). Moreover, though not a necessary and sufficient factor, knowledge is a foundation block that anchors other food behaviour determinants. Thus, to what extent is this fundamental variable applicable to the food consumption decisions of urban households in developing countries?

In Handan, China, although street food vendors and consumers have adequate knowledge of food safety, this does not translate into safe food practices and hygienic working conditions by street food vendors (Ma et al., 2019). However, mitigating factors like age and educational level affected food safety knowledge. In communities with low educational levels, their food safety knowledge was equally low (Ma et al., 2019). Soon et al. (2020), in a study in Malaysia using Structural Equation Model (SEM), found that food knowledge did not affect food practices. However, food attitude positively correlated with food safety practices. This finding is contrary in part to an earlier study by Lim et al. (2016), who found that food safety knowledge

had a negative effect on food safety behaviour while food safety attitude had a positive effect on behaviour in selected communities on the island of Sabah.

Other socioeconomic factors affect the knowledge-behaviour relationship. Women's educational level, age and kind of occupation are key determinants of their nutritional knowledge. Women (18-39 years) in Belgium with higher nutritional knowledge also exhibited better nutritional behaviour. They consumed more fruits and vegetables than those with less nutritional knowledge (De Vriendt et al., 2009). Block (2004) also noted that with a similar household budget, mothers with higher nutritional knowledge allocate a higher share of the household budget to healthier items (micronutrient-rich foods) compared to mothers with less nutritional knowledge who engage in the opposite. In addition, children's knowledge of healthy diets is equally important as that of their guardians. Higher nutrition knowledge of both child and guardian positively correlated with most of the child's healthy food consumption behaviour (Asakura et al., 2017).

Another factor that affects the knowledge-behaviour relationship is the source of information. The effectiveness of nutritional information depends on the trustworthiness of the source of information (Samoggia & Riedel, 2020; Quaidoo et al., 2018; Cash et al., 2015). Young adults (18-25 years) in Ghana sampled from the Accra Metropolis source most of their nutritional information from online platforms. However, they considered nutritional information from healthcare professionals a more reliable source of nutrition information (Quaidoo et al., 2018). Nutrition apps provide and improve consumers' healthy diet information and have led to behavioural changes (Samoggia & Riedel, 2020).

In summary, the household is a crucial food environment ensuring food safety and nutrition security. Food safety and nutrition knowledge has not always translated into positive behaviour; where it did, the relationship has been weak (Spronk et al., 2014). The household is the final barrier to preventing and transmitting foodborne diseases (Soon et al., 2020), and their positive food safety behaviour enhances the fight against unsafe foods.

2.2.2 Food safety concerns in urban Ghana

The importance of food safety as a public health and socioeconomic issue must be considered, especially in developing countries like Ghana. Institutional catering (restaurants, food vendors, "chop bars", and schools) are a significant source of food safety concerns in Ghana (Ababio & Lovatt, 2015). As recently as January 2023, fifty-three people experienced symptoms of foodborne disease with one fatality after consuming food from a local food outlet (street

vendor) in Accra (FDA, 2023). Similarly, in May 2022, the FDA had to temporarily close down a major restaurant chain in Accra after many of its patrons experienced symptoms of foodborne diseases after consuming food from a branch of the restaurant (FDA, 2022). In all these circumstances, the FDA investigations revealed poor sanitation, poor food handling practices and heavy microbial load (pathogens) in the food sold by these eateries (FDA, 2023; 2022). The two examples above show that the cooking area and ingredients used in food preparation are as important as the eating area.

Further, institutional food handlers in sampled institutions in Ghana only partially comply with food safety practices in the discharge of their work. Their knowledge of foodborne diseases and their transmission and food temperature controls was limited. About 71 percent of sampled respondents did not know Salmonella and Hepatitis A were foodborne pathogens. However, about 80 percent of them correctly identified typhoid fever and bloody diarrhoea as food-related diseases (Akabanda et al., 2017). At the production stage, some farmers engaged in urban agriculture did not practice appropriate agronomic practices. Fresh vegetables cultivated in some urban areas in Ghana could be more wholesome. Due to the lack of adequate fresh water for irrigation, farmers resort to polluted water for their irrigation activities (Amoah et al., 2007). A test of vegetables (spring onions, lettuce and cabbage) from urban farms in Kumasi tested positive for total and faecal coliforms and *Escherichia coli* bacteria (Abass et al., 2016).

Although food safety is a shared responsibility (FAO & WHO, 2021), consumers still grapple with their role in ensuring food safety in the food environment (Jevšnik et al., 2008). Many consumers believe food handlers at the source of food purchases are more responsible for food safety issues. Consumers are limited in food safety issues like chemical contamination and residue deposition in food products. Chemical and heavy metal contamination may not be detectable by the physical eye. An example of this challenge is aflatoxin contamination in infant food in some developing countries (Kumi et al., 2014; Blankson & Mill-Robertson, 2016). The production of commercial infant food (Blankson & Mill-Robertson, 2016) and home-made infant food (Kumi et al., 2014) contain aflatoxin levels beyond acceptable limits because the source ingredients, like maize, groundnuts and beans, are contaminated. Notwithstanding the hidden food safety hazards that confront households, proper personal hygiene and household WASH behaviour can prevent many foodborne diseases (Brockett et al., 2020).

2.3 Conceptual framework

Different theories and models explain behaviour and behaviour change (Gorton & Barjolle, 2013; Michie et al., 2008; Michie et al., 2005; Hardeman et al., 2002). These theories have shaped our understanding of the factors influencing behaviour change (Bandura, 2004). For example, according to Ajzen's theory of planned behaviour, behavioural intention is the immediate predictor of actual behaviour change (Ajzen, 1991). A person's intention is the individual's effort to undertake a behaviour. Also, behavioural intention is influenced by an individual's attitude, subjective norm, and perceived behavioural control. These factors are further shaped by the normative beliefs, motivation and evaluation of outcomes by the individual (Ajzen, 2020).

Additionally, internal (knowledge, skill and individual abilities and characteristics) and external (resources, money, time, equipment and legal barriers) factors can interfere with the actualisation of behaviour (Ajzen, 2020). Therefore, for example, households will have a firm intention to purchase food from a hygienic food environment and practice food safety cooking practices at home when they have a positive attitude towards that behaviour, how much social pressure they feel to perform that behaviour (subjective norms) and the belief that they can practice these behaviours comfortably. Therefore, according to Ajzen (2020), knowledge (correct factual information) does not directly influence actual behaviour, but rather knowledge influences beliefs, which in turn influences attitude, subjective norms and perceived behavioural control. However, from the social cognitive theory by Bandura (2004), knowledge creates a precondition for change. A person with appropriate knowledge and essential skills can successfully perform a behaviour because of a high self-efficacy (confidence) in his or her ability (Bandura, 2004). Therefore, although knowledge is just a factor that influences behaviour (Sobal & Bisogni, 2009; Worsley, 2002), it is a critical factor in the formation of behaviour. Other factors (moderators) affect the strength of the knowledge-behaviour relationship, while others (mediators) explain the mechanisms of the knowledge-behaviour relationship (Bamberg & Möser, 2007; Meinhold & Malkus, 2005).

This study focuses on food safety and nutrition knowledge, and cooking practices. We present the conceptual framework in Figure 2.1. Knowledge can directly affect food behaviour; or indirectly affect food behaviour through the food attitude of the individual (Liu et al., 2019). A positive food safety attitude positively correlates with proper food safety behaviour. Internal and external factors in our study, like the food handler's personal and household characteristics, source of information (government and private sources), and educational level, influence their

knowledge. Subsequently, the relevant acquired food knowledge may indirectly influence food behaviour through the attitude of household members towards food safety and healthy diets. The household with appropriate knowledge and skills will then have to overcome barriers like market access, the cost of foodstuffs, kitchen space, cooking utensils and fuels to perform food safety cooking practices and prepare healthy meals. Therefore, the food handler within the household may have a higher healthy diet knowledge but may need more income to afford the proper dietary diversity.

For this chapter and the nature of the data we have, we analyse the relationship between food safety knowledge and food cooking behaviour and source of food purchases in urban areas. We assume that households with the requisite food safety knowledge will purchase food from markets or places that meet their food safety standards. Also, at home, the food handler's food preparation behaviour before, during and after cooking is affected by their food safety knowledge. The underlying assumptions are that the household has the requisite tools and cooking area to translate the food safety cooking knowledge into appropriate cooking behaviour: the availability or lack of cooking tools and the cooking area may hinder observing appropriate cooking behaviour.

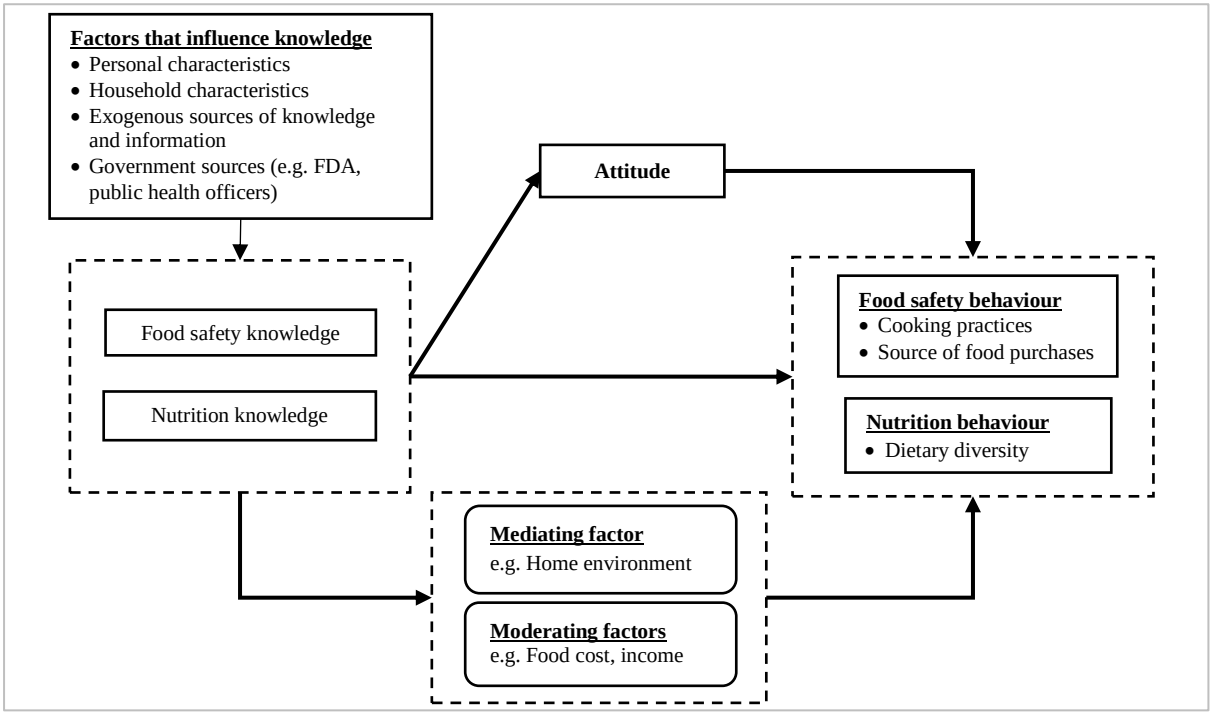


Figure 2.1: Conceptual framework of the effect of food safety and nutrition knowledge on behaviour

2.4 Study area, sampling design and data source

2.4.1 Study area for primary data collection

The study area is Ghana, located in West Africa (Figure 1.1). The study sites are located in three cities in Ghana-Accra, Kumasi and Tamale Metropolises, in the southern, middle and northern parts of Ghana, respectively (Figure 2.2). According to Ghana's 2010 Population and Housing Census (PHC), these cities are the biggest in the southern, middle and northern parts of Ghana based on the population size of the cities. They have large food markets integral to the county's food system. The three study sites provide a national picture of the urban food system investigated from different geographic and socioeconomic perspectives. We provide further details on these unique cities surveyed in this study.

Accra Metropolis

The Accra Metropolitan Assembly (AMA) is in southern Ghana. According to the 2010 PHC, the metropolis makes up about 42 percent of the total population of the Greater Accra Region. The entire metropolis is urban. However, there are variations in the socioeconomic status of the people. There are about 450,748 households in the metropolis. About 47 percent of the population are migrants. The informal private sector is the largest employer, with about 48 percent of the inhabitants self-employed. The city is the country's economic hub and has some of the largest food markets in the country. The primary food market is the Makola market, with other satellite markets and food outlets scattered in the 72 communities in the metropolis. The AMA has 3 sub-metros: Ablekuma South, Ashiedu Keteke and Okaikoi South. The Ashiedu Keteke sub-metro is the heart of economic activities in the capital. The central business district and the Makola and Agbogbloshie markets are in the Ashiedu Keteke sub-metro (GSS, 2013).

Kumasi Metropolis

The Kumasi Metropolitan Assembly (KMA) is in the middle of Ghana. According to the 2010 PHC, the metropolis makes up about 36 percent of the total population of the Ashanti Region and has about 440,283 households. The city is a vibrant commercial centre. Strategically positioned to link the north and the south of the country. The key locations in the metropolis are the Kejetia lorry park, the Kejetia central market and the Adum shopping centre. These locations significantly shape the economic activities and food systems of the city. The Kejetia central market is the largest open-space food market in West Africa, and the food section is one of the largest in Ghana. Other markets in the city are Asafo, Bantama, Oforikrom and Atonsu markets. The region is generally considered one of the country's bread baskets. The city's food system and the rural food system of neighbouring districts are closely linked. Food

prices in the city are lower compared to other cities in the country. The Kumasi Central Market is in the Subin and Menhyia sub-metros (GSS, 2013).

Tamale Metropolis

The Tamale Metropolitan Assembly (TaMA) is in northern Ghana. According to the 2010 PHC, it accommodates about 9.4 percent of the Northern Region's population. About 80 percent of the metropolis is urban. The total number of households in the metropolis is 219,971. The metropolis is the centre of economic activity in the Northern region and other regions in the northern part of Ghana. This city is unique because of its geographical location and the socio-cultural and economic status of the people. As a result, the nature and type of food consumed vary from those eaten in the middle and southern parts of the country. In addition, food systems in the metropolis are connected to other national and international systems and the rural food system (GSS, 2013).

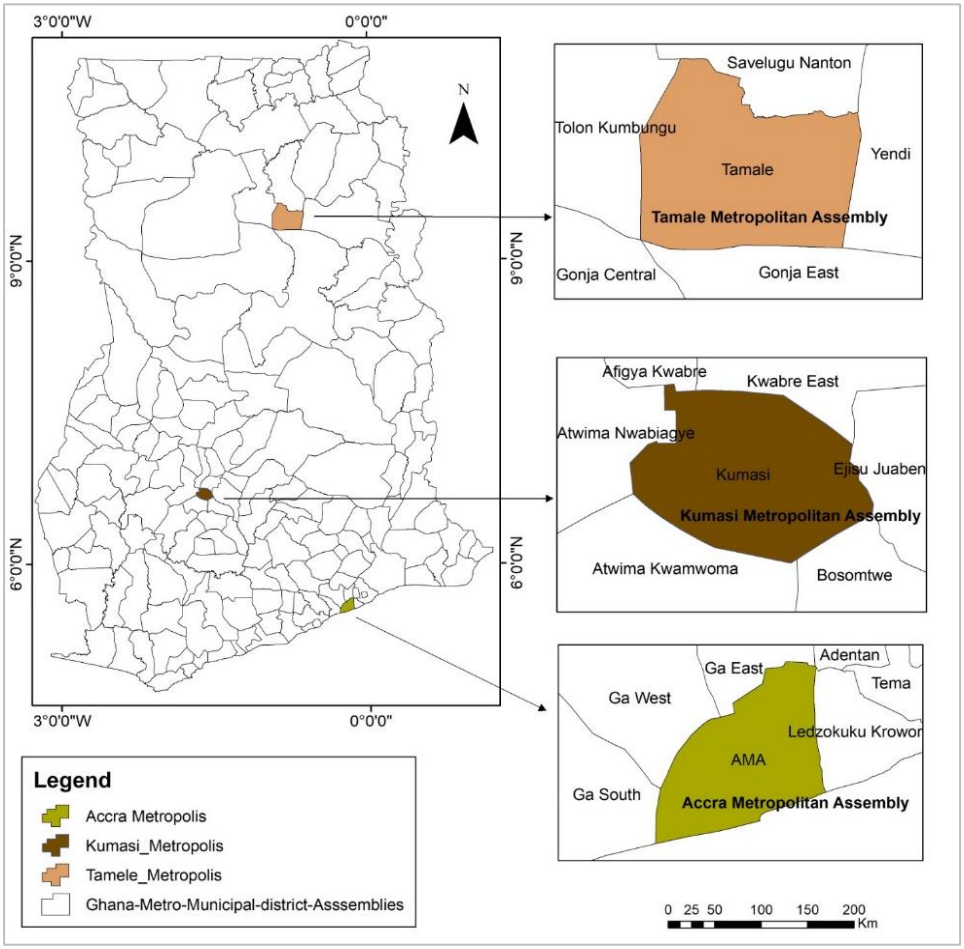


Figure 2.2: A map of Ghana showing the study sites

2.4.2 Sampling design

2.4.2.1 Household survey sampling design

We used a multistage sampling technique in the sampling of households. A three-stage sampling procedure was applied. The first stage was purposive, and the subsequent two stages were randomisations. In the first stage, we selected the three largest cities in the south, middle and north of Ghana based on the 2010 PHC. The choice of these study sites was because; of the presence of major food markets, level of development and urbanisation, food socialisation behaviour, socioeconomic characteristics and agroecological characteristics. The three study sites provide a national picture-geographic, ecological, demographic, socio-cultural and socioeconomic perspective of the urban food system in large and main cities in Ghana. The consideration is to have a geographically evenly distributed sample. Also, because we want to link the households to the market survey, the household survey was done in the same metropolitan areas (sub-metros) where the major food markets were.

The second stage of sampling was randomisation at the level of the Enumeration Area (EA). The EAs are the lowest geographical units demarcated by the Ghana Statistical Service (GSS) for national population census purposes. The GSS performed the randomisation at the EA level. Based on our budget and geographical representation, the GSS randomly selected the total EAs for each study site based on the 2010 PHC.

The third and final stage of randomisation was at the household level within each EA. Within each EA, data collectors did random walks to the households. They started from the EA base, the major landmark within the EA, and moved in four opposite directions to sample the households. Where the houses are densely populated, we sampled after every 10^{th} house. In Accra and Tamale, we sampled 18 households from each EA, whiles in Kumasi, we sampled 12 households each. The total sample collected was 672 households from 44 EAs. However, after data cleaning and management, 609 responses had complete data for analysis. Table 2.1 presents the distribution of households sampled.

Table 2.1: Number of households sampled

Region	City	Sub-metro/district	Number of EAs sampled	Number of households sampled
Greater Accra	Accra	Ashiedu-keteke	12	216
Ashanti	Kumasi	Manhyia	10	120
		Subin	10	120
Northern	Tamale	Tamale	12	216
			44	**672**

Source: Author's computation, 2020

2.4.2.2 Market survey sampling design

We used a two-stage sampling approach for the market survey. We used purposive and random sampling approaches in the first and second stages. We used purposive sampling to select three markets in Ghana's south, middle and northern parts. We selected the markets from Accra, Kumasi and Tamale. The markets selected were the Makola and Agbogbloshie Markets in Accra, Kumasi Central Market in Kumasi and Tamale Central Market in Tamale. The criteria for selecting these cities are: they have major food markets that are hubs for aggregating and redistributing a wide variety of food products to other cities and regions in Ghana and neighbouring countries. Also, these markets play essential roles in the national and regional food systems. Urban households depend directly and indirectly on these markets for their food needs. In addition, retailers in smaller and satellite markets in these cities source many of their products from these major markets for onward sale in communities far from the major markets. The selected markets also provide a reliable outlet for agricultural products from production (rural communities and towns) areas to be sold.

In Accra, we identified the boundaries of the Makola and Agbogbloshie Markets. It is important to note that the selected markets have thousands of actors. However, there is homogeneity (groups/clusters) in the types of products sold and the structure of the selling outlets. Therefore, we sampled based on products sold and structures in the markets. First, we conducted a mapping survey (retailer listing) of types of food retailers and structures in the Makola and Agbogbloshie markets. In the mapping survey, we randomly selected samples within a particular cluster for a fair geographical distribution—about 1000 retailers. During sampling, we also sampled retailers among a particular cluster other than the one in which we expected to find them. For example, when a vegetable seller is among cereal (maize) sellers, the vegetable seller is enumerated. After the mapping survey, we randomly sampled about 205 respondents for the market survey, which involved administering a more detailed questionnaire. Based on the experience from Accra, in Kumasi and Tamale markets, we did a recognizance visit to the markets to identify the main clusters based on types of food sold and types of structures (e.g., wholesalers, retailers and immobile hawkers). After identifying the clusters, we did random walks to enumerate respondents. We sampled 200 and 160 respondents in the Kumasi and Tamale Central markets.

2.4.3 Survey data and data used

The NOURICITY dataset provides a unique blend of household and market information on the urban food system in Ghana. As a result, although our dataset is not nationally representative, our dataset contains information that is not in the other nationally representative data sets. Table 2.2 shows some similarities and differences among different datasets covering food and nutrition-related topics. Although the NOURICITY dataset has a relatively smaller sample size than the nationally representative datasets, some household characteristics are similar across datasets.

Table 2.2: Datasets that cover food and nutrition related topics in Ghana

	NOURICITY data	**GSPS data**	**GDHS data**	**GLSS**
Survey characteristics				
Coverage	Selected cities	National	National	National
Survey rounds	2	3	7	7
Duration between rounds	Semi-annual; annual	Periodic (3-year interval)	Periodic (3-5 years interval)	~5 years
Dataset dimension	Panel	Panel	Repeated cross-sectional	Repeated cross-sectional
Type of survey	Household and market survey	Household and community survey	Household survey	Household and community survey
Survey sample size	Household: ~600 Market: ~560	~5000	~ >15000	~>15000
Key indicators related to food and nutrition security, and food safety				
Household KAP of food safety	Yes	No	No	No
Food safety knowledge in the market	Yes	No	No	No
Food hygiene in the market	Yes	No	No	No
Household dietary diversity	Yes	Yes	Yes	No
Food expenditure	Yes	Yes	No	Yes
Anthropometry	No	Yes	Yes	Yes
Governance, peace and security	No	No	No	Yes
Household characteristics				
	NOURICITY 1	GSPS 2 report[+]	GDHS 6 report [+]	GLSS 7 report [+]
Average household size	3.9	2.9	3.1	3.5
% male headed household	52.1	57.4	62.9	64.3
Average age of household head	47.3	47.7	-	44.2

Note: [+] urban area figures. GSPS-Ghana Socioeconomic panel survey, GDHS-Ghana demographic and health survey, GLSS-Ghana living standard survey

Even with the two rounds of household and market surveys undertaken, we rely primarily on data from the first round of the household survey to address the research questions in this chapter. Because during the data collection process, we did not introduce any interventions

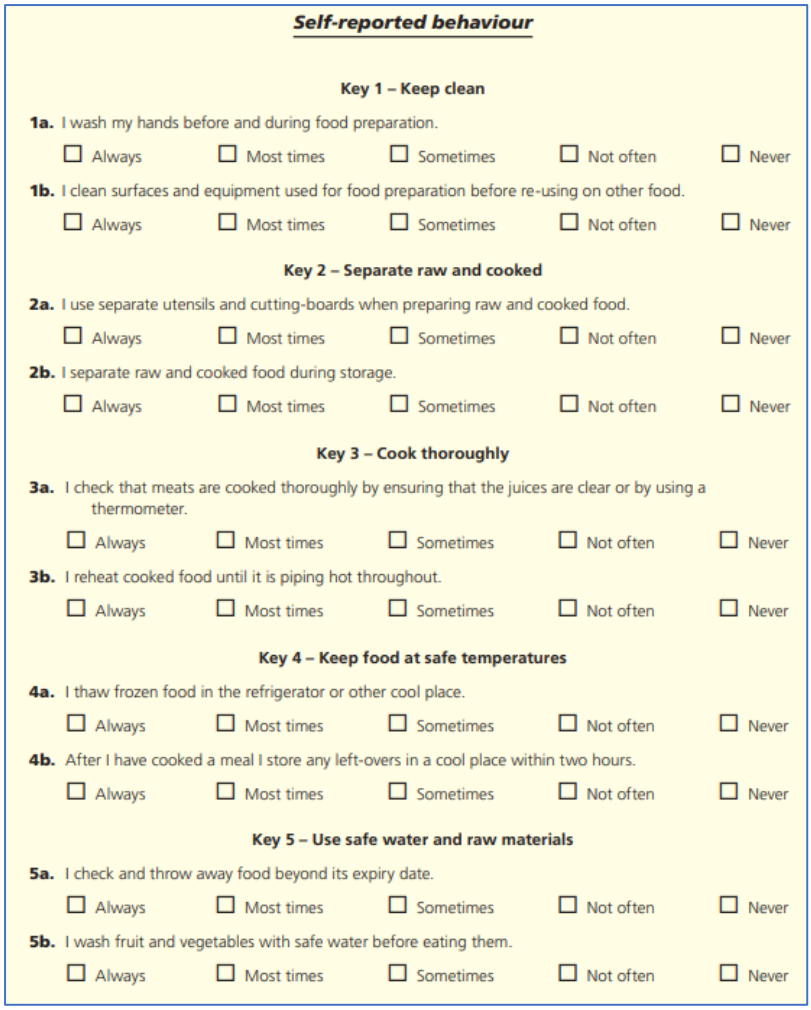
between survey rounds to change the households' food safety and nutrition KAP, the key variables of interest in this chapter. So, we do not expect a change in household cooking behaviour over the six months between the two rounds. We used data from the two rounds in chapter three of this thesis.

2.5 Empirical strategy

2.5.1 Measurement of key variables

In this chapter, the primary outcome variables are household dietary diversity score (HDDS) and food safety cooking behaviour. The HDDS range from 0-12, representing the consumption of foods categorised into 12 groups based on nutritional value (Swindale & Bilinsky, 2006). Next, we compute food safety cooking behaviour (Figure 2.3) using respondents' responses to 10 statements on their food safety behaviour contained in the WHO's "5 keys to safer foods" (WHO, 2006a). Respondents indicate whether they "always", "most times", "sometimes", "not often", and "never" practice the stated behaviours. So, food safety cooking behaviour is the sum of all the "always" responses per household. The higher the aggregated number, the better the household implements appropriate food safety cooking behaviour according to WHO standards.

The explanatory variables used for analysis include household knowledge and attitude towards food safety, household nutrition knowledge, source of food safety information, household wealth index, and household characteristics. Food safety and nutrition knowledge are computed based on the summation of correct answers to standard WHO questions on household food safety and nutrition. Using principal component analysis (PCA), households' wealth index (a proxy for income) is computed based on households' assets.



Self-reported behaviour

Key 1 – Keep clean

1a. I wash my hands before and during food preparation.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

1b. I clean surfaces and equipment used for food preparation before re-using on other food.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

Key 2 – Separate raw and cooked

2a. I use separate utensils and cutting-boards when preparing raw and cooked food.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

2b. I separate raw and cooked food during storage.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

Key 3 – Cook thoroughly

3a. I check that meats are cooked thoroughly by ensuring that the juices are clear or by using a thermometer.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

3b. I reheat cooked food until it is piping hot throughout.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

Key 4 – Keep food at safe temperatures

4a. I thaw frozen food in the refrigerator or other cool place.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

4b. After I have cooked a meal I store any left-overs in a cool place within two hours.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

Key 5 – Use safe water and raw materials

5a. I check and throw away food beyond its expiry date.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

5b. I wash fruit and vegetables with safe water before eating them.

☐ Always ☐ Most times ☐ Sometimes ☐ Not often ☐ Never

Figure 2.3: Extract from the "Five keys to safer food manual", (WHO, 2006a)

2.5.2 Estimation strategy

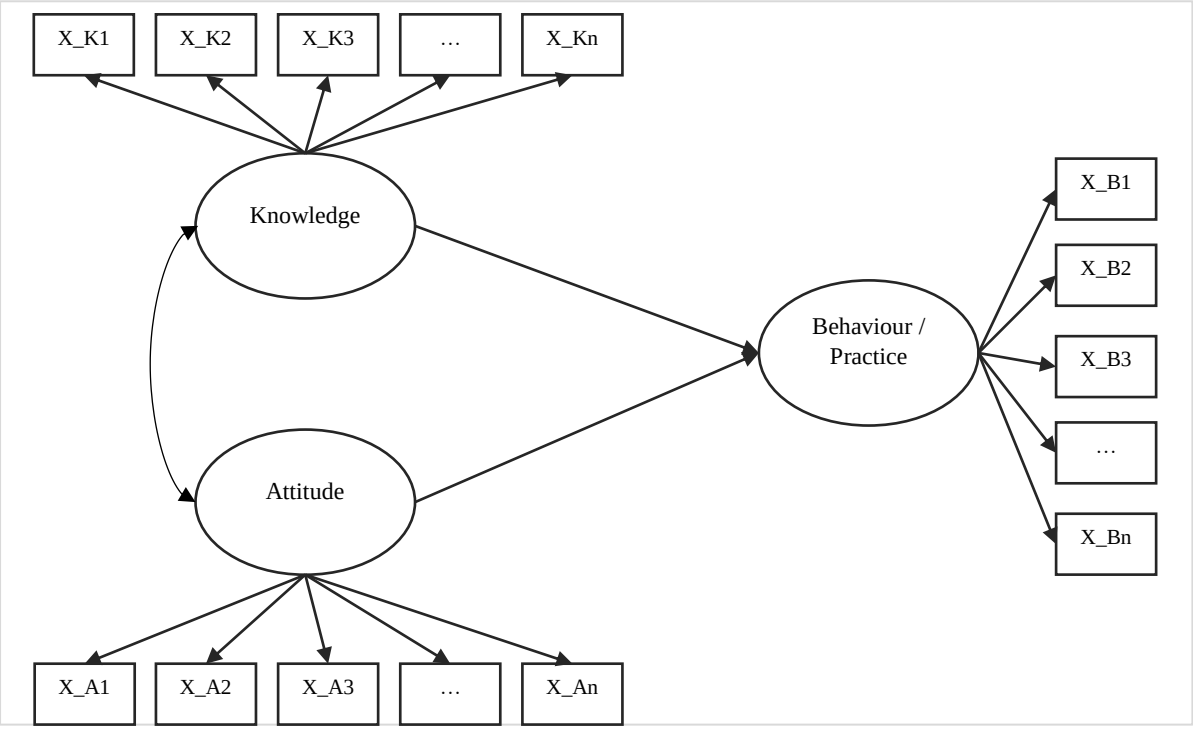
We applied Structural Equation Models (SEM) to address the questions on the effect of household food safety knowledge and attitude on food cooking practices/behaviour. The latent variables are food safety knowledge, attitude and behaviour (Tolvanen, et al., 2012). Therefore, to measure the latent variables, a set of indicators that best explain various components of the latent variables are measured. In addition, the complex interactions between knowledge, attitude and behaviour make them interdependent and bidirectional. SEM is appropriate to address these peculiarities. A system of equations is required to establish the relationship between food safety knowledge and food safety cooking behaviour (Bollen & Noble, 2011). Some of these linkages involve latent variables that have to be estimated. Therefore, we built a measurement model of the relationship between each indicators and knowledge, attitude and behaviour. We then combined the measurement models of these latent variables to establish their relationship while controlling for measurement errors in the observable indicators (Bollen & Noble, 2011).

The indicators of each latent variable (knowledge, attitude and behaviour) are the observable attributes that constitute knowledge and the respondent's responses to a set of questions showing their attitude towards food safety (positive or not). In addition, we measure the respondent's behaviour based on self-reported confirmation of their activities before, during and after food preparation and where the household purchases food for cooking. The indicator variables (Xs) of each latent variable used in the study are in Table A.6. The complex interaction of the various variables of interest and their bidirectional nature leads to endogeneity and measurement error challenges. In our conceptual framework, we assume that multiple factors measure multiple variables, and the factors can be correlated and have feedback loops. This results in non-recursive models (Kline, 2011). Moderators are also incorporated into the knowledge-behaviour models to analyse the pathways through which knowledge-behaviour models interact.

We performed three activities to build the SEM for our study: exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and run SEM. We used STATA 15.1 to perform all the analyses. The EFA extracted the items/questions used to construct the latent variables of food safety knowledge, food safety attitude, food safety cooking practices/behaviour and healthy food knowledge. The extracted factors have eigenvalues greater than (>) 1 using the principal factor method (pf), communality values greater than (>) 3 and factor loadings of scale items greater than (>) 0.4. In addition, we conducted the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, Bartlett's test of sphericity and Cronbach alpha test to test the appropriateness of the items used to reflect the latent variables (Hair et al., 2019; Hair et al., 2010; Gliem & Gliem, 2003).

After conducting the EFA to select the appropriate items, we performed a CFA to confirm the relationship among the variables of interest based on the study's conceptual framework. After this, we ran the SEM model to find the model that best fits the theory and data of the study. After running a SEM model, we performed a goodness of fit test based on some indices to determine the appropriateness of the model for its intended purpose. The recommended cut-off levels for the goodness-of-fit indices (Brown, 2015; Yu, 2002; Hu & Bentler, 1999) include; the Root Mean Squared Error of Approximation (RMSEA) and Standardised Root Mean Squared Residual (SRMR) values less than (<) 0.08 and Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) greater than (>) 0.9. Models that meet these thresholds are a close-fit and suitable for their intended purpose.

As presented in Figure 2.4, the study extends this basic model to include all the outcome variables of interest and the moderating indicators. They study specifies three models to determine which best explains the relationship between food safety knowledge, attitude, healthy diet knowledge, and food safety cooking behaviour.



X_Ks, X_As and X_Bs are the indicators/observables (questions/statements) of K, A and B respectively. K, A, and B are latent variables. The Xs are explained in Table A.6

Figure 2.4: Basic model of the link between food safety and nutrition knowledge and behaviour

2.6 Results and discussion

2.6.1 Source of food purchases and food safety concerns by urban households

The source of food purchases is an important component of a household's food decision-making. From Table 2.3, convenience is the principal reason for choice of market for food purchases among sampled households. Convenience in terms of proximity to the market and the availability of all products at one location. About 66 and 58 percent of households considered the distance to the market and availability of all products at one location among their top three considerations when choosing the market to purchase food items. Table 2.4 shows that out of the options provided, 50 and 19 percent of households selected distance to the market and availability of all products at one location, respectively, as their main reason for the choice of market. The findings show that transaction cost considerations are of high importance to households. Households in urban areas adopt time-saving mechanisms to deal with the growing opportunity cost of time. They cut back on time allocated to domestic

activities, including food preparation and shopping, and channel the time saved into other economic activities. As a result, they optimise their interactions with the food environment by choosing accessibility (short distance to the market) and convenience (brevity of time) (Turner et al., 2020).

Table 2.3: Choice of food market and awareness of FDA

	Accra	Kumasi	Tamale	Total	*P-value*
% of households' who consider….. as 1 of their top 3 considerations for choice of market					
Convenience (short distance to market)	70.86	67.43	60.19	65.85	0.0716*
Convenience (all products at one place)	58.86	54.59	60.65	57.96	0.4252
Safety standards/good quality products	15.43	15.14	22.22	17.73	0.0992*
% of households aware of Food and drugs authority (FDA)	49.71	54.59	26.39	43.32	0.0000***
% of households that have received any form of education from FDA	15.43	26.61	9.72	17.41	0.0000***
N	175	218	216	609	

+ANOVA conducted across study sites. *** p<0.001, ** p<0.05, * p<0.1

Furthermore, Table 2.3 and Table 2.4 show that food safety concerns were low among the considerations of respondents. Many households need to be aware of the primary state institution with the mandate of championing food safety. Less than 50 percent of households are aware of the Food and Drugs Authority (FDA), the primary state institution to champion food safety issues in Ghana. Moreover, only 18 percent of households considered food safety among their top three considerations for choosing a food market (Table 2.3). Additionally, only 2 percent of households had food safety concerns as their topmost consideration in selecting a food market (Table 2.4). The relatively lower consideration for food safety in the choice of food markets is not necessarily a lack of care for safe food. The social construct around food and cooking in Ghana may explain this observation. Consumers who have had positive previous experiences with a retailer and have developed a trustworthy relationship may continue to purchase food items from that retailer, irrespective of the current food safety status of the retailer (Rheinländer et al., 2008). Consumers may continue to patronise a particular food retailer provided there are no immediate adverse effects from consuming food from that source.

Table 2.4: Households' main reason for choice of market for purchase of food items

Main reason for choice of type of market for shopping	N	%
Overall sample		
Convenience (short distance from my house)	303	49.75
Convenience (all products at one place)	115	18.88
Lower price of products	103	16.91
The products are fresh	44	7.22
Can buy in bulk	19	3.12
Safety standards/quality of product	14	2.30
Social construct	4	0.66
Buy products on credit	3	0.50
Cultural reasons/tradition	3	0.50
Others	1	0.16
Total	609	100.00
Accra		
Convenience (short distance from my house)	93	53.14
Lower price of products	29	16.57
Convenience (all products at one place)	27	15.43
The products are fresh	14	8.00
Safety standards/quality of product	7	4.00
Social construct	3	1.72
Can buy in bulk	1	0.57
Cultural reasons/tradition	1	0.57
Total	175	100.00
Kumasi		
Convenience (short distance from my house)	115	52.75
Lower price of products	41	18.81
Convenience (all products at one place)	34	15.6
The products are fresh	17	7.8
Can buy in bulk	7	3.21
Safety standards/quality of product	3	1.37
Cultural reasons/tradition	1	0.46
Total	218	100.00
Tamale		
Convenience (short distance from my house)	95	43.98
Convenience (all products at one place)	54	25.00
Lower price of products	33	15.28
The products are fresh	13	6.02
Can buy in bulk	11	5.09
Safety standards/quality of product	4	1.85
Buy products on credit	3	1.39
Cultural reasons/tradition	1	0.46
Social construct	1	0.46
Others	1	0.46
Total	216	100.00

Source: Author's computation, 2020

Open-air markets are still the main markets patronised by households in cities. The main market in the city/community, which are open-air markets, remains the preferred choice for food purchases. In Table 2.5, about 59 and 31 percent of households sourced food items from the

community's main and satellite markets, respectively. This finding is consistent with Hannah et al. (2022), who found that open-air markets are the preferred option for urban households in eighteen cities in Kenya and Zambia because open-air markets meet households' expectations regarding dietary preference, convenience, accessibility and prices of foodstuffs.

On the other hand, our findings show that about 1 percent of households sourced their food items from supermarkets. Supermarket shopping for food products, especially fresh fruits and vegetables, and some local food commodities still need to be higher among respondents in urban areas. Despite the growth in the supermarket sector in Ghana (Andam et al., 2018), we may attribute households' very low patronage of supermarkets to the uniqueness of the study areas, which are close to major traditional open-air markets. In places where open-air markets and supermarkets are nearby, consumers patronise open-air markets because of lower prices, fresher products and convenience (Wertheim-Heck et al., 2019; Hannah et al., 2022). In addition, unlike open-air markets, supermarkets are associated with food safety because of the implementation of quality and safety standards throughout the supply chain (Reardon et al., 2010). However, supermarkets sold more processed foods from the start of operations than fresh fruits and vegetables (Rao & Qaim, 2016), especially local and indigenous varieties. So major traditional markets, compared to supermarkets, are more convenient (proximity and all products at one location) for households to get their domestic fresh fruits and vegetables and processed food items from other retail shops in the market.

Table 2.5: Where households mostly purchase food items

Where respondents mostly purchase food items	N	%
Overall		
Main market in the city/community	361	59.28
Daily market (satellite market)	186	30.54
Periodic markets	34	5.58
Sidewalk	20	3.28
Supermarkets	6	0.99
Others	2	0.33
Total	609	100.00
Accra		
Main market in the city/community	93	53.14
Daily market (satellite market)	68	38.86
Periodic markets	8	4.57
Sidewalk	6	3.43
Total	175	100.00
Kumasi		
Main market in the city/community	111	50.92
Daily market (satellite market)	84	38.53
Periodic markets	10	4.59
Sidewalk	9	4.13
Supermarkets	4	1.83
Total	218	100.00
Tamale		
Main market in the city/community	157	72.69
Daily market (satellite market)	34	15.74
Periodic markets	16	7.41
Supermarkets	5	2.31
Sidewalk	2	0.93
Others	2	0.93
Total	216	100.00

Source: Author's computation, 2020

2.6.2 Household food safety knowledge and information

Based on the World Health Organisation's (WHO's) five (5) keys to safer food (WHO, 2006a), we assessed households on their knowledge of safer foods and practices at home before, during and after cooking. The results presented in Table 2.6 show that households' average score on food safety knowledge is 60.9 percent. Households in Tamale (61.5%) had the highest score, and households in Kumasi (60.1%) had the lowest score on food safety knowledge. However, differences in food safety knowledge across study sites are not statistically significant. Food handlers performed better on some questions than others (Table A.2). Over 90 percent of respondents know it is essential to wash hands before handling food, cooked food should be kept very hot before serving and wash fruit and vegetables before use. Although 83 percent of food handlers know that raw food needs to be stored separately from cooked food, only 17 percent of them know that it is a false statement that the same cutting board can be used for

raw and cooked foods provided it looks clean. Although over 96 percent of food handlers know it is essential to wash fruit and vegetables before use, only 20 percent of them know that safe water cannot be identified by how it looks. Also, only 21 percent of food handlers know that cooked meat cannot be left at room temperature overnight to cool before refrigerating.

Regarding food handlers' attitudes, about 75.5 percent of households had a positive attitude towards or agreed with the food safety guidelines presented to them (Table 2.6). However, food handlers have different attitudes towards safe food handling activities and general hygiene (Table A.3). Over 90 percent of food handlers have a positive attitude towards keeping kitchen surfaces clean to reduce the risk of illness and inspecting food for freshness and wholesomeness. However, only 31 percent of food handlers have a positive attitude towards meat thermometers as useful kitchen gadgets for ensuring food is cooked thoroughly.

Regarding food handlers cooking practices, only 53 percent of households practised all the safety guidelines provided "always" (Table 2.6). Food handlers practised more activities than others (Table A.4). Most maintain general hygienic conditions in their cooking spaces: they constantly wash their hands before and during food preparation (78.8%) and wash fruit and vegetables with safe water before eating (79.2%). The least practised safe food handling activities are thawing frozen food in the refrigerator or other cool place (31.2%), using separate utensils and cutting boards when preparing raw and cooked food (36.1%) and storing any left-over food in a cool place within two hours after cooking (36.3%). Based on the WHO's five keys to healthy diets (WHO, n.d.), respondents also scored an average of 18 out of 20 on their knowledge of healthy diets. Respondents in Accra had the lowest average mark of 17 out of 20. Regarding healthy diet knowledge (Table A.5), food handlers knew about the potentially harmful effects of consuming high amounts of fats, oils, sugar and salts.

Table 2.6: Food safety knowledge, attitude and self-reported behaviour

	Accra	Kumasi	Tamale	Total	*P-value*
Food safety knowledge, attitude and behaviour					
Average accurate percentage score	61.14	60.13	61.53	60.92	0.5020
% of positive attitude towards food safety guidelines	73.0	78.2	75.0	75.5	0.0144**
% of practiced food safety behaviour always	47.14	55.64	55.05	53.00	0.0045**
Healthy diets knowledge	16.97	17.94	18.75	17.95	0.0000***
N	175	218	216	609	

+ANOVA conducted across study sites. *** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation, 2020

The results clearly show that households are knowledgeable about food safety and healthy diets and have a positive attitude towards food safety. However, fewer households practice food

safety cooking behaviour always. These findings are consistent with the results of Makhunga et al. (2023). Using the WHO's five keys to safer food, the authors found that food handlers in the eThekwini District in South Africa had good knowledge, positive attitude and acceptable behaviour towards safe food handling. However, unlike our findings, household food handlers in Bangladesh showed insufficient food safety knowledge and handling practices (Islam et al., 2023). Also, Langiano et al. (2012) observed that respondents in Cassino, Italy had insufficient food safety knowledge on the transmission of foodborne diseases and pathogens.

The home environment is the primary source of food safety information. Many household food handlers acquired food safety information from their mothers/guardians and relatives (Table 2.7). Mothers/guardians and other relatives account for about 42 and 21 percent of responses as the sources of food safety information. About 13 and 9 percent of respondents source food safety information from friends and school, respectively. The home is still an important place for food socialisation. The home can serve as a platform to introduce food safety conversations that can improve knowledge and behaviours. Our finding on the source of food safety information is similar to that of Marklinder et al. (2020). The authors found that among sampled university students in Sweden, a majority (45%) of them had their food safety knowledge from family and friends.

Table 2.7: Sources of information on food safety

	Source of food safety information	Frequency of responses	% of responses	% of cases
1	Mother/guardian	491	42.15	81.16
2	Other relatives	250	21.46	41.32
3	Friends	157	13.48	25.95
4	School	109	9.36	18.02
5	Media (mainstream/social)	84	7.21	13.88
6	Public health officer	44	3.78	7.27
7	Social grouping	28	2.4	4.63
8	Search on the internet	2	0.17	0.33
	Total	**1165**	**100**	**192.56**

Source: Author's computation, 2020

2.6.3 Household food expenditure and correlation with KAP

Food expenditure is a significant share of household budget in many low-and middle-income countries (Regmi & Meade, 2013). Expenditure on food influences the household's food environment and food choices. From Table 2.8, food expenditure constitutes a significant component of household expenditure in Ghana. The average food expenditure share is 45 percent, and the average monthly food expenditure per capita is GHS175.7. However, there are geographical differences in household food expenditure per capita and food expenditure share

of total household expenditure. For example, households in Accra spend about 50 percent of their household expenditure on food compared to households in Tamale, who spent about 37 percent. Equally, households in Tamale have the least monthly food expenditure per capita (GHS78.1) compared to households in Accra, who spend about GHS254.7 per household member. Some possible reasons for this result include lower food prices in Tamale and Kumasi than in Accra. Also, households' own production is higher in Tamale than in Accra and Kumasi, so households in Tamale spend less money on food purchases than in Accra and Kumasi.

Table 2.8: Food expenditure per capita and food expenditure share of total household expenditure

Study cities	**Food expenditure share (%)**	**Monthly food exp. per capita (GHS)**
Accra	50.120	254.685
Kumasi	49.585	209.006
Tamale	36.615	78.071
Total	45.138	175.692
Diff. across cities (*p-values*)	*0.000*	*0.000*
Total N	609	609

***p<0.001, **p<0.05, *p<0.1

Source: author's computation, 2020

In Table 2.9, we show the correlation among the variables that may influence households' food safety cooking behaviour. The results show that food expenditure per capita positively correlates with household wealth status. Also, HDDS positively correlates with household wealth status and food safety knowledge. Household wealth status positively correlates with food safety attitude, behaviour and healthy diet knowledge. Food safety knowledge and behaviour are negatively correlated. In Lee et al., 2017, the perceived food safety knowledge of food handlers did not translate into appropriate practices. Further, attitude positively correlates with behaviour (Mihalache et al., 2021) and healthy diet knowledge.

Table 2.9: Correlation between HHDS and food safety knowledge, attitude, self-reported behaviour

	Food exp/ capita	HDDS	Wealth status	Knowledge	Attitude	Behaviour	Healthy diets knowledge
Food exp/ capita	1.0000						
HDDS	-0.0404	1.0000					
Wealth status	0.1406***	0.3475***	1.0000				
Knowledge	-0.0114	0.1327**	0.0536	1.0000			
Attitude	-0.0533	0.0122	0.2832***	-0.0985	1.0000		
Behaviour	-0.0595	-0.0197	0.2406***	-0.1603***	0.9249***	1.0000	
Healthy diets knowledge	-0.0272	-0.0357	0.2354***	0.1406***	0.3640***	0.3521***	1.0000

*** p<0.001, ** p<0.05, * p<0.1; total number of households (N) =595

2.6.4 SEM analysis

2.6.4.1 Exploratory factor analysis - factor loading extraction

We performed exploratory factor analysis (EFA) to identify the items that affect the structure of the latent variables (food safety knowledge, healthy diet knowledge, attitude and behaviour). Table 2.10 and Table A.6 present the sampling adequacy and reliability and the factor loadings of the items used in the EFA, respectively. The number of items (indicators) used to estimate the latent variables are 4 and 6 for food safety knowledge and attitude, and 8 and 12 for food safety cooking practice/behaviour and healthy diet knowledge, respectively. In Table 2.10, the KMO values are 0.54, 0.70, 0.79 and 0.74 for food safety knowledge, attitude and behaviour, and healthy diet knowledge, respectively. The corresponding Cronbach's alpha values are 0.35, 0.62, 0.77 and 0.73, respectively. The overall KMO and Cronbach alpha values for the 30 items are 0.80 each. The KMO and Cronbach's alpha values are all within recommended levels for all the latent variables (Hair et al., 2019; Hair et al., 2010; Gliem & Gliem, 2003) except the Cronbach alpha value of 0.35 for food safety knowledge. In Table A.6, the factor loadings of the items presented are above 0.4. For each latent variable, the average factor loading is above 0.5, indicating that convergent validity is present (Mihalache et al., 2021). Thus, the items extracted from the EFA to the CFA to construct the model are appropriate.

Table 2.10: Sampling adequacy (KMO) and internal consistency (Cronbach alpha)

Latent variables	Kaiser-Meyer-Olkin (KMO)	Bartlett's test of sphericity (p-value)	Cronbach's alpha	No. of questions/items
Food safety knowledge	0.537	0.000	0.3534	4
Food safety attitude	0.696	0.000	0.6202	6
Food safety behaviour	0.789	0.000	0.7732	8
Nutrition knowledge	0.735	0.000	0.7277	12
Total*	0.799	0.000	0.8037	30

*All items (questions/statements) used to compute all latent variables

2.6.4.2 Confirmatory factor analysis

After running the SEM model, we performed a goodness of fit test to determine the appropriateness of the model for its intended purpose. Our models' goodness of fit summary statistics shows acceptable results based on recommended cut-off levels (Brown, 2015; Yu, 2002; Hu & Bentler, 1999). The Root Mean Squared Error of Approximation (RMSEA) and Standardised Root Mean Squared Residual (SRMR) values are within recommended levels of less than (<) 0.08 (Table 2.11). Specifically, RMSEA values are 0.08 and 0.05 for models 1 and 2, respectively. The SRMR values are 0.06 and 0.07 for models 1 and 2, respectively. The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are very close to the recommended

levels of greater than (>) 0.9. Our models have CFI values of 0.83 and 0.85 and TLI values of 0.78 and 0.83 for models 1 and 2, respectively. Thus, the models are satisfactory for the data, and with RMSEA and SRMR values within acceptable limits, with caution, the models can be used for their intended purpose.

Table 2.11 shows the estimated standardised results of the models and their goodness of fit statistics. In model 1, we estimated the relationship among food safety KAP. The results indicate that food safety knowledge ($\beta1=0.595$, $p>0.05$) and attitude ($\beta1=0.220$, $p>0.05$) positively affect food safety cooking practices/behaviour. However, the effect is not statistically significant. In addition, food safety knowledge and attitude are positively correlated ($\beta1=0.902$, $p<0.05$), and this association is statistically significant. These findings are similar in part to Soon et al. (2020), who found that the effect of food safety knowledge on food safety practices was negative and statistically not significant among consumers in Malaysia, but attitude had a positive and significant effect. Further, Akabanda et al. (2017) showed that the food safety knowledge of food handlers in Ghana needed to correspond with their food safety practices. Mihalache et al. (2021) observed the contrary. The authors observed that food safety knowledge and shopping attitude had a positive and statistically significant effect on kitchen practices among consumers in Romania (Mihalache et al., 2021).

In model 2, we included healthy diet knowledge in the food safety KAP model (model 1). The results show that food safety knowledge ($\beta1=0.648$, $p>0.05$), healthy diet knowledge ($\beta1=-0.311$, $p>0.05$), and food safety attitude ($\beta1=0.307$, $p>0.05$) do not have a statistically significant effect on households' food safety cooking practice/behaviour. However, a statistically significant positive correlation existed between food safety knowledge, attitude and healthy diet knowledge (Table 2.11).

Table 2.11: Results of the paths of food safety knowledge, attitude and behaviour

Pathway	Model 1		Model 2	
	Std. estimate	p-value	Std. estimate	p-value
Food safety Knowledge → Food safety behavior	0.595	0.257	0.648	0.143
Food safety Attitude → Food safety behavior	0.220	0.671	0.307	0.383
Knowledge of healthy diet → Food safety behavior			-0.311	0.105
Food safety Knowledge ↔ Food safety Attitude	0.902	0.000	0.607	0.000
Food safety Knowledge ↔ Healthy diet knowledge			0.148	0.000
Healthy diet knowledge ↔ Food safety Attitude			0.310	0.000
Goodness of fit statistics				
RMSEA	0.075		0.054	
SRMR	0.060		0.066	
CFI	0.825		0.851	
TLI	0.782		0.825	
Observations	595		595	

Source: Authors' computation, 2021

In model 3, we include the household wealth status in the model as a moderating factor of knowledge and attitude on cooking practices/behaviour. Within the household, income is a significant moderator in the food environment. Compliance with appropriate food safety measures has cost implications for the household. The appropriate cooking space, cooking utensils and kitchen tools, safe water and foodstuff to cook; constrain the household's choice to practice appropriate food safety behaviour.

The goodness of fit summary statistics (Table 2.12) shows that model 3 is fit for purpose. The RMSEA and SRMR values are 0.05 and 0.07, respectively. The CFI and TLI values are 0.84 and 0.81, respectively. The results show that food safety knowledge ($\beta1=0.745$, $p>0.05$) and attitude ($\beta1=0.204$, $p>0.05$) have a positive but statistically insignificant effect on food safety cooking practices/behaviour. Household food handlers can pay more attention to food safety cooking practices than currently. They are knowledgeable about food safety and have a positive attitude towards food safety guidelines (Table 2.6). However, the absence of a statistically significant effect of knowledge and attitude on food safety cooking behaviour (models 1-3) may be due to the perceived consequence of food handlers' food safety cooking practices/behaviour not resulting in any immediate adverse impact on their health that will cause them to change their food safety cooking practices/behaviour. The perceived consequence of a practice/behaviour will influence the level of compliance (Worsley, 2002). Also, other mediating factors like income influences the practice of appropriate food safety cooking behaviour.

Table 2.12: Household wealth status as a moderating factor in household food safety KAP model

Pathway	Model 3	
	Std. estimate	p-value
Food safety Knowledge → Food safety behavior	0.745	0.122
Food safety Attitude → Food safety behavior	0.204	0.591
Knowledge of healthy diet → Food safety behavior	-0.368	0.086
Knowledge of healthy diet → HDDS	0.039	0.459
Household wealth status → Food safety behavior	0.131	0.004
Household wealth status → Food expenditure per capita	0.069	0.095
Household wealth status → HDDS	-0.286	0.868
Food expenditure per capita → HDDS	-0.126	0.001
Food safety Knowledge ↔ Food safety Attitude	0.832	0.000
Food safety Knowledge ↔ Healthy diet knowledge	0.621	0.000
Healthy diet knowledge ↔ Food safety Attitude	0.319	0.000
Goodness of fit statistics		
RMSEA	0.052	
SRMR	0.065	
CFI	0.840	
TLI	0.813	
Observations	595	

Source: Authors' computation, 2021

Household wealth status ($\beta1=0.131$, $p<0.05$) has a positive and statistically significant effect on households' food safety cooking practices/behaviour. A unit change in household wealth status leads to a 0.13 unit increase in practising appropriate food safety cooking behaviour: this implies that as a household's wealth status improves, households practise more appropriate food safety cooking behaviour. Furthermore, with improved wealth, households are more likely to have access to cleaner cooking areas and improved water and sanitation facilities (Adams et al., 2016; Behera et al., 2016), which are critical to food safety. On the other hand, poorer households are more likely to use solid fuels like wood, animal dung and charcoal which adversely affects their health (Behera et al., 2016) and compromises the hygiene of the cooking area. In addition, poorer households cannot practice appropriate WASH behaviours, including hand washing with soap (WHO & UNICEF, 2021; Gaffan et al., 2022), and therefore, the household food environment is compromised.

A counterintuitive result is healthy diet knowledge's statistically negative effect ($\beta1=-0.368$, $p<0.05$) on food safety cooking behaviour. Food safety and healthy nutrition are complementary concepts but practically can sometimes be incompatible because food safety encompasses food handling, preparation and storage, and healthy nutrition addresses the

nutritional quality of food (Walls et al., 2019). So, for example, food cooked at high temperature and longer to kill harmful food pathogens risk destroying the nutrient value of the food (Coe et al., 2022; Prabhu et al., 2009). Also, the knowledge of the toxic effect of trans-fatty acids in food is optional to practice personal hygiene (e.g. washing hands before and during food preparation) when cooking. Therefore, food safety knowledge and nutrition knowledge may differ. Therefore, our finding may arise because some nutrition knowledge may be outside the skills required to practice appropriate food safety cooking behaviour. Our results show a stronger correlation between healthy diet knowledge and households disposing of expired food products than households cooking food at the right temperature. Households know that overcooking fruits and vegetables leads to losing essential vitamins. However, few households practice cooking and storing leftover foods at the right temperature and place (Table A.7). Model 3 also shows that the correlation between food safety and nutrition knowledge, attitude and behaviour remains positive and statistically significant.

Other pathways (model 3) are significant in the household food safety consideration. Household wealth status has a positive and statistically significant effect on household food expenditure per capita ($\beta1=0.069$, $p<0.05$): this implies that a unit increase in household wealth status is associated with a 0.07 unit increase in household food expenditure per capita. However, household wealth status has a negative and statistically insignificant effect on HDDS (($\beta1=-0.286$, $p>0.05$). Food expenditure per capita also has a negative and statistically significant effect on HDDS ($\beta1=-0.126$, $p<0.05$). These findings may be attributed to increasing-income households likely shifting to consuming other processed and ultra-processed foods high in fats, sugars and salts, but not necessarily more diversified foods (Kearney, 2010; Monteiro et al., 2010). Consumption of unhealthy ultra-processed foods is a public health concern. However, concurrently, improved incomes and convenience-induced motives drive the consumption of processed and ultra-processed foods in the long run (Reardon et al., 2021). For example, in developing countries, households may spend on relatively costly processed foods when their income increase, reducing the consumption of more diversified, relatively cheaper local alternatives. In Ghana, households may reduce the consumption of cooked beans with red palm oil, gari and fried plantain (red-red) and increase their consumption of fried rice (oily rice with ready-made spices and seasoning). The former is a more balanced meal than the latter.

2.6.5 Ghana's food safety policy

The empirical results underscore food safety as a public good, which requires government to regulate the delivery of this public good, primarily supplied by the private sector. Therefore, we briefly describe food safety-related policies in Ghana.

In 2022, Ghana developed the National Food Safety Policy (NFSP) and the National Policy for Aflatoxin Control in Food and Feed (NPACFF) (Ministry of Health [MoH], 2022; Government of Ghana [GoG], 2022). The combined goal of these policies is to build a resilient system that assures safe and suitable food for all consumers and increases the income of food value chain actors (MoH, 2022; GoG, 2022). The NFSP covers food safety challenges along the food value chain—production, processing, storage, transportation and marketing—and proposes strategies to enhance food safety and safeguard consumers, including market failure correcting regulations (MoH, 2022; GoG, 2022). The new policies indicate the Government of Ghana's awareness and intent to integrate food safety into the food system.

Food safety interventions are not new to Ghana's health and nutrition space. Historically, food safety issues have been featured in legislation and national policy documents (Table 2.13 and Table A.8). So, the NFSP consolidates the programmes and interventions in different national policies to improve coordination and efficiency in implementing food safety targets. The NFSP's guiding principles are inter-sectoral collaboration and coordination, inclusiveness, transparency, risk assessment, protection of consumer interest, traceability and precautionary principles (MoH, 2022). The food safety policy aligns with global, regional and national food safety regulations, programmes and conventions. The policy aligns with global regulations and conventions, including the UN Decade of Action on Nutrition, Codex Alimentarius, Organisation for Animal Health, WTO agreement on sanitary and phytosanitary measures, and International Plant Protection Convention. At the regional level, the NFSP aligns with policies and programmes like the Maputo Plan of Action 2016-2030, Africa Regional Nutrition Strategy 2015-2025, and the Comprehensive Africa Agriculture Development Programme (CAADP) 2018-2020 (MoH, 2022).

At the national level, the NFSP aligns with many national development policies, including the National Health Policy (NHP), National Nutrition Policy (NNP) and Food and Agriculture Sector Development Policy (FASDEP) (Table 2.13). For example, the NNP highlights the strong interconnection between nutrition and food safety, pointing to the fact that it takes a robust food safety system to attain nutrition security and public health and safety goals (MoH,

2016). In addition, the food value chain in Ghana is dominated by the informal sector, which is a major challenge for monitoring and enforcing regulations. Accordingly, the NFSP emphasises surveillance of the food value chain as critical to detecting and containing food safety risks. The NFSP has a strategy to strengthen the existing foodborne disease surveillance network and early warning systems by improving coordination among agencies along the value chain (MoH, 2022). Additionally, the NFSP will promote the education and sensitisation of the public on food safety measures.

Table 2.13: Policies and strategies complementary to National Food Safety Policy

Institution	Name of Policy	Start time	End time
Ministry of Health (MoH)	National Food Safety Policy	2022	-
	National Policy for Aflatoxin Control in Food and Feed	2022	-
	National Health Policy (NHP) (*revised*)	2020	-
	National Nutrition Policy (NNP)	2016	-
	Health Sector Gender Policy (HSGP)	2009	-
	Regenerative Health and Nutrition Strategic Plan	2007	2011
	Under Five's Child Health Policy (U5CHP)	2007	2015
	Nutrition and Malaria Control for Child Survival	2007	2013
	Universal Salt Iodisation (USI)	1995	-
Ministry of Finance (MoF)/National Development Planning Commission (NDPC)	Ghana Shared Growth and Development Agenda (GSGDA II)	2014	2017
	Ghana Shared Growth and Development Agenda (GSGDA I)	2010	2013
	Growth and Poverty Reduction Strategy (GPRS II)	2006	2009
	Ghana Poverty Reduction Strategy (GPRS I)	2003	2005
Ministry of Food and Agriculture (MoFA)	Planting for Food and Jobs (PFJ)	2017	
	Medium Term Agriculture Sector Investment Plan (METASIP) II	2014	2017
	Medium Term Agriculture Sector Investment Plan (METASIP) I	2011	2015
	Ghana National Irrigation Policy (GNIP)	2010	
	Food and Agriculture Sector Development Policy (FASDEP) II	2007	2015
	Food and Agriculture Sector Development Policy (FASDEP) I	2002	2006
Ministry of Local Government and Rural Development (MoLGRD)	Ghana National Urban Policy Action Plan (GNUPAP)	2012	-
	Environmental Sanitation Policy	2010	-
Government of Ghana (GoG)	National Plan of Action on Food and Nutrition (NAPFN)	1995	2000
Ministry of Trade and Industry (MoTI)	Ghana Trade Policy (GTP)	2004	2010

Source: Authors' compilation based on different Government of Ghana documents

Legal framework and institutional roles

The current legal framework that regulates the conduct of institutions and stakeholders on food safety is the Public Health Act (Act 851). The Public Health Act mandates the Food and Drugs Authority (FDA) to be the primary regulator to spearhead the implementation of food safety activities in Ghana. Prior to the Public Health Act (Act 851), the pieces of legislation setting up the Ghana Standards Authority (GSA) (NRCD 173), the Environmental Protection Agency (EPA) (Act 490), the Tourism Authority (Act 817) and the Metropolitan, Municipal and District Assemblies (MMDAs) (Act 462) all had mandates to regulate segments of the food

system. The Public Health Act (Act 851) addresses the uncoordinated multiplicity of regulators in the sector by mandating the FDA as the primary regulator of the food and drugs sector. The Act also prescribes sanctions and penalties for defaulters. Accordingly, the FDA has prepared guidelines to guide different aspects of food safety in Ghana.

In accordance with Part Seven of the Act, the FDA has developed guidelines for food safety management and food market surveillance. The food safety management guidelines include handling foodborne disease outbreaks (FDA/FSMD/GL-FBD/2012/01), licensing of food service establishments (FDA/FSMD/GL-FSE/2013/02), code of hygienic practice for food service establishments (FDA/ FSMD/CP-FSE/2013/03) and manual for foodborne disease surveillance in Ghana (FDA/FSMD/GL-FBD/2014/01). The food market surveillance guidelines include guidelines for the safe disposal of unwholesome food products (FDA/FID/GL-DFP/2013/04) and repackaging of food product(s) (FDA/FID/GL-AD/2013/05). Additionally, the Ministry of Health, through the FDA, has also prepared the Food Safety Emergency Response Plan (FoSERP), which is situated within the National Public Health Emergency Response Plan (NPHERP) and will be activated when any emergency occurs along the food chain (MoH, 2021).

The Public Health Act and the NFSP in addition to the mandates of the FDA, also outline the mandates and roles of other government agencies in regulating and enforcing food safety in Ghana. The regulation and enforcement of food safety guidelines are anchored on the collaborative role among the FDA and other key government agencies like the Ministries of Health, Food and Agriculture, Local Government and Rural Development (metropolitan, municipal and district assemblies (MMDAs)), Environment, Science, Technology and Innovation, Tourism and, Trade and Industry (Ghana Standards Authority (GSA)). Other government ministries and agencies include Employment and Labour Relations, Sanitation and Water Resources, Education, Finance, National Development Planning Commission (NDPC) and Biosafety Authority. Aside from the roles of government institutions and agencies, the NFSP also outlined the role of private sector organisations, consumers and consumer associations, and other collaborators in ensuring food hygiene and safety (MoH, 2022).

Challenges in collaboration among food safety institutions and agencies

The NFSP adopts a multisectoral approach to policy implementation. There are some concerns and gaps in coordinating food safety at various levels. Food safety implementing institutions face many challenges that limit their effective collaboration and coordination at various stages

of the food system. Aside from the financial and human resource constraints that bedevil public institutions in developing countries, there are overlaps in the mandates of various implementing institutions, leading to poor coordination, conflict among institutions and dereliction of duty by institutions. The Public Health Act (Act 851), the primary legal document that empowers various food safety regulating institutions, does not exhaustively address the mandate of all stakeholders in the food and nutrition space.

For example, processed foods are better regulated than raw/fresh foods in Ghana because, by the Public Health Act (Act 851), manufacturers of food and food products must register their products and production sites with the FDA and comply with standards set by the Ghana Standards Authority (GSA), failure of which will result in penalties and sanctions. However, smallholder farmers and traders of raw/fresh plant foods who bring their products directly to the market do not undergo any form of registration of their raw/fresh foods. They are unlikely to be inspected for phytosanitary conditions at their origin before entering the market—a responsibility of the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA) (Plants and Fertilizers Act, 2010-Act 803). Furthermore, inspection by sanitation and health officers—under the Ministry of Local Government and Rural Development—in the markets is irregular and seldom. Therefore, there are gaps in the coordination among actors at the farm level and those in the markets.

Another example is the FDA and the Veterinary Services Department (VSD) of MoFA regarding the licensing of animal slaughterhouses. The FDA has overlapping mandates with VSD. Under the Public Health Act (Act 851), the FDA must collaborate with VSD to inspect slaughterhouse meats to ensure safety. However, the Act, which empowers the FDA (Food Division) to regulate and license the processing, storage and retail of animal products, including meat, is silent on the role of the VSD in the licensing process. Therefore, the FDA has discretionary authority to involve VSD in its licensing processes. Thus, the effectiveness of this collaboration between the two institutions is doubtful because the FDA can independently grant slaughterhouse licenses without VSD input.

The FDA is constrained by staff strength to adequately carry out their mandate at the local assembly level (i.e. MMDAs). The FDA relies on sanitation and health officers who work under the assembly to undertake monitoring and inspect food vendors and enforce food safety guidelines and by-laws in markets. These district officers fall under the Ministry of Health (MoH) and the Ministry of Local Government and Rural Development (MoLGRD). The food

inspection role of the district sanitation and health officers overlaps with that of the VSD, which inspects the safety of meat products in slaughterhouses. This overlap may lead to possible disagreements among officers at the local level and dereliction of their responsibilities.

Gaps in the National Food Safety Policy

The NFSP document identified "poor handling and packaging of fresh produce at the farm level and local markets" as a problem. However, the policy failed to identify any specific innovative strategy to address this problem. The problem of poor handling of fresh produce at the farm level and local markets is predominantly a problem of the domestic supply chain. The sanitation and hygiene conditions in traditional open-air markets in Ghana are poor. Unlike the domestic food supply chain, fresh produce for export meets particular food quality standards enforced in the receiving countries (Linderhof et al., 2019). Therefore, the NFSP, as part of its strategies to enhance food safety, should implement strategies, including infrastructure development of the domestic supply chain to improve sanitation and hygiene in the food environment, especially the traditional open-air markets, which are still the primary source of food access for households.

The NFSP has many strategies to safeguard food from "farm to fork". It is consistent with other well-established food safety policies and programmes, including the WHO's "Global Strategy for Food Safety 2022-2030: towards stronger food safety systems and global cooperation" (WHO, 2022b) and the European Union's food safety policy (European Parliament and Council, 2002). Many of the strategies of the NFSP are to ensure the safety of the food produced and purchased by the consumer. However, monitoring and regulating how consumers handle food within the household is more challenging. Nonetheless, food handling within the household is equally important. The NFSP does not sufficiently elaborate on how to promote food safety within the household. However, two strategic actions in the NFSP to strengthen food safety governance in Ghana are to develop a social behaviour change communication (SBCC) strategy for food safety and to promote, encourage and coordinate the education of consumers on food safety by key stakeholders. These strategic actions, when developed, can include proper food handling and cooking practices in the home and promoting the boycott of doubtful food environments.

Furthermore, the NFSP did not emphasise food safety in a sustainable development context. The NFSP, unlike the WHO's Global Strategy for Food Safety 2022-2030, did not promote food safety within a sustainable food system—economic, social and environmental

sustainability (WHO, 2022b). Food safety measures do not always align with sustainability goals. For example, food safety measures farmers adopt to mitigate the contamination of fresh food products by foodborne pathogens can impair water quality and biodiversity (Olimpi et al., 2019). In addition, improper application of food safety standards can lead to the disposal of safe food, resulting in food waste (FAO, 2015). The NFSP should have provided guidelines and identified relevant institutions to ensure food safety compliance does not adversely impact economic, social and environmental sustainability.

2.7 Conclusion

Food safety has assumed a global dimension resulting from factors like public health risks, more complex global food systems, and economic productivity loss due to loss of working hours resulting from foodborne illnesses. Rapid urbanisation, public infrastructure deficits and unplanned growth in some cities, especially in developing countries, strain the urban food system. Also, patronising traditional open-air markets, especially in developing countries, increases the risk of spreading foodborne diseases. On the other hand, proper food safety practices in the household will safeguard against the spread of many foodborne diseases. Thus, urban households are essential stakeholders in the pursuit of safe food consumption. The chapter sought to answer the primary research question of the effect of household food safety knowledge on food safety cooking practices/behaviour of urban households. In addition, what is the effect of income as a moderating factor in the food safety knowledge and practice/behaviour relationship? The chapter relied mainly on primary data from the first round of household surveys under the NOURICITY project to address the research questions. The data was from three Ghanaian—Accra, Kumasi and Tamale—cities. We used a combination of descriptive analysis and SEM models to estimate the results.

We conclude that many urban households do not prioritise food safety as the primary consideration when choosing food markets. Other considerations other than food safety is the primary driver of consumers' choice of food markets. Only 18 percent of respondents considered food safety one of their top three considerations for the choice of market. Only 2 percent of respondents considered food safety their main reason for choosing a food market. Food safety is a public good, thus requiring government policy and regulations to protect consumers. Many food safety attributes are not readily observable during the purchase of food. Therefore, the government must set standards and a framework within which actors in the food system will comply and deliver safe and healthy foods to consumers.

We also conclude that convenience (68.6% of sampled households) in terms of proximity to markets and availability of all products at one location was the primary consideration for urban households for their choice of food markets. The next is lower prices (16.9% of sampled households). Economic considerations of reducing their transaction cost (e.g. transportation cost and time spent on food shopping) underline households' choice of market. Open markets remain the preferred food market for households because of the convenience and price of food products sold. Although there is upward growth in supermarkets, supermarket shopping for food products, especially fresh fruits and vegetables and some local food commodities, could be higher among respondents in the study areas.

We also confirm that although households are knowledgeable and have a positive attitude towards food safety, neither food safety knowledge nor attitude has a statistically significant effect on food safety cooking practices/behaviour. However, household wealth status positively affects food safety cooking behaviour (model 3), indicating that households' food safety cooking behaviour improves when in addition to appropriate food safety knowledge, households are economically better off.

The high demands on urban dwellers from the labour market, especially in big cities like our study areas (Reardon et al., 2021), have altered urban life and households' cooking practices and eating behaviour. The study's results show that the government's food safety regulations of the food value chain are required to ensure food safety. Ghana's food safety policy is nascent, so all actors must be committed to its implementation. With households' low priority of food safety when they choose food markets, we concur with the NFSP strategy to immediately establish the food safety surveillance system to monitor and track the safety of foods on the market, particularly raw/fresh food products and outbreaks of foodborne diseases. In addition, the FDA and other food safety agencies should activate the Social Behaviour Change Communication strategy contained in the NFSP. As households are not adequately practising what they know about food safety, a well-crafted and targeted communication strategy should nudge consumers into adopting and practising food safety measures in the home. The regulatory bodies can use market sensitisation drives, outreach to schools and social groups, radio and TV advertisements in multiple languages, and social influencers to deliver the message of practising food safety practices.

Chapter 3: Seasonality, food safety and dietary diversity in urban Ghana

3.1 Introduction

The current global food system cannot provide healthy and safe diets inclusively and sustainably (von Braun et al., 2023a). Poor diets account for a significant number of deaths, estimated, for instance, at 1-in-5 deaths in 2017. Suboptimal diet consumption accounts for more deaths than any other risk factor. Specifically, the low intake of whole grains and fruits and the high consumption of sodium accounted for more than 50 percent of the deaths related to diet (Afshin et al., 2019). Aside from the nutritional content and level of processing of foods, food safety has become a priority for consumers globally (Gizaw, 2019; HLPE, 2017; Uyttendaele et al., 2016). Food safety is the assurance that there are no adverse health effects from food prepared and consumed by an individual (Codex Alimentarius, 2020). There is an intricate and inextricable link between food and nutrition security and food safety (WHO, 2022a). There can be no food and nutrition security without food safety (FAO, 2019).

The above paragraph shows the interconnectivity of food and health in the well-being of society. The food and health systems overlap at multiple points (von Braun et al., 2023b). Healthy diets, safer foods, animal health, the environment and NCDs are some linkages between the food and health systems. These linkages crystallised in concepts like One Health that aim to "*sustainably balance and optimise the health of people, animals, and ecosystems...*" (Adisasmito et al., 2022). The nexus between the health of people, animals and ecosystems contributes to food systems' complexity. As food systems grow in length and complexity, consumer demands are equally growing in number and sophistication: coupled with improved incomes, consumers demand more food safety (Gizaw, 2019; HLPE, 2017; Uyttendaele et al., 2016). Every year, 600 million and 420,000 people fall ill and die, respectively, from eating contaminated food (WHO, 2015). The severity of unsafe food's effect on consumers highlights the need for food systems that can provide safe food.

Furthermore, environmental factors in the form of seasonal variations in rainfall and temperature compound the complexity of food systems. Therefore, weather seasonality is an environmental factor affecting food systems (Sibhatu & Qaim, 2017). Weather seasonality could influence household food consumption decisions, for example, via the availability of food varieties, food accessibility and price (Gilbert et al., 2017; Becquey et al., 2012). Weather seasonality affects these factors through different mechanisms. Seasonality tends to shape the dietary diversity of the household through both demand- and supply-side factors (FAO et al.,

2011). Although seasonal changes are a regular and expected phenomenon, households may need to be fully aware of the magnitude or intensity of a particular season and the degree to which it will affect their livelihoods. Thus, their adaptation strategies vary over time in order to smoothen consumption over the different seasons.

Weather seasonality and agricultural production are linked, especially in developing countries, because most agricultural production is rain-fed (Cooper et al., 2008; Rosegrant et al., 2002). Therefore, rainfall levels during planting and sunshine (temperature) during harvesting directly affect production levels and distribution of food products. Unlike rural areas, where most households depend significantly on their own production to meet their food consumption needs (Sibhatu & Qaim, 2017), most households in urban areas rely on purchased food to meet their needs (Frayne et al., 2014). Therefore, the mechanism through which seasonality affects household dietary diversity will vary between urban and rural areas. Further, depending on the level of market integration with the global food system, weather seasonality will affect the availability of some foods in the market and food prices (Gilbert et al., 2017).

Weather seasonality also affects food safety. Some foodborne diseases are linked to specific weather and climatic conditions and are prevalent at specific times of the year (Simpson et al., 2020; Lee et al., 2019; Smith et al., 2019; Liu et al., 2013; Smith et al., 2014; Tirado et al., 2010). For example, the *Salmonella* transmission risk increases with high rainfall (Lee et al., 2019). So open-air markets and street food vending, standard features (Gonzalez et al., 2014) of urban areas and the food system in developing countries can be environments where pathogens can easily find their way into food and water if not hygienically maintained.

Therefore, weather seasonality can affect health, food safety and household dietary diversity. In addition, weather seasonality can also affect the availability and accessibility of food products on the market. Therefore, this chapter explores the effects of weather seasonality on urban households' food safety, dietary diversity, and availability of food commodities in urban food markets. First, we test the hypothesis that seasonality does not affect household dietary diversity in urban areas with major food markets. Also, we test the hypothesis that weather seasonality affects households' food safety outcomes. Specifically, the chapter answers the following questions: What is the effect of seasonality on urban households' dietary diversity, food expenditure per capita and the incidence of diarrhoea/vomiting due to food consumed?

The structure of this chapter is as follows. Section 3.2 provides a related literature review on weather seasonality and its effect on malnutrition, dietary diversity and food safety. Section

3.3 presents the study's conceptual framework, while section 3.4 covers the study area, source of data and sampling design used in data collection. Section 3.5 presents the empirical strategy used to answer the research questions. Finally, section 3.6 and section 3.7 presents the empirical results and discussion, and conclusions of the study, respectively.

3.2 Literature review

3.2.1 Weather seasonality, dietary diversity and malnutrition

Some of the most devastating forms of undernutrition and poor eating occur during the "hunger season" of the year. Low food stocks, higher food prices and low employment characterise the hunger period. Households in most rural areas grapple with this annual challenge of food insecurity (Brugh et al., 2018; Audsley et al., 2010; Vaitla et al., 2009). Where food markets in urban areas depend on supply from rural food production systems, food prices suffer from seasonal fluctuations, affecting urban households' purchasing and consumption decisions (Hirvonen et al., 2016).

There are different pathways through which seasonality affects the malnutrition status of individuals and households. Although there is a body of literature on the effects of seasonal changes on food and nutrition security and malnutrition (Abizari et al., 2017; Sibhatu & Qaim, 2017; Hirvonen et al., 2016; Becquey et al., 2012; Hillbruner & Egan, 2008; Savy et al., 2006), especially in developing countries, the literature is skewed towards rural areas (Becquey et al., 2012; Hillbruner & Egan, 2008). However, some studies have examined seasonality and urban food and nutrition security in developing countries (Abay & Hirvonen, 2016; Hirvonen et al., 2016; Becquey et al., 2012; Hillbruner & Egan, 2008). The effects of seasonality are more predominant in rural areas than in urban areas. Notwithstanding, seasonality still significantly impacts urban dietary diversity and composition.

From the empirical literature, seasonality affects malnutrition in urban areas through dietary diversity and diet composition (Hirvonen et al., 2016; Becquey et al., 2012), availability and food commodity prices, loss of employment (Hillbruner & Egan, 2008) and illness. The intermediary outcomes of these effects are seasonal weight losses and changes in reproductive outcomes like insufficient weight gain during pregnancy and low birth weight (Panter-Brick, Lotstein & Ellison, 1993, cited in Savy et al., 2006). Low birth weights and stunting during childhood are potential risk factors for overweight and obesity later in life (FAO et al., 2018).

Also, in the lean season, even when food is available on the market, households, especially the urban poor, are priced out of most food commodities and their diet quality is compromised

(Vilar-Compte et al., 2021; Matz et al., 2015). As a result, they either reduce their consumption (Amendah et al., 2014; Birhane et al., 2014) or switch to other foods of low dietary diversity or high in fats and calories (Chege et al., 2021). In addition, households may engage in other coping strategies like the sale of assets and jewellery (Matz et al., 2015), deplete their savings and rely on social networks (Ansah et al., 2021); and in rural areas engage in off-farm activities and crop diversification (Tesfaye & Tirivayi, 2020; Babatunde & Qaim, 2010) for consumption smoothing.

Further, weather seasonality can affect household water, sanitation and hygiene (WASH) behaviour (Howard et al., 2020). Improper food handling, lack of clean water and improper sanitary conditions around food can all promote food contamination and illnesses like diarrhoea (Usman et al., 2019; WHO, 2017a; WHO, 2015). The population of some foodborne diseases increase with precipitation and temperature changes (Simpson et al., 2020; Lee et al., 2019; Smith et al., 2019). Hence, the continuous seasonal change through these multifaceted pathways has short- and long-term effects that potentially affect households' health outcomes, productivity, and national output.

3.2.2 Dietary diversity in urban areas

Rapid urbanisation in developing countries presents several development challenges, including infrastructure and public health challenges (World Economic Forum, 2015; Cohen, 2006). The Sustainable Development Goal (SDG) 11-sustainable cities and communities are some of the major global initiatives to enhance well-functioning, robust and sustainable cities (UN, 2015a). Urban households depend on purchased food for most of their food consumption needs (IFPRI, 2017). This makes the availability of markets an essential component of the urban food system. A well-integrated market connected to the global food system is needed to ensure a constant and stable food supply. Urban dwellers can benefit from a higher diversity of food products in markets connected to global food systems. Households that live in big cities that are well connected to global food systems and with higher income levels have higher dietary diversity (Kc et al., 2018). However, the pricing of food products in some of these markets can also be out of the reach of some urban dwellers (especially the urban poor and marginalised) and thus curtail their dietary diversity (Battersby & Peyton, 2014; Birhane et al., 2014).

Supermarkets are fast becoming regular features of food systems in developing countries (Reardon et al., 2021; Béné et al., 2019; Qaim, 2017; Reardon & Hopkins, 2006). Their impact on diet quality and diversity is mixed (Reardon et al., 2021; Otterbach et al., 2021; Debela et

al., 2020; Khonje et al., 2020; Rupa et al., 2019). For example, Rupa et al. (2019) showed that households in Vietnam with higher food expenditure share from supermarkets and hypermarkets do not translate into higher household dietary diversity because of higher exposure of households to more processed food. Also, in Demmler et al. (2018), regular supermarket food shopping is linked to increased adult body mass index (BMI) in urban Kenya. However, Debela et al. (2020) found that supermarkets affect child nutrition through the variety of products sold and dietary diversity in Kenya.

Linked to the growing presence of supermarkets in developing countries is the challenge of the food environment's unrestrained exposure of consumers to processed and ultra-processed foods, including sugar and sweets (Reardon et al., 2021; Otterbach et al., 2021; Khonje & Qaim, 2019; Popkin & Reardon, 2018; Hawkes, 2008). Children, especially children from poor households, are the most vulnerable to some of these foods. As a result, children from poor households consume less diversified foods and higher caloric diets and have a higher likelihood of experiencing future short and long-term food and nutrition insecurity (Frayne & McCordic, 2018; Drimie et al., 2013).

3.3 Conceptual framework

The conceptual framework of this chapter is presented in Figure 3.1. This study draws inspiration from the more detailed food system framework of von Braun et al. (2023b) and HLPE (2017). These studies highlight the overlaps and interconnectivity of the food system with other systems like health, energy, ecology and climate systems. This chapter highlights the linkages and relationships among seasonality, food safety-related illness (diarrhoea/vomiting), prices and household dietary diversity as components of the food system.

Seasonality is tracked to assess its effect on household food safety and dietary diversity. As presented in section 3.2.1, seasonality can directly affect household dietary diversity and household health status through food. Seasonality can also affect the household through food availability, accessibility and food safety in the market. For example, depending on the season, some food products are more (less) abundant than others, leading to increased (decreased) food availability, which can result in lower (higher) prices and, thus, more (less) food accessibility to households. Similarly, the activities of foodborne pathogens change (increase or decrease) under different environmental conditions (Simpson et al., 2020; Lee et al., 2019). For example, Lee et al. (2019) showed that under wet conditions, the activities of *Salmonella* increase.

Therefore, the risks of foodborne disease transmission in the markets and households are higher at specific times of the year.

Appropriate WASH behaviour can prevent many foodborne diseases. However, urban households in developing countries may struggle to access safe cooking and drinking water in the dry season, which can undermine their WASH behaviour. Inconsistent water supply and water security are a challenge in developing countries due to poor investment in infrastructure, including water and sanitation (Van der Bruggen et al., 2010). In addition, the risk of water contamination increases due to improper water and sanitation management (WHO & UNICEF, 2017). When consumed or used in food preparation, unsafe water can contain harmful microorganisms like E. coli, which can cause diarrhoea and food contamination (WHO, 2019b).

Also, covariate shocks like a pandemic or droughts can adversely affect livelihoods and inhibit food production and distribution to urban areas. Covid-19 is a major global covariate shock which started in 2019 and continued into 2020, leading to disruptions to global and local food systems, extended lockdowns in cities, loss of livelihoods, and morbidity and death of people. We explore the effect of Covid-19 on household dietary diversity and food expenditure. Households' access to formal and informal safety nets can improve households' resilience to shocks like Covid-19.

This study captures seasonality over two periods (dry and wet seasons). The first survey was in the dry season, and the second was in the rainy season. Food safety was measured based on the number of diarrhoea/vomiting cases recorded by the household due to food consumption. In addition, we used respondents' access to social safety nets, food availability and perception of changes in food prices to capture the effect of COVID-19 on the household.

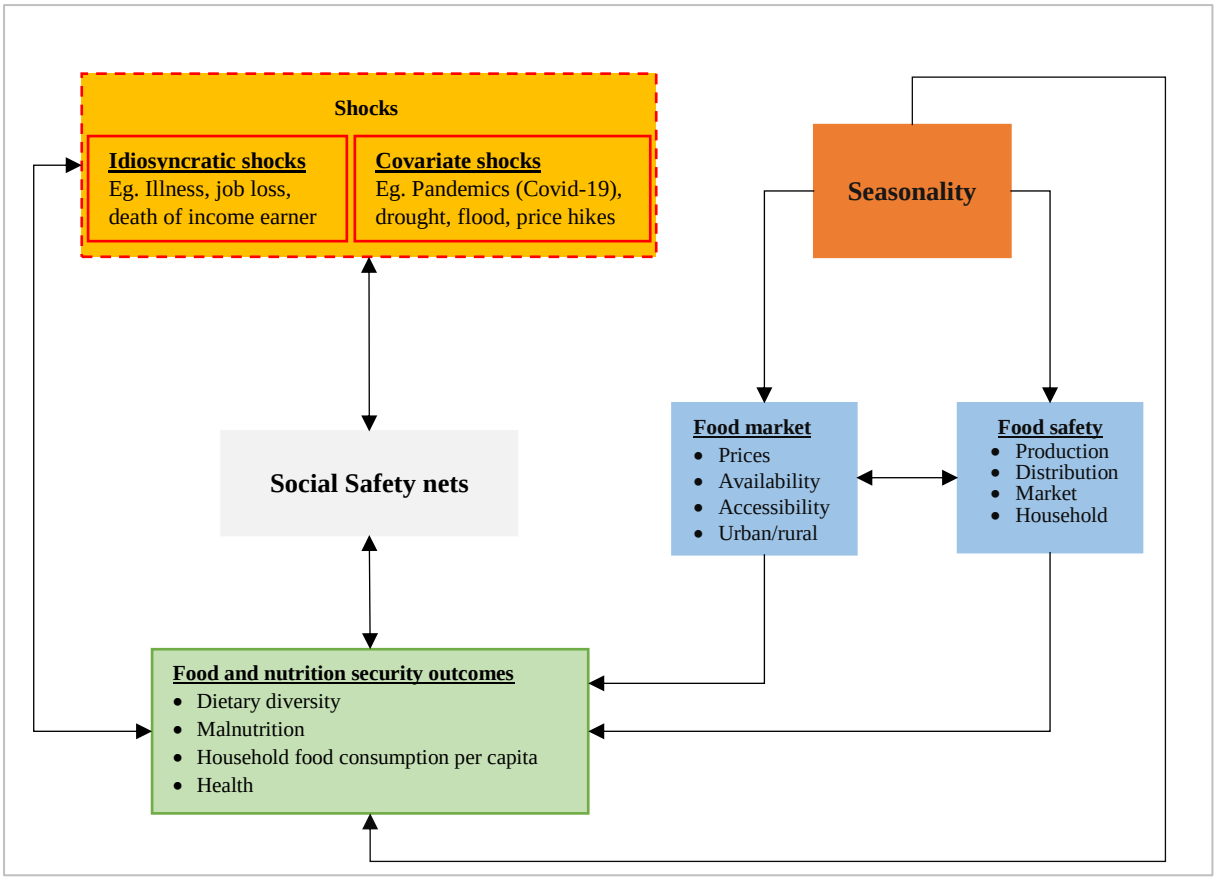


Figure 3.1: Conceptual framework showing the link between seasonality and household food security

3.4 Study area, data sources and sampling design

3.4.1 Study area for primary data collection

Primary data is relied on to address the research questions of this chapter. See section 2.4.1 and section 2.4.2 for a detailed description of the study area and sampling design, respectively.

3.4.2 Data used and sources

This chapter uses data from two (2) rounds of household and market surveys and fresh food microbial analysis. The household and market surveys were conducted in all three cities to explore the issues of food safety and nutrition, dietary diversity, and food consumption behaviour of households. Additionally, we conducted a food safety analysis to test the presence of some foodborne pathogens in food commodities sold in the Agbogbloshie market in the Accra metropolis. The microbial analysis assessed the presence and concentration of foodborne pathogens in the food commodities sold in the market. The combination of the different data sources provided different perspectives on the urban food system in Ghana. A panel was developed with two rounds of data collection (Table 3.1) to account for weather seasonality and how it affects dietary behaviour.

Table 3.1: Household and market attrition levels between rounds of data collection

Study sites	Round 1	Round 2	Attrition level (%)
Household survey			
Accra	216	175	18.98
Kumasi	240	218	9.17
Tamale	216	216	0.00
Total	**672**	**609**	**9.38**
Market survey			
Accra	205	179	12.68
Kumasi	200	164	18.00
Tamale	160	159	0.63
Total	**565**	**502**	**11.15**

Weather seasonality is an important variable affecting households' food and nutrition security and safety. Weather seasonality is linked to the cropping calendar in Ghana since agricultural activities are highly rainfall-dependent. There are two rainy seasons in the southern and middle parts (Accra and Kumasi) of Ghana-major season (April-June) and minor season (September-October) and in between the dry season. In northern Ghana, there is a single season. The rainy season is June-August, and the dry season is September-May. Therefore, we modelled the data collection after these distinct seasons (rainy and dry seasons). The first round of data collection was done in November-December 2019 (dry season). This is the harvest period for most staple foods in Ghana. The second round of data collection was conducted in June-July 2020 (rainy season). This is the primary cropping season for most crops. During the latter part of the rainy season, fruit and vegetables are more abundant than in the dry season: this has implications for the dietary diversity of households. Figure 3.2 presents the crop calendar of some staples in Ghana.

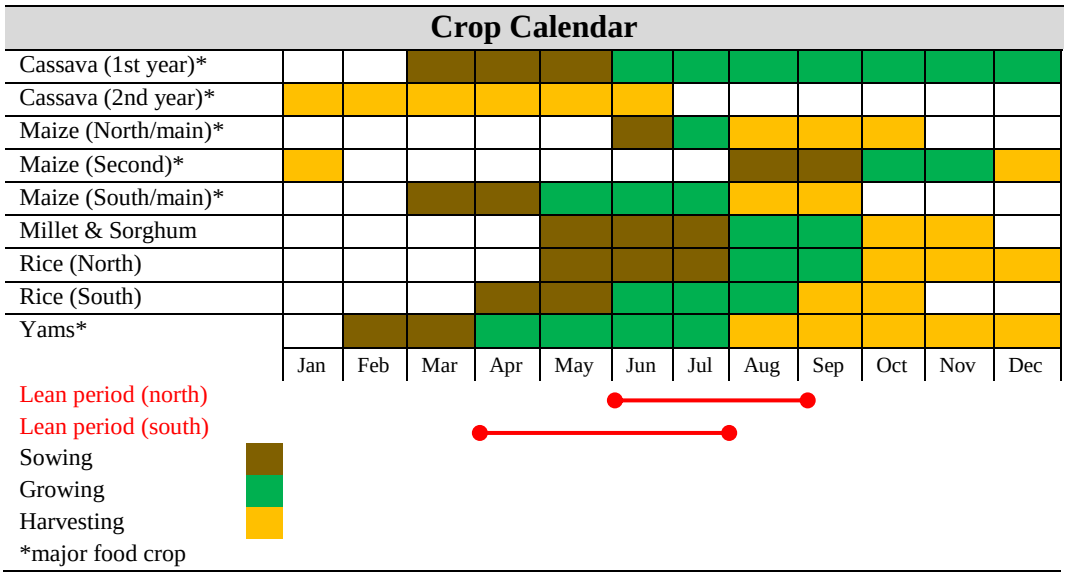


Figure 3.2: Crop calendar of some staples in Ghana
Source: FAO/GIEWS, FEWSNET, 2019

3.4.2.1 Attrition levels between rounds of data collection

The overall attrition levels for the household and market surveys are about 9 and 11 percent, respectively (Table 3.1). The period between the two rounds of data collection was about six months (November/December 2019 - June/July 2020). We interviewed all the households in Tamale across the two rounds. Accra had the highest attrition level for the household survey, about 19 percent. The reason for the high attrition level in Accra was that migrants from the northern part of Ghana dominated some of the Enumeration Areas (EAs) we surveyed. Therefore, during the outbreak of the Covid-19 pandemic, some households returned to the northern part of Ghana. These households are primarily young females who migrated to the south of Ghana for economic reasons. The migration of people, especially young people, from the north to the south of Ghana in search of better economic opportunities is well documented (Awumbila & Ardayfio-Schandorf, 2008). These people mostly settle in and around Old Fadama and Korle Dudor, which are part of our study areas in Accra. Unfortunately, they did not provide telephone numbers for follow-up telephone calls; thus, we could not trace them for the follow-up survey.

Similarly, due to higher Covid-19 incidence in Accra and Kumasi, local government authorities, compared to Tamale, imposed stricter restrictions. Initially, the Makola, Agbogbloshie and Kumasi Central markets were closed for fumigation, so some market women and men relocated to other towns and regions. Further, retailers had alternating days to come to the market to ensure social distancing. Additionally, parts of the Kumasi Central market were demolished to reconstruct modern structures. As a result, city authorities relocated the retailers to other parts of the market or satellite markets, and it was not easy to trace them. These reasons account for the high attrition level from the markets in Accra and Kumasi. On the other hand, market activities were less disrupted in Tamale because there was no lockdown in Tamale.

Household attrition group analysis

Households that did not participate in the second round of the survey (referred to as the "attrition group") have particular characteristics. Specifically, we compared their socioeconomic status (SES) and HDDS to the overall sample. Table A.9 presents the characteristics of the household attrition group. The attrition households were located in Accra and Kumasi only. About 71 percent (45 households) of the 63 households in the attrition group were female-headed (Table A.9). Out of the 45 attrition female-headed households, about 51 percent were in Accra and 20 percent in Kumasi. Given the disproportionally high number of

female (11) headed households, we focus on the female population of this group for further analysis. About 63 percent of the attrition female-headed households in Accra are single. The mean household size of single female-headed households (1.5) is lower than that of female-headed households (1.8). An indication that some of the single female-headed households have other dependents. Most female-headed households in the attrition group belong to the lowest category of the computed household wealth index.

Regarding HDDS, the attrition group had a lower mean HDDS of 5.7 compared to the overall group's HDDS of 6.9 (Table 3.2). Respondents who participated in both survey rounds had a higher mean HDDS of 7.0 in the first round. The largest attrition numbers were in Accra; the mean HDDS were 5.6 and 7.1 for the attrition and non-attrition groups, respectively.

Table 3.2: Mean HDDS of attrition group

	Accra		Kumasi		Tamale		Total	
Mean HDDS of	Mean	N	Mean	N	Mean	N	Mean	N
Households (round1)	6.810	216	7.025	240	6.907	216	6.918	672
Households (wave1&2)	7.091	175	7.151	218	6.907	216	7.048	609
Households (attri. group)	5.610	41	5.773	22	-	-	5.667	63
Households (attr. grp_female heads)	5.781	32	5.308	13	-	-	5.644	45

Source: Authors' computation, 2020

Households in the attrition group are among the lowest in the SES category. Most (47.6%) of female-headed households in the attrition group belong to the lower or lower-middle SES group (Table 3.3). In Accra, the majority (60%) of single-headed households are in the lower SES. Also, only 10 percent of single female-headed households are in the upper-middle or upper SES category.

Table 3.3: Female headed household and SES categorisation

% of female headed households among attrition households by SES	Accra	Kumasi	Total	N
Lower	26.98	6.35	33.33	63
Lower middle	9.52	4.76	14.29	63
Middle	7.94	3.17	11.11	63
Upper middle	4.76	1.59	6.35	63
Upper	1.59	4.76	6.35	63
Total	50.79	20.63	71.43	63
% of single female headed households by SES				
Lower	60.00	-	52.17	
Lower-middle	15.00	33.33	17.39	
Middle	15.00	-	13.04	
Upper middle	5.00	-	4.35	
Upper	5.00	66.67	13.04	
N	*20*	*3*	*23*	

Source: Authors' computation, 2020

For further analysis and estimation, we used a balanced panel of 609 households who participated in both survey rounds. Attrition tends to cause biased estimates (Montalbano et al., 2018; Michler & Josephson, 2017; Alderman et al., 2006). Thus, we did an attrition analysis to test the impact of household attrition on estimates. Attrition analysis was conducted for households in two out of the 3 study sites-Accra and Kumasi, because no household dropped out in Tamale. We performed a Probit analysis to determine the similarities between households participating in both surveys and those participating only in the first survey. We created a dummy variable (dependent variable), where households that participated in only survey 1 equal to 1 and 0 otherwise. We regressed all household characteristics of interest on the dummy attrition variable. The results show that households in only survey 1 have smaller household sizes, are younger and have lesser economic endowment (wealth index) compared to those who took part in survey 2 (p-value < 0.10). On all other characteristics of interest, the households are similar. Further, a test of the means of outcome variables of interest: HDDS and household food expenditure/capita also show that HDDS varies between attritors and non-attritors but household food expenditure/capita is not statistically different between attritors and non-attritors in Accra and Kumasi. The relative similarity between attritors and non-attritors in the outcome and household characteristics indicates that selective attrition on observables does not bias estimates if we use a balanced panel.

3.4.3 Sampling design and fresh food sample collection technique

In section 2.4.2, we presented the household and market survey sampling designs. This sub-section presents the sampling technique employed to collect food samples for the food safety microbial analysis.

3.4.3.1 Fresh food sample collection and testing

We performed a microbial analysis on selected vegetables and cereals from the Agbogbloshie market in Accra to determine the presence of some selected foodborne pathogens. We selected four (4) food commodities for analysis. The vegetables selected were tomatoes and cabbage, and the cereal and legumes were maize and groundnuts, respectively. The microbial analyses performed are total Coliform, *E. coli*, *Staphylococcus*, and *Salmonella* counts—also, detection tests for *Salmonella spp.* and *Listeria monocytogenes*. Further, given the high incidence of aflatoxins in cereals (Kumi et al., 2014), the maize and groundnut samples were tested for Aflatoxin B1 (AFB1) concentrations.

The movement of the food commodities was traced from when they arrived in the market from the farm to when the final retailer sold them. We traced and collected samples over several days. The food samples were collected at various stages (sampling points) when the food commodities arrived in the market. The first samples were collected immediately after the food trucks arrived at the market (when the trucks were offloading). We assume that samples collected at this stage will capture the conditions of the food commodities from the source of production through the transportation phase to the market. Therefore, we documented the wholesalers who received these goods on the first day. On the second day after the delivery day, we collected the second sample from wholesalers who received the commodities on the first day. The 2-day time span between the first and second samples captures the market conditions that affect the food commodities in the market (e.g. environment, sanitation and storage conditions). After another two days, we collected a final food sample from the retailers selling in smaller quantities (most customers buy from these sellers). These final samples are not necessarily from the initial trucks sampled, but they were samples bought by the retailers from similar trucks that delivered the food products on the same day the first samples were taken from the sampled trucks.

Table 3.4 presents the number of samples collected from the Agbogbloshie market. The testing of the food samples was conducted by and at the Noguchi Memorial Institute for Medical Research (NMIMR), University of Ghana. In total, 43 samples were collected and tested for selected food microbes. Also, twenty-three (23) samples were tested for Aflatoxin B1.

We could not increase the number of samples used in the microbial analysis because testing food samples is costly. Moreover, many foodborne pathogens affect food safety. Therefore, we focused on the common ones linked to sanitation, hygiene and storage. Unfortunately, due to budget constraints, this study could not collect samples from all three major markets surveyed in the study. Therefore, although the total number of food samples collected from the Agbogbloshie market is not nationally representative, it indicates the levels of foodborne pathogens present in food commodities sold in major food markets in Ghana.

Table 3.4: Total food samples tested for selected food pathogens

	Samples tested				
	Tomatoes	Cabbage	Maize	Groundnuts	Total
Microbial analysis	10	11	14	8	43
Aflatoxin B1			13	10	23

Source: NOURICITY, 2020

3.5 Empirical strategy

3.5.1 Measurement of key variables

Household Diarrhoea/vomiting incidence

We use self-reported incidence of diarrhoea/vomiting and illness from food consumed at home or outside the home as a proxy for food safety. This variable is computed as a dummy (1/0) and a count variable. The dummy variable is 1 for households with reported diarrhoea/vomiting or food illness recorded by any household member over the last month and 0 otherwise. Food safety as a count variable is the number of household members suffering diarrhoea/vomiting over the last month.

The author acknowledges that there are multiple causes and sources of diarrhoea (Kirk et al., 2015; WHO, 2015). However, contaminated food and water are the most common sources of diarrhoea (WHO, 2022a; WHO, 2019c). Furthermore, there is a positive correlation between food contamination and safety and the incidence of diarrhoea and vomiting (Larbi et al., 2021; Kapwata et al., 2018; Kirk et al., 2017).

Household dietary diversity score

Household Dietary Diversity Score (HDDS) is another one of the dependent variables of interest. It is the number of unique food groups the household consumes over a given period. The HDDS is based on a 24-hour recall period to improve the accuracy of the information collected. The HDDS consists of 12 food groups, which are their nutritional values-cereals; roots and tubers; vegetables; fruits; meat, poultry and offal; eggs; fish and seafood; pulses, legumes and nuts; milk and milk products; oil and fats; sugar and honey; and miscellaneous (e.g. condiments, coffee, tea). The HDDS ranges from 0-12 for each household, and the average HDDS for the sampled group will be the proportion of the sum of all HDDS to the total number of households sampled. In addition, the HDDS serves as a proxy to measure the socio-economic level of the household, given that a higher HDDS correlates positively with high-quality protein and household income (Swindale & Bilinsky, 2006).

Household food expenditure per capita

Household food expenditure per capita is another dependent variable of interest. This variable captures how much the household averagely spends on food needs per person over the last month. The higher the food expenditure per capita, the more likely the household will spend on more diversified and protein-based foods (Somé & Jones, 2018; Thorne-Lyman et al., 2010).

Household food expenditure per capita is the total food expenditure in the last month divided by the household size.

Other covariates of interest

We compute household food safety knowledge as a set of 11 true/false statements on household food safety knowledge. Each household's total score indicates the level of household food safety knowledge. The questions are from the WHO's "5 keys to safer foods" (WHO, 2006a). The next covariate is the average monthly prices of major staple crops in Ghana from 2013 to 2020. The prices are from the weekly food prices collected by ESOKO-Ghana from markets across the country, including the Agbogbloshie and Makola, Kumasi Central and Tamale Central markets. In addition, seasonality is a dummy variable (1/0), where 1 is the dry season (first survey), and 0 is the rainy season (second survey). Other variables include household characteristics like gender, age, education, marital status and employment status of household head; household size; household wealth status; and proportion of household members employed.

3.5.2 Seasonality, food safety and household dietary diversity in urban areas

There are different causes of household malnutrition (Abay & Hirvonen, 2016; de Pee et al., 2015; Müller & Krawinkel, 2005; Smith & Haddad, 2000). Critical among them are poor dietary diversity and illness. In addition, illnesses like diarrhoea result from poor environmental hygiene and water and food contamination. Therefore, to estimate the effect of seasonality on the incidence of diarrhoea/vomiting, HDDS and food expenditure per capita, we use the reduced form regression models of the following type:

$$y_{it} = \alpha_0 + \alpha_1 S_{it} + \alpha_2 \boldsymbol{X}_{it} + \alpha_3 \boldsymbol{P}_{it} + \epsilon_{it} \quad (1)$$

where y_{it} is the respective outcome variable—the incidence of diarrhoea/vomiting, HDDS and monthly food expenditure per capita. The incidence of diarrhoea/vomiting is both a dummy and a count variable, HDDS is a count variable, and food expenditure per capita is a continuous variable. Subscripts i and t denote household observation and time (survey round), respectively. Season (S) is a dummy variable: it is the main explanatory variable of interest. **P** is a vector of prices of the main staples in Ghana. **X** is a vector of household characteristics (gender, age, education, employment and marital status of household head; household size, wealth status, proportion of household members employed and household food safety knowledge). The coefficient α_1, measures the effect of seasonality on the outcome variables (the incidence of diarrhoea/vomiting, HDDS and monthly food expenditure per capita). We

used fixed effect models to control for unobserved time-invariant variables that may influence the outcome variables and other covariates.

To estimate the effect of seasonality on the incidence of diarrhoea/vomiting, if the incidence of diarrhoea/vomiting is a dummy variable, we use Correlated Random Effects (CRE) Probit model. The CRE Probit addresses the incidental parameter problem associated with using Probit fixed effects (Wooldridge & Zhu, 2020; Greene, 2003). The incidental parameter problem arises in panel data analysis when running a non-linear regression (e.g. Logit, Probit) and the time (T) dimension is small (e.g. survey period=2), and the number of observations (cross-sectional units) is large (N→ ∞). Under such circumstances, only a fixed number of time periods are available to estimate the unobserved heterogeneity parameters for each cross-sectional unit and thus result in inconsistent estimates (Wooldridge & Zhu, 2020; Cruz-Gonzalez et al., 2017). The CRE approach accommodates time-constant variables and fixed effects estimates on the time-varying covariates (Wooldridge, 2013; 2010). The CRE estimation can be expressed as follows:

$$y_{it} = \alpha + \beta x_{it} + \gamma \bar{x}_i + r_i + u_{it} \qquad (2)$$

where y_{it} is the incidence of diarrhoea/vomiting status for household i at time t, x_{it} is the time varying explanatory variables of households, $\bar{x}_i$ is time averages of the time varying explanatory variables, β is the fixed effects estimate, $(r_i + u_{it})$ is a composite error term, r_i is the time-constant unobservable variables, and u_{it} is the idiosyncratic error term. Adding the time averages $(\bar{x}_i)$ controls for the correlation between the unobserved effects (α_i) and the sequence$\{x_{it}: t = 1,2\}$ (Wooldridge, 2013; Mundlak, 1978).

Furthermore, we use the Poisson fixed effects model to estimate the count outcome variables (HDDS and the number of household members suffering diarrhoea/vomiting). For the effect of seasonality on HDDS (Islam et al., 2018; Kouser & Qaim, 2011; Silva & Tenreyro, 2011a; Silva & Tenreyro, 2011b), the Poisson model can be expressed as:

$$Prob(Y_{it} = y_{it}|X_{it}) = e^{-\lambda_{it}} \lambda_{it}^{y_{it}} / y_{it}! \qquad (3)$$

where y_{it} is the HDDS that varies across households (i) and over time(t). We assume the Poisson distribution to have a conditional mean (λ_{it}), which depends on a vector of exogenous variables (X_{it}). According to Cameron & Trivedi (2013), the conditional mean (λ_{it}) can be expressed as a log-linear model of the form:

$$In\ \lambda_{it} = \beta X_{it} + \gamma Z_i + \varepsilon_i + \mu_t \quad (4)$$

where X_{it} and Z_i are vectors of time-variant and time-invariant exogenous variables, with β and γ as the respective vectors of parameters to be estimated, ε_i represent unobserved household effects, and μ_t represents time-specific effects.

From equation (4), if the unobserved household effects (ε_i) are not correlated with any other covariate (X_{it} and Z_i), then we can use random effects panel estimators to achieve unbiased estimates (Kouser & Qaim, 2011; Cameron & Trivedi, 2013). However, although we assume that weather seasonality is not correlated to other unobserved household characteristics, the unobserved household characteristics may correlate with other covariates in our model. For example, households' skills, beliefs, culture and attitudes towards food and health may correlate with their dietary diversity decisions (HDDS) and other covariates like household food safety knowledge, employment and income. For example, higher income correlates with higher HDDS (Swindale & Bilinsky, 2006), and other household characteristics like education and skills affect employment type and income earnings. Under these conditions, the HDDS will partly depend on the unobserved variables leading to measurement error issues, endogeneity issues, and the estimated coefficients of HDDS suffer from selection bias (Islam et al., 2018; Kouser & Qaim, 2011). Therefore, we use household fixed effects to control for selection bias and eliminate time-invariant unobserved factors (Islam et al., 2018; Kouser & Qaim, 2011). Additionally, we use household wealth status instead of household income, which is less prone to endogeneity issues in the model (Muthini et al., 2020).

Regarding the effect of seasonality on monthly food expenditure per capita, we used linear (ordinary least squares [OLS]) fixed effects model for the estimation (Allison, 2009). We run pooled OLS and first-difference (FD) regressions for robustness checks. Using the pooled data can produce precise estimators under the appropriate assumptions, like a constant relationship over time between the dependent variable and some independent variables in the model. A drawback of the pooled data approach is that the OLS estimator can produce inconsistent estimates because of heterogeneity bias (Wooldridge, 2013). Furthermore, we expect similar results for the linear fixed effects and the first-difference regressions (Wooldridge, 2023).

For the robustness check for the effect of seasonality on the incidence of diarrhoea/vomiting, we run standard Probit regression for the pooled data. Additionally, when the incidence of diarrhoea/vomiting is a count variable, we run the standard Poisson on the pooled data, CRE Poisson and the Poisson pseudo-maximum likelihood estimator with multiple levels of fixed

effects (PPMLHDFE) for our estimation. We use the PPMLHDFE model because of the likelihood of a high number of households that did not experience diarrhoea/vomiting (high number of zeros) in our sample and the non-convergence of the Poisson fixed effects model (Correia et al., 2020). All regressions were done using STATA 15 (StataCorp, 2017).

3.6 Results and discussion

3.6.1 Summary statistics

3.6.1.1 Household summary statistics

Household demographics

Table 3.5 presents summary statistics of all households that participated in both surveys (N=609). About 52 percent of households are male-headed. Accra (38.9%) and Kumasi (38.1%) have relatively lower numbers of male-headed households. The average age of a household head is 47 years, with Accra (44 years) having averagely the youngest household head, compared to 51 years for household heads in Tamale. Unmarried (single) household heads constitute a relatively significant component of respondents in Accra and Kumasi. Out of this number, a disproportionate number are female. In Accra and Kumasi, 88 and 82 percent of unmarried household heads are female. The average household size is 3.9. Tamale has the highest number of household members, 5.0, compared to 3.4 and 3.3 for Accra and Kumasi, respectively. The average percentage of household members employed is less than 50 percent.

In summary, household characteristics vary across cities except for the employment status of household heads and the proportion of unmarried female household heads. Further, households in Tamale have the most male-headed households, oldest household heads, largest household sizes, and lowest number of single (unmarried) household heads. The above household characteristics are mainly in tandem with the latest round of the nationally representative survey of the Ghana Living Standards Survey 7 (GLSS 7). According to the GLSS 7 report (GSS, 2019), the national average household size is 3.8, with urban areas having an average size of 3.5. The national mean age of a household head is 44.2 years, and about 45.6 years in Accra.

Compound houses are the most common type of dwelling for households. About 67 percent of the total sample live in compound houses (Table 3.5). The majority of households live in either rented dwellings or family houses/dwellings belonging to other relatives (Table A.10). The majority of respondents in Accra (47.43%) and Tamale (43.06%) live in family houses/dwellings belonging to other relatives. The Accra result is unique to the specific study

area. Respondents in Kumasi (49.54%) mostly live in rented dwellings. According to the GLSS 7 report, nationally, about 57.3 percent of households live in compound houses, and 37.2 percent of households in urban areas live in rented dwellings.

Table 3.5: Household demographics

Variable	Accra	Kumasi	Tamale	Total	Diff. across sites (p-value)
Household head characteristics					
Male headed households (%)	38.86	38.07	84.26	52.08	0.000***
Age of household head (mean)	44.191	45.873	51.174	47.270	0.000***
Education level of household head (%)					0.000***
None	7.43	13.76	41.67	21.84	
Primary	15.43	9.63	1.85	8.54	
Secondary	72.00	68.35	36.11	57.96	
Tertiary	5.14	8.26	20.37	11.66	
Read &write in English (%)	69.14	63.30	50.00	60.26	0.0003***
Marital status of household head (%)					0.000***
Single	18.86	20.64	3.24	13.96	
Monogamous	45.71	50.92	76.39	58.46	
Polygamous	0.00	0.00	10.19	3.61	
Divorced	13.14	6.88	2.31	7.06	
Widowed	16.00	14.68	6.94	12.32	
Separated	5.14	6.42	0.93	4.11	
Cohabitation	1.14	0.46	0.00	0.49	
N	*(175)*	*(218)*	*(216)*	*(609)*	
Gender of unmarried household head (female=1)	87.88	82.22	85.71	84.71	0.7943
N	*(33)*	*(45)*	*(7)*	*(85)*	
Other household characteristics					
Household size (mean)	3.377	3.335	4.968	3.926	0.000***
% of household heads having employment	89.14	82.11	82.87	84.40	0.1203
Mean percent of household members employed	51.314	47.448	41.224	46.351	0.0017***
% of households living in compound houses	73.14	60.55	69.91	67.49	0.0191**
N	*(175)*	*(218)*	*(216)*	*(609)*	

+ANOVA conducted across study sites. *** p<0.01, ** p<0.05, * p<0.1

Source: Author's computation from household survey, 2020

HDDS and food expenditure per capita

Figure 3.3 and Table 3.6 present HDDS. Figure 3.3a presents the percentage of households consuming different numbers of food groups in the dry and rainy seasons. Most households consumed between 6 and 9 food groups during the two periods. However, HDDS in the rainy season (7.5) was statistically higher than in the dry season (7.0) (Table 3.6). The city-level analysis shows that Accra and Kumasi have similar and higher HDDS over the two periods compared to households in Tamale. For the specific food groups consumed (Figure 3.3b), cereal and cereal products, oils and fats, and sugar and honey products were consumed by more than 50 percent of households in both seasons. Most households also consumed white tubers and roots. The share of households that consumed oil and fats, and sugar and honey products increased by more than 10 percent in the rainy season. Similarly, the share of households that

consumed vegetables increased by about 9 percent in the rainy season. The share of households that consumed fruits, meat, offal and poultry, and dried beans, nuts and seeds were broadly similar between seasons.

Furthermore, the overall average monthly food expenditure per capita decreased in the rainy season, but this change was not statistically significant. Similarly, food expenditure per capita decreased in Kumasi and increased in Tamale in the rainy season, but they were not statistically significant. However, the decrease in Accra's average monthly food expenditure per capita was statistically significant. Accra's monthly food expenditure per capita decreased from GHS 256.7 in the dry season to GHS 176.2 in the rainy season.

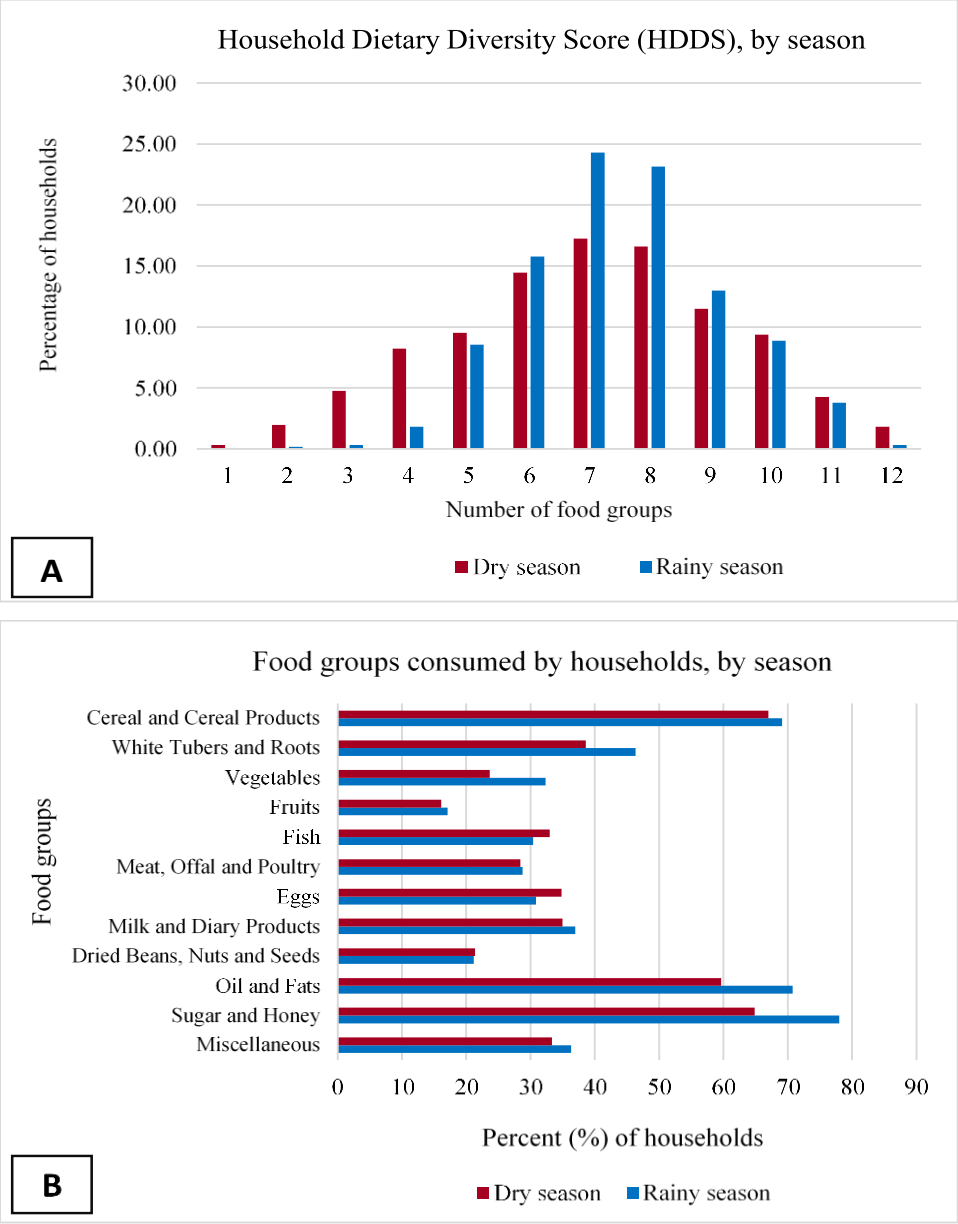


Figure 3.3: (a) Household Dietary Diversity Score; (b) Food groups consumed by households over the past 24 hours by season

Table 3.6: HDDS and food expenditure per capita by season and cities

Cities	Mean scores		Total	Diff. across surveys (survey 2-survey 1)
	Survey 1 (dry season)	Survey 2 (rainy season)		
HDDS				
Accra metropolis	7.091	7.577	7.334	0.486**
Kumasi metropolis	7.151	7.638	7.394	0.487**
Tamale metropolis	6.907	7.356	7.132	0.449**
Overall (N=609)	7.048	7.521	7.284	0.473***
Monthly food expenditure per capita (GHS)				
Accra metropolis	254.685	176.187	215.436	-78.498*
Kumasi metropolis	209.006	205.911	207.459	-3.095
Tamale metropolis	78.071	87.696	82.884	9.625
Overall (N=609)	175.70	155.44	165.567	-20.26

*** p<0.01, ** p<0.05, * p<0.1

Household health and diet

Table 3.7 presents households' self-reported illnesses related to food contamination. More households suffered diarrhoea or vomiting in the dry season than in the rainy season. About 9 and 8 percent of households suffered from diarrhoea or vomiting in the dry and rainy seasons, although this difference is not statistically significant. More households also suffer illnesses from consuming food away from home than home-cooked food. On average, 10 percent of households suffered from illnesses related to food consumed away from home compared to about 3 percent of households who suffered from illnesses related to food consumed at home. The difference in illness resulting from food consumed away from home and food consumed at home is statistically significant, indicating a lesser food safety status of food away from home. However, no statistical significance is observed in households' illnesses across survey rounds.

Table 3.7: Health and diet

	Survey 1 (dry season)	Survey 2 (rainy season)	Total	Diff. across surveys
Suffered diarrhoea or vomiting (%)	9.195	7.882	8.539	-1.313
Illness related to food consumed away from home (%)[a]	10.345	10.181	10.263	-0.164
Illness related to food consumed at home (%)[b]	2.299	2.956	2.627	0.657
Difference between (a-b)	8.046***	7.225***	7.635***	
Total number of households (N)	609	609	1218	

*** p<0.01, ** p<0.05, * p<0.1; t-test of diff. between illness resulting from food consumed away from home and food cooked at home are statistically significant.

Source: Author's computation, 2020

Household wealth index

The household wealth index was computed using Principal Component Analysis (PCA) (Vyas & Kumaranayake, 2006). The household wealth index was computed with 18 variables: they comprise non-productive assets, housing characteristics, and utilities (Table A.12 and Table A.13). PCA scores were computed based on each study site, so we did not have to apply weights to the index since they were generated within each scale or study site. Thus, the scale reflects the variation in the wealth status of households within each study site. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and the Bartlett test of sphericity were conducted to test the appropriateness of the variables used to compute the wealth index (Table A.11). KMO values vary between 0 and 1. The values that are closer to 1 are better. A value greater than 0.5 is a suggested minimum acceptable value (Hair et al., 2010; Kaiser, 1974). The obtained KMO value is 0.756 and is considered satisfactory. Also, based on Kaiser's characterisation of KMO values (Kaiser, 1974), 0.70 to 0.79 is considered middling (average), which is satisfactory enough to proceed with the analysis. Further, from the Bartlett test of sphericity, we reject the null hypothesis that the variables used to compute the wealth index are orthogonal. Thus, the dataset to compute the wealth index of households is suitable for its purpose.

The overall asset ownership ranged from as low as about 10 percent (laptop) to as high as about 95 percent (mobile phone) (Table A.12). Mobile phone ownership is high across the wealth quintiles (socioeconomic status-SES). It ranged between 76 percent of lower SES households to 100 percent of upper SES households. Also, using gas/LPG/Biogas for cooking is very low among households except for households in the upper-middle and upper SES quintiles. Ownership of residential land is also very low among households. It ranged between 8 percent and 20 percent for lower and upper SES quintiles, respectively. An intra-SES analysis (Table 3.8) of the overall sample shows that within each SES, except for the lower SES (60.2 %), lesser proportions (<50%) of female-headed households are in the higher SES categories: this implies that more male-headed households are in, the higher SES categories than female-headed households. This indicates that male-headed households are relatively wealthier than female-headed households.

Table 3.8: SES quintiles and proportion of female headed households

SES quintiles	Total sample	
	%	N
% of female headed households in		
Lower	60.19	108
Lower-middle	46.92	130
Middle	41.74	115
Upper-middle	38.58	127
Upper	41.09	129
Total number of households		609

Source: Author's computation, 2020

Households and livelihoods during Covid-19

Before the commencement of the second round of household and market surveys, there was a partial lockdown in Ghana due to Covid-19. This sub-section presents a descriptive analysis of how households' income was affected and whether households had access to any social safety nets. The results show that food availability was not a challenge for urban households. Over 95 percent of households indicated that staples and fresh food items were available in the market (Table 3.9). About 55 percent of households had members who lost their jobs or had reduced salaries/sales/revenue. About 24 and 58 percent of households had members who lost their source of income and had reduced income, respectively, due to Covid-19. About 18 percent of households received cash transfers from the government or family/friends. More households relied on income support from family and friends than the government.

From the overall results, the livelihoods of households deteriorated during Covid-19. Covariate shocks like Covid-19 disrupt livelihoods, resulting in job losses and reduced income (FAO et al., 2021; von Braun et al., 2023b; Gitz et al., 2016; Lipper et al., 2014). Ghana's primary formal social protection programme—the Livelihood Empowerment Against Poverty (LEAP) programme, currently covers about 350,000 households (UNICEF, 2022). It provides bimonthly cash transfers to the very poor in society who do not have any opportunity to engage in economic activity (Ghana LEAP, 2018). Therefore, most households in urban areas are not beneficiaries of this programme. Thus, the government provided free water and electricity for households below the lifeline threshold and partial subsidies for the rest of the population to cushion their household budgets during the Covid-19 outbreak (Schotte et al., 2021).

Table 3.9: Food availability and household livelihood during Covid-19

	%	N
Availability of items in the market (March-May, 2020)		
Basic food[1]	96.39	609
Fresh food items[2]	97.04	609
Lost job or reduced salaries/revenues (March-May, 2020)	55.17	609
Household members not earning income due to Covid-19 as at June 2020	24.47	609
Household members have reduced income due to Covid19 as at June 2020	57.64	609
Main income source		
Support from families and friends	11.17	609
Government assistance/social safety nets	0.33	609
Received cash transfer from government/family/friends in May 2020	17.57	609

[1]Basic/staple food items (eg. maize, rice, gari, beans, millet, etc);

[2]Fresh food items (eg. eggs, meat, vegetables, fruits, etc)

3.6.1.2 Retail data summary statistics

About 89 percent of the respondents in the market survey are women (Table 3.10). The average age of respondents is about 44 years. About 23 percent of the retailers still need to get formal education. This percentage is exceptionally high in Tamale, where about 52 percent of respondents still need formal education. Retailers in Accra have the highest proportion of migrants from other parts of the country. On average, respondents have been engaged in their retail business for 15 years. Small retailers form the majority of respondents in the survey. Small retailers are immobile sellers selling their food products on the floor and other materials (mats, paper and polythene) and table tops. The average expenditure per customer among small retailers is GHS14.35.

Most small retailers source their fruits and vegetables, cereals, meat and starchy staples locally. Further analysis of the products sold shows that a predominant share of processed food products is imported. In contrast, the fresh and minimally processed ones come from domestic sources. Due to high transportation and renting of trading spot costs, coupled with high food spoilage, most retailers purchase just enough stock to sell for the day. Therefore, they source most of their food products from within the market from distributors/transporters who bring the products directly to the market.

Respondents can access waste disposal bins, toilet facilities and running water in the various markets. However, only 24 percent of respondents in the Tamale market have access to running water. In addition, market supervision by health and sanitation officers of the local assembly is low. About 42 percent of respondents have never received any form of visitation from any sanitation officer since they started operating their business at their current location.

Regarding awareness of food safety issues related to the main products sold, the results show that more than 55 percent of retailers know at least one safety measure about the products they sell (Table 3.11). However, there are variations in the level of awareness among sellers of different products in Accra, Kumasi and Tamale. Higher proportions of sellers of meat products, pulses and vegetables are aware of the food safety issues related to the products they sell. Further analysis of these food safety issues shows that they are mostly related to food preservation and how to maintain a longer shelf life of the products. This indicates that retailers are mainly driven by profit motives and not necessarily safety concerns. For example, most tomato sellers indicated that "heat" (high temperatures) is unsuitable for tomatoes, so they ensure they store their products in cool and ventilated places. Yam sellers also spoke about heat, making their yams quickly rotten.

On the other hand, sellers of cereals and dry pulses were concerned about moisture. They mentioned that a moist environment makes moulds develop on their products and decreases their shelf life, so they have to wrap their products and keep them on shelves to avoid contact with moisture and dust. Only one cabbage seller indicated that too much application of chemicals in the farming of cabbage contributes to the quick spoilage of the product.

Table 3.10: Retail respondents' summary statistics

Variable	Accra	Kumasi	Tamale	Total
% female respondents	92.68	89.00	82.50	88.50
Age(mean)	44.59	44.52	41.31	43.64
% respondents with no education	12.68	11.50	51.88	23.36
% respondents who migrated to current location to do business	34.63	4.00	6.88	15.93
Average length of doing business (years)	13.61	15.60	14.46	14.55
N	*205*	*200*	*160*	*565*
Average purchase per customer (small retailers) [GHS]	15.28	13.51	14.28	14.35
Do you have access to: (%)				
Waste disposal	78.54	66.50	63.75	70.09
Toilet facilities	90.73	80.50	88.75	86.55
Running water	80.00	61.50	23.75	57.52
Visit from sanitation officers/inspectors (%)				
Never	29.76	47.00	51.25	41.95
Annually	32.20	13.00	16.25	20.88
Monthly	18.05	16.00	6.25	13.98
Weekly	6.83	6.00	12.50	8.14
Quarterly	7.32	8.00	5.63	7.08
Daily	1.95	9.00	1.88	4.42
Bi-annually	3.41	0.50	3.13	2.30
Fortnightly	0.49	0.50	3.13	1.24
N	*205*	*200*	*160*	*565*
Source of primary product sold (%)				
Within the market	42.93	65.50	29.38	47.08
Other sellers within the region	21.46	12.00	22.50	13.81
Other sellers outside the region	8.29	7.00	12.50	13.63
Other sellers within this community	14.63	7.50	16.25	12.57
Own production	10.24	7.50	14.38	10.44
Outside the country	2.44	0.50	3.13	1.95
Others	0.00	0.00	1.88	0.53
N	*205*	*200*	*160*	*565*
Most important cost constrain (%)				
Transportation	44.39	48.00	32.50	42.30
Staffing (wages)	1.95	0.00	0.00	0.71
Storage	6.34	10.50	10.00	8.85
Spoilage	12.68	17.00	18.13	15.75
Debts	9.27	6.50	14.37	9.73
Rent of trading spot	11.71	13.50	11.25	12.21
Rent of living space	0.98	0.00	1.25	0.71
Electricity	11.71	3.00	3.75	6.37
Other	0.98	1.50	8.75	3.36
N	*205*	*200*	*160*	*565*

Note: Results based on round 1 data. Questions in this table were not captured in round 2

Table 3.11: Awareness (self-reported) of food safety issues linked to main food product sold

	Accra		Kumasi		Tamale		Total		*p-value*
	%	N	%	N	%	N	%	N	
% of …retailers									
Vegetables	45.8	48	56.4	55	78.2	37	58.57	140	0.0090***
Fruits	33.3	3	47.1	17	71.4	7	51.85	27	0.4708
Roots/tubers/plantain	28.6	14	51.9	27	88.2	17	56.90	58	0.0021***
Dry grains	62.5	16	47.4	19	57.9	19	55.56	54	0.6608
Pulses	50.0	6	28.6	14	100.0	12	59.38	32	0.0003***
Starchy staples	55.6	18	20.0	10	81.8	11	53.85	39	0.0152**
Meat (fresh meat)	37.5	8	70.0	10	77.8	9	62.96	27	0.2110
Total	46.90	113	49.34	152	78.57	112	57.29	377	0.0000***

Note: ANOVA conducted across cities. *** p<0.01, ** p<0.05, * p<0.1

3.6.1.3 Food safety and foodborne microbial analysis

In addition to retailers' self-reported awareness of food safety issues, a microbial analysis was performed on selected vegetables and cereals from the Agbogbloshie market in Accra to determine the presence of some selected foodborne pathogens. Therefore, the results presented in this section are indicative rather than representative of the potential foodborne pathogens associated with the selected food commodities in major food markets in cities in Ghana.

From the microbial analysis (Table 3.12), no *Salmonella* spp. was enumerated from cabbage, tomatoes, maize or groundnut samples. Similarly, no *E. coli* was enumerated from cabbage, tomatoes and groundnut samples except for maize. One maize sample from a wholesaler had an *E. coli* level of 1.71 log cfu/25g. *Staphylococcus aureus* was seen in the sampled cabbage from one of the trucks and a groundnut wholesaler. *Listeria spp.* and *Salmonella spp.* were not detected in any of the 43 samples tested. However, *Enterococcus faecalis* was observed in one maize sample from a wholesaler, a tomato wholesaler and retailer, and groundnuts from a truck. The presence of *Enterococcus faecalis* in these samples is indicative of faecal contamination. The evidence of faecal matter contamination in some food samples raises concerns about the type of water used for cultivating vegetables, the personal hygiene of the transporters and the vehicles in which these products are transported and the hygiene and sanitation conditions that pertain in the market. *E. coli* and *Enterococcus faecalis* are linked to cholera and diarrhoea occurrences (Kirk et al., 2015).

Similarly, maize and groundnut products contained high levels of aflatoxins (AFB1). The European Union (EU) has set a limit of 5.0 ppb for AFB1 in maize meant for human

consumption. In comparison, groundnuts have a limit of 2.0 ppb for direct consumption and 8.0 ppb for those undergoing sorting and other physical treatment (European Union, 2023). According to Ghana's National Policy for Aflatoxin Control in Food and Feed (NPACFF), Ghana has not set aflatoxin-acceptable limits for all food items (GoG, 2022). However, it has set the limit for groundnuts to be 5.0 ppb. The results show that only one out of the thirteen maize samples had AFB1 levels below 5.0 ppb—maize sample from a truck had AFB1 value of 4.9 ppb—while all groundnut samples exceeded the limits of 2.0 ppb and 8.0 ppb, except for one sample from a groundnut retailer with an AFB1 value of 6.8 ppb.

If these food products are used for food and animal feed, the US Food and Drugs Administration (FDA-US) has set a permissible limit of 20.0 ppb for total aflatoxin (AFB1, AFB2, G1, G2) (FDA-US, 2013; Cai et al., 2020). However, some samples had only AFB1 levels exceeding 20.0 ppb. Three of the thirteen maize samples (23.1% of total samples) had AFB1 concentrations above the permissible limit of 20.0 ppb. One of the wholesalers who processed maize into corn dough[1] had an AFB1 concentration level of 23.1 ppb, while two of the three maize retail samples had AFB1 concentrations of 25.3 ppb (corn dough) and 33.4 ppb (maize grains). The presence of high aflatoxin levels in maize at different sampling points shows that aflatoxin contamination can occur at any stage of the supply chain if the products are not correctly handled. This is because samples taken from all three trucks had AFB1 concentrations less than 20.0 ppb, but as the products were stored with other bags of maize and processed into corn dough, higher aflatoxin contamination occurred. Mixing different sacks of maize from different sources during storage can lead to contaminated maize, affecting good maize that may have arrived from the farm. Similarly, one out of ten groundnut samples had AFB1 above 20.0 ppb—a sample from one of the groundnut trucks had an AFB1 level of 27.3 ppb. This indicates that aflatoxin contamination occurs during the production and transportation stages of the supply chain. The other raw, roasted, and paste groundnut samples had AFB1 levels lower than 20.0 ppb.

The presence of dangerous foodborne pathogens in some of the food samples, coupled with the about 30 percent of sampled retailers in the Agbogbloshie market who have limited visits from market sanitation officers, raises questions about food safety. Therefore, it places a higher burden on households to ensure the utmost food safety when handling food purchased from traditional open-air markets in Ghana. Thus, it is unsurprising that about 9 and 8 percent of all

[1] Corn dough is maize that is soaked in water for about 2 days, drained and milled into fine flour

households sampled (Table 3.7) reported suffering diarrhoea or vomiting in the dry and rainy seasons, respectively. About 10 percent of households surveyed in Accra suffered from diarrhoea or vomiting, and 17 percent suffered illness related to food consumed away from home during the dry season.

Table 3.12: Presence of selected foodborne pathogens in selected purchased food commodities

A			**Microbial levels**		
Commodity	**Sampling Point**	**No. of samples tested**	***E. coli*** (log cfu/25g)	***Staphylococcus* spp.** (log cfu/25g)	***Salmonella* spp.** (log cfu/25g)
Cabbage	Trucks	3	0.00	**3.99**	0.00
	Wholesalers	4	0.00	0.00	0.00
	Retailers	4	0.00	0.00	0.00
Tomatoes	Trucks	3	0.00	0.00	0.00
	Wholesalers	3	0.00	0.00	0.00
	Retailers	4	0.00	0.00	0.00
Maize	Trucks	3	0.00	0.00	0.00
	Wholesalers	7	**1.71**	0.00	0.00
	Retailers	3	0.00	0.00	0.00
Groundnuts	Trucks	3	0.00	0.00	0.00
	Wholesalers	1	0.00	**3.00**	0.00
	Retailers	4	0.00	0.00	0.00

B			**Aflatoxin B1 contamination**		
Commodity	**Sampling Point**	**No. of samples tested**	**No. of samples with AFB1 permissible limits**		
			(>5.0 ppb)[a]	**(>8.0 ppb)[a]**	**(>20.0 ppb)[b]**
Maize	Trucks	4	3		0
	Wholesalers	6	6		1
	Retailers	3	3		2
Total		**13**	**12**		**3**
Groundnuts	Trucks	3	3	3	1
	Wholesalers	2	2	2	0
	Retailers	5	5	4	0
Total		**10**	**10**	**9**	**1**

[a] EU Commission Regulation (EU) 2023/915 of 25 April 2023 on maximum levels for certain contaminants in food and repealing Regulation (EC) No 1881/2006 has set the permissible limit at less than 5.0 ppb for maize, less than 2.0 ppb for groundnut for direct consumption and less than 8.0 ppb for groundnut subjected to sorting and other physical treatment

[b] US Food and Drugs Administration set the total aflatoxin action limit to food and feed at 20.0 ppb

Source: Summary based on results of samples tested at NMIMR

3.6.1.4 Seasonality and price of food commodities

From Figure 3.4, the price (adjusted for annual CPI-2018) of food commodities fluctuated between 2013 and 2020. However, the level of fluctuation is food commodity specific. Over the period, the unit price of maize is lower and less volatile than the unit price of tomatoes. In addition to the fluctuating food prices, they also show some seasonal trends (Figure 3.5). Prices

of maize, cassava and rice show lower seasonal trends than yam, plantain and tomatoes. The regional analysis shows that the prices are generally lower in Tamale than in Accra and Kumasi (Figure A.1). Food price volatility is a significant issue in Ghana (Abokyi et al., 2018; Amikuzuno, 2009). Critical causes include high dependence on rain-fed agriculture, poor storage facilities and lack of value addition and processing. Therefore, producers quickly flood the market with their products when they harvest to minimise spoilage (e.g. perishables like tomatoes), resulting in oversupply and a sharp fall in prices. Also, in the lean season, the food supply is low, resulting in the prices of food products rising sharply.

Further, there is a growing demand for staples like maize for other purposes besides food. For example, there is a growing demand from the poultry industry for maize as feed (Andam et al., 2017), which puts much pressure on the price of maize in the market. The effect of these price changes on households in urban areas buying most of their food commodities from the market is likely higher than their rural counterparts. Therefore, weather seasonality affects food prices, leading to potential household food accessibility and dietary diversity challenges (Kaminski et al., 2014).

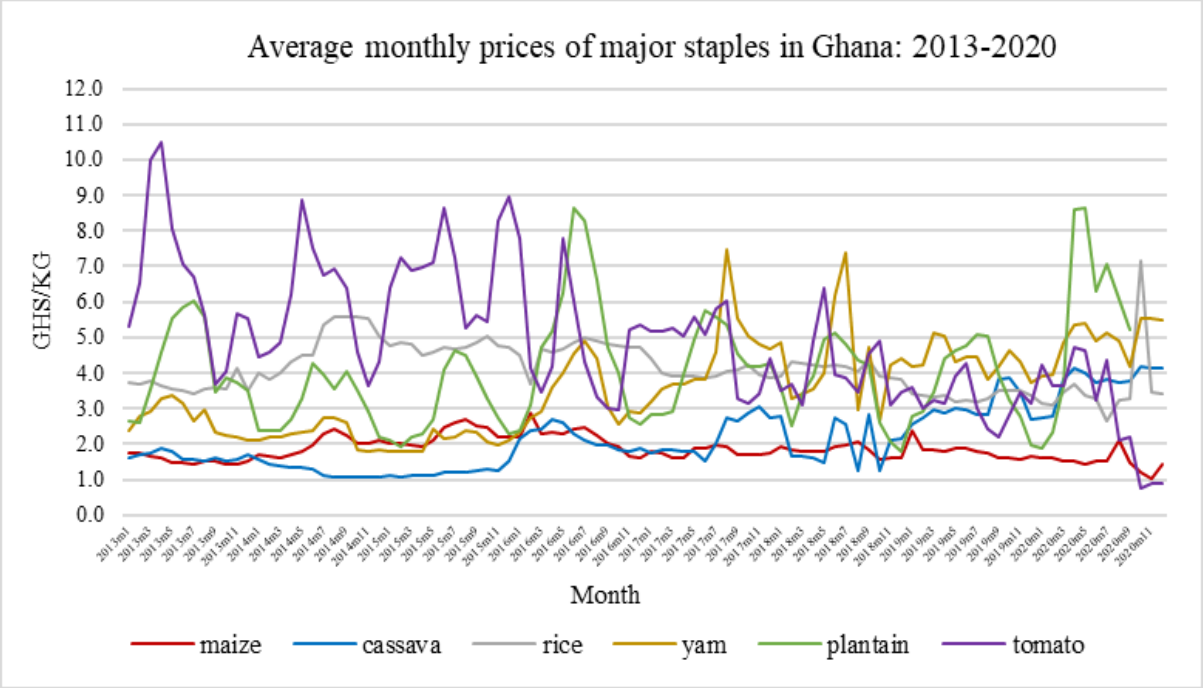


Figure 3.4: Real price trend of major food staples in Ghana, 2013-2020
Source: Authors' construction, 2021. Data from ESOKO-Ghana

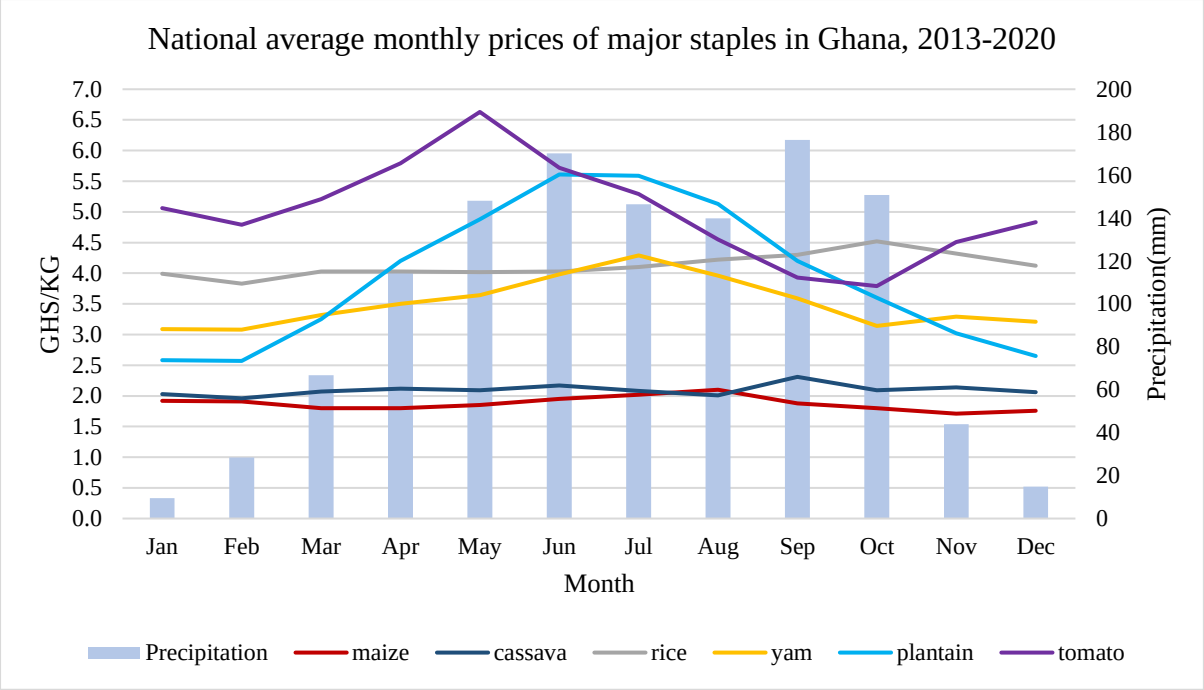


Figure 3.5: National average monthly prices of major food staples in Ghana, 2013-2020
Source: Authors' construction, 2021. Price data from ESOKO-Ghana. Precipitation data from Ghana - Summary | Climate Change Knowledge Portal (worldbank.org), 10/03/2023

The price changes due to Covid-19 effects can be computed based on the difference between the current price changes between seasons and the historical price changes between seasons before the outbreak of Covid-19 in Ghana. In the absence of this price data of food commodities from the selected markets, a dummy variable is created based on the purchasing experience of respondents when they purchased food commodities from the selected markets during the Covid-19 period.

Covid-19 seemingly had different levels of effects on different food commodities (Table 3.13). About 51 percent of respondents attribute the changes in prices of staple foods (maize, rice, gari, millet, yam, cassava, beans, and sorghum) to Covid-19. However, only 31 percent attribute the changes in the price of fruits and vegetables (tomatoes, onions, kontomire, jute mallow, bra, cabbage, banana and watermelons) to Covid-19.

Table 3.13: Perceived source of price changes

Perceived source of price changes	Staple foods (%)	Fruits and vegetable (%)
No price change	9.20	18.72
Seasonal price changes	36.95	47.29
Covid-19 effect	51.40	30.54
Both seasonal and Covid-19 effect	2.45	3.45
N	609	609

Source: Authors' computation, 2022

3.6.2 Effect of seasonality on household incidence of diarrhoea/vomiting

As earlier acknowledged, diarrhoea in the household is attributable to several causes. However, contaminated food and water are the primary causes of diarrhoea in many households (WHO, 2022a; WHO, 2022b). Thus, controlling for water usage in the household, use of improved toilet facilities, sharing of toilet facilities and food safety knowledge of households, the incidence of diarrhoea can serve as a good proxy for household food safety. It is important to note that we did not include access to improved water sources as a variable in the estimations. About 95 percent of households sampled have access to improved water sources (piped household water connection, public standpipe or a borehole). However, its availability can be inconsistent, so households must store water in the house. Therefore, the high proportion of households with access to improved water sources will not provide the needed variation in the estimation. The other sanitation variables mentioned were accounted for in the computation of household wealth status. We also did not include in the estimations the personal underlying health conditions of household members.

Table 3.14 presents the results of Correlated Random Effects (CRE) Probit estimations. From the analysis, weather seasonality affects the incidence of diarrhoea/vomiting among urban households when controlling for household fixed effects (Table 3.14). Columns 1 and 2 present the regression results with and without households' self-reported effect of Covid-19 on food prices, respectively. The results show that the incidence of diarrhoea/vomiting in sampled urban households is higher in the dry season compared to the rainy season. The results show that all things equal, in the dry season, the incidence of diarrhoea/vomiting increases averagely by a probability of 38 percentage points compared to in the rainy season. The literature on diarrhoea infections in Ghana shows that diarrhoea is seasonal and that children are the most vulnerable.

Previous studies in Ghana (Avoka et al., 2021; Tetteh et al., 2018; Enweronu-Laryea et al., 2014) are in tandem with our results that the incidence of diarrhoea is higher in the dry season and also influenced by the wealth status of households and source of food purchases (Larbi et al., 2021). The seasonal incidence of diarrhoea is also consistent with the literature that shows that the quantity of water supply and water availability to households strongly affects their WASH behaviour and health outcomes (Howard et al., 2020; Usman et al., 2019; Tucker et al., 2014; Howard et al., 2003). So, constant safe water supply improves households' WASH behaviour and health outcomes. Our findings are inconsistent with studies by Anyorikeya et al.

(2016) and Asamoah et al. (2016), who found the incidence of diarrhoea to be higher during the rainy season in their study areas.

The results also show that the incidence of diarrhoea/vomiting varies across household heads' educational levels. The incidence of diarrhoea/vomiting is lower among households whose heads have a higher level of formal education compared to households whose heads have no formal education. Kumi-Kyereme and Amo-Adjei (2016) found that in Ghana, children in households with higher wealth status and mothers with higher formal education had lesser odds of suffering from diarrhoea. Generally, socioeconomic disparities significantly influence households' access to resources, including healthcare. Therefore, as households' socioeconomic status (including wealth status, education) improves, incidences of diarrhoea are likely to decline (Sumampouw et al., 2019; Alirol et al., 2011).

Furthermore, the results also show that the price of maize is positively associated with the incidence of diarrhoea/vomiting. All things equal, a one-unit change in the price of maize averagely increases the probability of the incidence of diarrhoea/vomiting by 160 percentage points. The incidence of diarrhoea/vomiting is higher in households that said Covid-19 affected the price of staple foods than those who did not. The contrary was observed for households who said Covid-19 affected the prices of vegetables. Increases in the price of staple foods like maize imply that food-insecure households adopt coping strategies that may compromise their food quality. Consuming low-quality food is a significant food security coping strategy adopted by food-insecure households (Farzana et al., 2017). Low-quality food may be sold cheaper, but it could be contaminated and, thus, unsafe for consumption.

Table 3.14: Effect of seasonality on households' incidence of diarrhoea/vomiting

Variables	1		2	
	Coef.	*AME*	Coef.	*AME*
Season (Dry)	2.499**	0.378***	2.453**	0.383***
	(1.061)	(0.134)	(1.034)	(0.134)
Characteristics of household				
Age of household head	0.005	0.001	0.019	0.003
	(0.053)	(0.007)	(0.054)	(0.007)
Sex of household head (male)	-0.838	-0.126	-1.271	-0.209
	(0.823)	(0.141)	(0.852)	(0.164)
Household size	0.036	0.005	0.016	0.002
	(0.164)	(0.022)	(0.166)	(0.023)
Education of household head[*]				
Primary	-5.608***	-0.158***	-4.991**	-0.158***
	(2.021)	(0.008)	(1.957)	(0.008)
Secondary	-1.872	-0.330	-0.966	-0.155
	(1.728)	(0.329)	(1.600)	(0.303)
Tertiary	0.199	0.029	0.991	0.205
	(2.526)	(0.406)	(2.443)	(0.671)
Household wealth status				
Lower-middle	0.017	0.002	-0.078	-0.010
	(0.302)	(0.041)	(0.298)	(0.039)
Middle	-0.167	-0.021	-0.204	-0.026
	(0.349)	(0.042)	(0.346)	(0.041)
Upper-middle	-0.425	-0.049	-0.445	-0.051
	(0.382)	(0.037)	(0.386)	(0.037)
Upper	0.125	0.018	0.152	0.022
	(0.466)	(0.068)	(0.466)	(0.071)
Household food safety knowledge	0.007	0.001	0.007	0.001
	(0.008)	(0.001)	(0.008)	(0.001)
Marital status of household head				
Single	-0.321	-0.038	0.235	0.035
	(1.438)	(0.148)	(1.353)	(0.225)
Monogamous	0.516	0.068	0.591	0.080
	(0.885)	(0.118)	(0.849)	(0.116)
Polygamous	3.570	0.838***	1.825	0.486
	(3.146)	(0.250)	(3.068)	(0.999)
Price of maize[+]	11.977**	1.612**	12.638**	1.726**
	(5.464)	(0.722)	(5.437)	(0.733)
Price of tomatoes[+]	0.173	0.023	0.137	0.019
	(0.192)	(0.026)	(0.184)	(0.025)
Employment status				
Employment status of household head	0.122	0.016	0.193	0.024
	(0.344)	(0.042)	(0.343)	(0.040)
Percent of household members employed	0.009	0.001	0.008	0.001
	(0.006)	(0.001)	(0.006)	(0.001)
Self-reported covid-19 effect				
Affected price of staple foods	0.613**	0.103**		
	(0.262)	(0.052)		
Affected price of vegetables	-0.772**	-0.072***		
	(0.356)	(0.021)		
Constant	-1.862*		-1.720*	
	(1.005)		(1.000)	
Time varying averaged regressors	Yes	Yes	Yes	Yes
Self-reported covid-19 effect	Yes	Yes	No	No
Number of observations	1212	1212	1212	1212
Number of unique households	606		606	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1;
Note: Coef.-CRE Probit coefficients; AME-Average Marginal Effects
* Reference base for educational level is "No formal education"
+Real price of maize and tomatoes are computed based on ESOKO-Ghana December and June price averages from 2013-2020.

We checked the robustness of our results on the association between weather seasonality and the incidence of diarrhoea/vomiting in different ways (Table A.14). We applied a standard Probit estimator to the pooled data. Furthermore, regarding the incidence of diarrhoea/vomiting as a count variable, we run a standard Poisson on the pooled data, CRE Poission and, due to the high number of households that did not experience diarrhoea/vomiting (high number of zeros), we applied the Poisson pseudo-maximum likelihood regressions (PPML) with multi-way fixed effects (Correia et al., 2020), which can control for the high number of zeros in the estimation. The pooled results show no statistically significant difference in the incidence of diarrhoea/vomiting between seasons. Household size, wealth status and price of maize affected the incidence of diarrhoea/vomiting. The CRE Poisson and PPMLHDFE results show a positive and statistically significant difference in the incidence of diarrhoea/vomiting between seasons: diarrhoea/vomiting is higher in the dry season than in the rainy season. This is consistent with the results of the CRE Probit estimation (Table 3.14). Comparing the magnitude of the coefficients of CRE Poisson and PPMLHDFE show that PPMLHDFE has a higher magnitude for the association between weather seasonality and the incidence of diarrhoea/vomiting. The difference in the magnitude of the coefficients can be attributed to the ability of the PPMLHDFE to handle the high number of zeros in the model.

Unlike the CRE Probit model, where there is a positive but insignificant effect between the percent of household members employed and the incidence of diarrhoea/vomiting, the CRE Poisson and PPMLHDFE estimations show a positive and significant effect between percent of household members employed and the incidence of diarrhoea/vomiting. The incidence of diarrhoea/vomiting is higher in households with a higher percentage of employed members than households with lower employed household members (Table A.14-col. 3 and 4). All things equal, a unit increase in the percent of household members employed is associated with a 1.8 percent increase in diarrhoea/vomiting cases. Households with more employed people outside the house have a higher propensity to eat food cooked outside the home. There are hygiene and food safety concerns in Ghana regarding food vendors and eateries. Major food contamination incidences have been recorded at both high-end restaurants and street food vendors, with some resulting in deaths (FDA, 2023; 2022; Akabanda et al., 2017). In addition, the cost of quality food outside the home is expensive (FAO et al., 2020). So, consumers may rely on the trustworthiness and reputation of the food outlet (Rheinländer et al., 2008) to continue patronising their food so long as they do not fall sick. Thus, consumers face a higher risk of food contamination when patronising food outside the home in Ghana (Larbi et al., 2021).

3.6.3 Effect of seasonality on HDDS and food expenditure per capita

Table 3.15 shows the effect of weather seasonality on household dietary diversity score (HDDS) and food expenditure per capita. In model 1, we present the results of a Poisson fixed effects estimation for HDDS. We did not compute marginal effects for the Poisson estimation because the coefficients can be interpreted as semi-elasticities (DeAngelo & Hansen, 2014; Cameron & Trivedi, 2013). In model 2, we present the results of a linear (OLS) fixed effects estimation for food expenditure per capita.

The results indicate that weather seasonality does not have a statistically significant effect on urban households' HDDS and total food expenditure per capita when household fixed effects are controlled. This may be because urban households, especially in major cities, purchase most of their food from markets (IFPRI, 2017). In addition, major urban markets have more diversified food supply sources (Table 3.10), so food availability is a lesser challenge in urban markets (Table 3.9). The different food markets and the diversified food supply sources curtail the effect of weather seasonality on HDDS and food expenditure. However, weather seasonality can affect household food consumption through the prices of food commodities.

For example, Kaminski et al. (2014) showed that seasonal food price changes are inversely correlated with household food consumption. From our analysis, the price of maize has no statistically significant effect on HDDS and monthly food expenditure per capita. However, the price of tomatoes has a negative and statistically significant effect on household monthly food expenditure per capita. All other things equal, a one unit increase in the price of tomatoes is associated with a 15.3 percent decrease in household monthly food expenditure per capita. This implies that households spend less on each member as food prices increase. Fresh tomatoes are a common ingredient in many household dishes in Ghana and are used in significant quantities. Thus, it is not a question of whether to use fresh tomatoes in cooking but what quantity to use. Therefore, significant increases in the price of tomatoes increase total food expenditure, and households reduce food expenditure per capita as a coping mechanism to smoothen consumption.

Other regression results show that monthly food expenditure per capita decreases by about 19.5 percent with a unit increase in household size. This implies that larger households spend relatively less on food per household member. However, large household sizes positively affect HDDS. A unit increase in household size is associated with a 3.4 percent increase in HDDS. The finding is corroborated by Thorne-Lyman et al. (2010), who found that household size

positively correlates to dietary diversity and negatively correlates to per capita monthly total food expenditure. Household size can positively affect dietary diversity because it is expected that with a large number of household members and their varied ages, the household is likely to have higher income and consume food with high dietary diversity to meet members' nutritional needs (Usman & Callo-Concha, 2021; Jateno et al., 2023). Conversely, household size can negatively affect household dietary diversity. Due to large family sizes, poor households may not be able to spend more on adequate nutritious food and thus reduce their diet quality and diversity to meet the hunger needs of all household members (Addai et al., 2022; Huluka et al., 2019; Powell et al., 2017).

Furthermore, the household wealth index has a positive effect on both HDDS and food expenditure per capita. Wealthier households eat more diversified foods and equally spend more per household member on food. A unit increase in wealth index would result in 3.6 and 6.9 percent increases in HDDS and food expenditure per capita, respectively. It implies that a marginal increase in households' wealth status increases the number of food groups households consume by 3.6 percent. Also, as households' wealth status increases, their food purchases increase by 6.9 percent per member. Our result aligns with Jones et al. (2014) and Swindale and Bilinsky (2006), who showed that wealthier households have higher food expenditure per capita and consume more diversified foods within food groups and more food groups. Household knowledge of food safety is positively associated with HDDS. A unit increase in household food safety knowledge will translate into a 0.4 percent increase in HDDS. This result may be attributable to the general positive effect of increased knowledge of food safety. Food safety and nutrition are inextricably linked (WHO, 2022a), although there are differences.

Covid-19 occurred after round one of the surveys. This disrupted the food supply system. So, we added households' perceived effect of Covid-19 on food prices. The results show that there was no statistically significant difference in HDDS of households who attributed price changes in fruit and vegetables and staple foods to Covid-19 and those who did not (col. 1). Conversely, respondents who attributed fruits and vegetable price changes to Covid-19, reduced their food expenditure per capita by about 18 percent over those who think otherwise (col. 2).

We ran separate estimations for the lowest and highest SES groups to see if seasonality affected HDDS and food expenditure per capita. The results show no statistically significant effect of seasonality on HDDS and food expenditure per capita for each group when controlling for household fixed effects. Therefore, the estimates are not presented in this study.

Table 3.15: Effect of seasonality on HDDS and food expenditure per capita

Variables	(1) HDDS	(2) Log(Total food expend./capita)
Season (Dry)	-0.025	0.216
	(0.120)	(0.298)
Characteristics of household		
Age of household head	0.005	0.016
	(0.009)	(0.012)
Sex of household head (Male)	0.237	-0.343
	(0.146)	(0.224)
Household size	0.033**	-0.217***
	(0.017)	(0.045)
*Education of household head**		
Primary	0.163	1.808***
	(0.154)	(0.434)
Secondary	0.088	0.585
	(0.178)	(0.497)
Tertiary	-0.318	1.666**
	(0.363)	(0.708)
Household wealth index	0.035***	0.067***
	(0.009)	(0.021)
Household food safety knowledge	0.004**	0.003
	(0.001)	(0.002)
Marital status of household head		
Single	-0.929***	0.727*
	(0.277)	(0.373)
Monogamous	-0.459***	-0.090
	(0.098)	(0.173)
Polygamous	-0.676*	-0.277
	(0.372)	(0.655)
Price of maize+	0.136	1.464
	(0.641)	(1.649)
Price of tomatoes+	0.016	-0.166***
	(0.023)	(0.051)
Employment status		
Employment status of household head	-0.010	-0.021
	(0.043)	(0.127)
Percent of household members employed	0.001*	0.000
	(0.001)	(0.002)
Self-reported covid-19 effect		
Affected price of staple foods	-0.031	0.074
	(0.030)	(0.080)
Affected price of vegetables	0.027	-0.200**
	(0.034)	(0.098)
Constant		2.113
		(3.535)
Observations	1,212	1,212
R-squared		0.132
Number of unique respondents	606	606

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Col. 1-Poisson fixed effects, col. 2-Linear fixed effects

* Reference base for educational level is "No formal education"

+Real price of maize and tomatoes are computed based on ESOKO-Ghana December and June price averages from 2013-2020.

We assessed the robustness of our results using different estimation approaches. We ran pooled Poisson and CRE Poisson estimations for HDDS (Table A.15) and pooled OLS and first-difference estimation for monthly food expenditure per capita (Table A.16). The pooled Poisson results show that seasonality affects HDDS. HDDS is lower in the dry season compared to the rainy season. All other things equal, the coefficient indicates that HDDS decreases by 5.4 percent in the dry season compared to the rainy season. When using CRE Poisson, HDDS is lower in the dry season; however, the difference is not statistically significant. Therefore, the Poisson fixed effects and CRE Poisson results are consistent. The pooled OLS regression results show a statistically significant difference in monthly food expenditure per capita between the dry and rainy seasons. The results of the first-difference estimation show that monthly food expenditure per capita is higher in the dry season, but the difference is not statistically significant. The linear fixed effects and first-difference estimation show the same coefficients, although there are minor differences in the robust standard errors.

3.7 Conclusion

Urban households depend on food markets for most of their food needs and thus are exposed to market imperfections. Urban food markets in major cities are linked to both global and domestic food supply chains. These domestic food supply chains rely on predominantly rain-fed agriculture production systems, especially in developing countries. Consequently, weather seasonality affects urban food availability and accessibility. Further, weather seasonality affects food safety through foodborne pathogens and sanitation and hygiene practices in the markets and their related activities. Environmental factors, including precipitation and temperature, influence the spread of foodborne pathogens. The burden of foodborne diseases is affecting households' quality of life, especially in Africa. Thus, this chapter addressed the effect of seasonality on urban households' food safety (incidence of diarrhoea/vomiting), dietary diversity and food expenditure per capita. The study also provided evidence of some foodborne pathogens in selected food commodities from an urban market. We used microbial food analysis and market and household data to address the research objectives. We used Probit, Poisson, CRE Probit, CRE Poisson, and fixed effect estimations to estimate the effect of weather seasonality on the incidence of diarrhoea/vomiting, HDDS and food expenditure per capita.

Even with our findings, the definition of some variables may constrain the study. For example, an index to measure food safety based on different household food safety indicators is more desirable than the use of the incidence of diarrhoea/vomiting as a proxy for food safety.

Similarly, measuring seasonality based on environmental and socioeconomic indicators may be more desirable than a dummy variable. Also, a more extended panel would provide stronger evidence of the effect of seasonality in urban areas.

Our market and microbial food analysis results show that food safety is a challenge in major food markets in cities in Ghana. Foodborne pathogens like *Staphylococcus aureus, Enterococcus faecalis, E. coli* and aflatoxins (AFB1) were found in selected food commodities at different sampling points in the market. Some of the tested foodborne pathogens are present before the food commodities get to the market, and the market environment was also shown to potentially introduce or spread other pathogens. Retailers of food have limited food safety knowledge. Although about 57 percent of sampled food retailers have some food safety knowledge of the commodities sold, this knowledge is mainly linked to food preservation and how to extend the shelf life of their commodities. The implication is that reducing associated transaction costs is important to food retailers relative to other food safety considerations. Most food retailers sell the same types of commodities throughout the year. Thus, they know how to handle their products under different environmental conditions to optimise their profits. Selling the same types of food commodities throughout the year also indicates all-year food availability. However, because of seasonal price changes, food accessibility (affordability) may be a challenge for urban households, adversely affecting the food security status of urban households, especially the vulnerable.

Our household results also show that weather seasonality affects households' food-related diarrhoea/vomiting infections (food safety). For example, many households suffer from food-related diarrhoea/vomiting in the dry season, potentially because inadequate or inconsistent access to improved water heightens the risks of noncompliance with WASH behaviour (Prüss-Ustün et al., 2014). Further, about 75 percent and less than 50 percent of households share toilet facilities and use improved toilet facilities, respectively, in our study. Therefore, households must adhere to food safety measures daily, including proper WASH behaviour, to maintain a safe home food environment.

When controlling for household fixed effects, we did not observe a statistically significant effect of weather seasonality on HDDS and food expenditure per capita in urban Ghana. However, seasonal food price changes have a minimal or no effect on HDDS and food expenditure per capita when controlling for household fixed effects. This may be because HDDS counts the number of food groups a household consumes and does not measure the

quantity and quality of food consumed. Thus, the quantity of food consumed by households from different food groups may change between seasons, but the dietary diversity score recorded may remain the same. However, wealthier households eat more diversified foods and spend more on food per capita, a potential indication of healthier food choices.

Our household results also show that the proportion of households that consume different food groups varies between the dry and rainy seasons. The proportion of households that consumed animal-based protein foods (egg and fish) declined in the rainy season, whiles meat, offal and poultry increased marginally. The greater availability and affordability of green leafy vegetables during the rainy season increased their consumption among households which is a healthy option to add to food dishes. However, the increase in the share of households consuming oil and fats and sugar and honey products are not necessarily healthy diet options. Consequently, avoiding and eliminating industrially-produced *trans-fatty* acids in the food system should be promoted (WHO, 2023). In addition, balanced consumption of sugar and healthier oils, like olive, canola, coconut and avocado, should be promoted and made affordable because oil and fats and sugar and honey are common ingredients in most dishes in developing countries.

Our results emphasise that in developing countries like Ghana, food safety is a challenge in cities and is associated with weather seasonality. However, weather seasonality in cities does not significantly affect urban households' HDDS. Ghana's current food system will require a transformation to become sustainable. There is a dichotomy between food production and supply chains for the domestic and foreign markets. For the foreign market food supply chain, sanitation and public health officers enforce food safety standards and ensure compliance strictly from the farm until export. However, the domestic market food supply chain lacks adequate monitoring and enforcement of food safety standards. The NFSP identified the high informality of the sector in Ghana as accounting for many activities not sufficiently regulated and the difficulty with product traceability (MoH, 2022).

The weak regulations, compliance and traceability issues are predominantly characteristics of the domestic supply chain. This is because, besides financial and human resource constraints, local authorities and public health officers face a dilemma about whether to enforce the law on food safety strictly[2]. Strictly enforcing the laws means destroying substandard food

[2] Based on the proceedings from stakeholders (policymakers and implementers at the national and local levels) in Ghana's food, nutrition and public health environment at the High-level Stakeholder workshop held in Accra-Ghana on 5th May 2022.

commodities (unprocessed food products), contributing to food availability and accessibility challenges. So, officers may be considerate in enforcing food safety standards in the domestic market. Therefore, in the short term, local authorities such as sanitation and public health officers should enforce laws (e.g. Ghana's Public Health Act) and regulations on food safety. The food safety surveillance and early warning system in the NFSP should be able to prevent the outbreak of diseases and detect and seize unsafe foods before they get to the markets. In the long run, technology, innovation, and logistics investment are required to upgrade traditional open-air markets. Although food availability is not a significant challenge for urban households, the focus should be on food accessibility, especially for the urban poor.

Chapter 4: Analysis of household double burden of malnutrition and time spent on food preparation in urban Ghana

4.1 Introduction

Malnutrition has received considerable attention over the past two decades (Gillespie et al., 2013; Nugent et al., 2020). It has featured prominently in local and global development plans and programmes. It was captured in the Millennium Development Goals (MDGs) and continues to find expression in the SDGs (UN, 2015a). Different strategies have been devised to tackle the multifaceted problem of malnutrition. However, efforts to end hunger, food insecurity and all forms of malnutrition are not yielding the expected results (FAO et al., 2020). With less than a decade to the 2030 deadline for attaining most of the SDGs, the Decade of Action for SDGs has been initiated to galvanise the needed leadership, evidence-based smart solutions and financial support to achieve the goals of a sustainable world (UN, 2021).

In developing countries, poverty, food insecurity and malnutrition in the form of undernutrition are predominantly in rural areas and, thus, have been the targets of most interventions, culminating in programmes like the MDGs (UN, 2015b). However, over the years, it has emerged that urban dwellers are equally experiencing multiple forms of malnutrition (Frayne et al., 2014; Ruel et al., 2017a). Unlike rural areas, food availability is not necessarily a challenge in urban areas because functioning markets have enough food to sell (Smith & Haddard, 2000). However, there is the problem of food accessibility (Frayne et al., 2014). Accessibility to food can be both physical and financial (Szabo, 2016). Consumers in urban areas experience a greater impact of food inaccessibility because they have to purchase most of their food. This makes them overly dependent on food markets and thus more vulnerable to potential price hikes (IFPRI, 2017). Urban dwellers can purchase up to 90 percent of their food (Ruel & Garrett, 2003). Therefore, the urban poor are at a greater risk of food insecurity if they cannot financially purchase the food they need for consumption.

As some households struggle to access food and suffer from undernutrition in developing countries, concurrently, most developing countries are experiencing a nutrition transition (Reardon et al., 2021; Popkin, 2008). Individuals and households are changing their lifestyles to meet the demands of a changing economy and society and are opting for more convenient options, including food. Urban dwellers especially are opting for “fast food” and “ready-to-eat” meals, which are primarily dense in sugars, salts, oils and fats (Popkin, 2008; Popkin et al., 2001). The consequence of consuming these products over a long period is the rise in

another form of malnutrition, namely overnutrition, which leads to overweight and obesity. Obesity is rapidly growing in urban areas in developing countries (FAO et al., 2020).

Convenience motives drive urban households' food consumption decisions because they want to save time for the labour market (Reardon et al., 2021). The choice of food to consume and where to consume it is a function of factors including income and price (French et al., 2019; Green et al., 2013; Steptoe et al., 1995). The decision to purchase food can be an economic decision. There is a trade-off or opportunity cost between preparing the food at home and spending time on other economic activities or leisure (Becker, 1965; Aguiar & Hurst, 2007; Aguiar et al., 2012). As urban households' income and wages increase, so does their opportunity cost of time allocation. As a result, they spend less time preparing food (Restrepo & Zeballos, 2020; Kohara & Kamiya, 2016; Dunn, 2015) and may adopt more time-conserving strategies to meet their food consumption needs. Therefore, households' time allocation decisions influence their food consumption behaviour and malnutrition status.

In addition to convenience motives, food prices influence the type and quality of food households consume. Most urban consumers, especially the urban poor, continue to shop from open-air markets and informal retail outlets (IFPRI, 2017; Wertheim-Heck et al., 2019). These open-air markets provide affordable fresh food sources for urban dwellers (Ahmed et al., 2019). Notwithstanding, the urban poor who cannot afford healthy food outside the home because of the high cost (FAO et al., 2020) go for alternatives like street foods to meet their dietary needs (Kazembe et al., 2019; Steyn et al., 2013). Although street foods are convenient, the handling, sanitary conditions, and nutritional status of some are questionable (Marras et al., 2016; Ruel et al., 2017b; Battersby & Watson, 2018b).

Thus, there is evidence of the double burden of malnutrition (DBM) in urban areas (Nugent et al., 2020; Popkin et al., 2020; Shrimpton & Rokx, 2012). The DBM refers to the coexistence of undernutrition (stunting, underweight, wasting) and overnutrition (overweight and obesity) at the individual, household, community or country level (Popkin et al., 2020; WHO, 2017c). The under and over-nutrition in urban areas, coupled with the relatively poor healthcare infrastructure and systems in Africa (WHO, 2018b), compound the impact of malnutrition on households and individual consumers and, ultimately, the development of countries.

This chapter explores the change in household DBM in urban Ghana. Furthermore, the chapter explores the relationship between the employment type of female household heads or spouses of male-headed households and time spent on food preparation and household DBM. We test

the hypothesis that households with female household heads or spouses of male-headed households engaged in work away from home spend less time preparing food and have a higher prevalence of household DBM. Specifically, the chapter answers the question: Does household DBM exist in urban areas in Ghana? Do working-away-from-home female household heads or spouses of male-headed households spend less time on food preparation, and what is the association between time spent on food preparation and household DBM?

The structure of this chapter is as follows: Section 4.2 provides a literature review on the subject, including malnutrition, time spent on food preparation, and socioeconomic factors that are likely to affect household malnutrition. Section 4.3 presents the conceptual framework of household time spent on food preparation and household DBM, while section 4.4 covers the source of data used and variables of interest. Section 4.5 describes the empirical strategy used to address the specific research questions. Finally, sections 4.6 and 4.7 present the study's empirical results, discussion, and conclusions, respectively.

4.2 Literature review

4.2.1 Nutrition transition in developing countries

Due to economic growth, improved wealth and urbanisation in developing countries, people are moving away from traditional diets and consuming increasingly high-sugar, energy-dense and more complex processed foods. This, coupled with the sedentary lifestyles of people, is contributing to obesity and its attendant NCDs like diabetes and cardiovascular diseases (Reardon et al., 2021; Cockx et al., 2018; Rtveladze et al., 2014; Popkin et al., 2012; Stuckler et al., 2012; Misra & Khurana, 2008). This phenomenon is termed "nutrition transition". Thus, the sustainable availability and consumption of safe, nutritious and healthy foods are important to mitigate food-related diseases. For example, the Pontifical Academy of Sciences advocates promoting food safety and healthy diets to enhance global nutrition security (Pontifical Academy of Sciences, 2018).

The critical role of safe and healthy diets[3] in the food and nutrition security discourse cannot be overemphasised because a poor diet has been identified as one of the leading causes of diseases. Although there are many direct and indirect causes of diseases and death, it is estimated that 1-in-5 deaths are diet-related (Afshin et al., 2019). Furthermore, consuming

[3] A safe and healthy diet contains the appropriate amounts of nutrients needed to meet and not exceed all physiological requirements in line with age and life stage, and not contain harmful substances that can cause health risks in quantities beyond maximum acceptable limits-Pontifical Academy of Sciences, (2018)

ultra-processed and processed foods and beverages high in sugars, salts and fats are major contributors to NCDs like diabetes and high blood pressure (Stuckler et al., 2012). In Africa, rapid urbanisation (UN, 2019) and economic growth (World Bank, 2018) has resulted in a higher number of overweight and obese people on the continent, as evidence from other countries like Mexico suggests (Rtveladze et al., 2014). Therefore, tackling the challenges of food and nutrition security will profoundly impact global development (InterAcademy Partnership, 2018), especially in developing countries.

However, many people in Africa are still hungry, undernourished, and lacking the right amounts of micronutrients. The continent had the highest prevalence of undernourishment (20.4%) in 2017-an upward trend since 2014. The picture is gloomier for Sub-Saharan Africa, which has a prevalence rate of 23.2 percent. Furthermore, low birth weights and stunting during childhood are potential risk factors for overweight and obesity later in life (FAO et al., 2018).

4.2.2 Prevalence of DBM in Africa

The growing incidence of DBM in Africa has led to the developing and adoption of a strategic plan (2019-2025) to reduce the DBM in the Africa region by WHO member countries in Africa (WHO, 2019a). Data from the 2020 "The State of food security and Nutrition in the World" report shows that malnutrition in all its forms continues to pose a challenge to humanity. With the current trend of progress and action, the SDGs on ending hunger and malnutrition will not be met by 2030. The report indicates that in 2019, globally, 21.3, 6.9 and 5.6 percent of children under five years were stunted, wasted and overweight, respectively. For stunted children under five years, about 90% of them are found in Africa and Asia. Africa accounts for about 40 percent of globally stunted children under five years (FAO et al., 2020). Africa still has a high level of undernutrition and a growing rate of overnutrition (overweight/obesity) (Onyango et al., 2019).

The incidence of the different forms of malnutrition in Africa is heterogeneous—the spread is not geographically evenly distributed. The challenge varies across regions. Some regions are more challenged with stunting, while others are challenged with wasting. For example, there is a higher prevalence of stunting in East Africa, while wasting and underweight are highest in West Africa (Akombi et al., 2017). Also, obesity is increasing at a rate higher than the reduction rate in the prevalence of underweight conditions in children under five years and adults in South Africa (Mbogori et al., 2020). Furthermore, there is a positive correlation between nutritional changes and urbanisation. The odds of women of childbearing age being overweight

and anaemic and a preschool-aged child being overweight and stunted are higher in urban and peri-urban areas than in rural areas (Jones et al., 2016).

Micronutrient deficiency, which is often termed "hidden hunger" (von Grebmer et al., 2014), can have detrimental effects, especially on unborn children (Black et al., 2013). In addition, pregnant women lacking vitamins A, D, & B12, iron and zinc may suffer complications during pregnancy like low birth weight and child disabilities (Kerac et al., 2014). Africa has the most burden of chronic and hidden hunger compared to other regions (Gödecke et al., 2018), and the region is not on course to achieving the targets of SDG-2 of Zero Hunger by 2030 (Chadare et al., 2022). In addition, the West Africa region is particularly not on course to achieve its anaemia targets (Chadare et al., 2022).

Within the household, the prevalence of DBM depends on the different combinations of overnutrition and undernutrition (Davis et al., 2020; Fongar et al., 2019). The typical combinations (coexistence) of overnutrition and undernutrition are; overweight/obese mother (OWOB) and thinness, wasting or underweight child; OWOB and stunted child; OWOB and anaemic child; and OWOB and micronutrient deficient child (Davis et al., 2020). Fongar et al. (2019) found that in rural areas of Western Kenya, the prevalence of DBM for OWOB and a micronutrient-deficient child was 17.3 percent, and that of OWOB and a wasted child was less than 0.6 percent. Kimani-Murage et al. (2015) found that the prevalence of an overweight mother and stunted child was 43 percent in poor urban settings in Nairobi, Kenya. Sampled households in the Greater Tunis area had a DBM prevalence of 24.4 percent for an obese mother and anaemic child (Sassi et al., 2019).

4.2.3 Time allocation to home-cooked food and malnutrition

Earlier studies have shown that when individuals increase their labour supply in the labour market, they are likely to spend less time preparing food at home. For example, employed women are more likely to spend less time on home food preparation and higher expenditure on meals away from home (Prochaska & Schrimper, 1973; Redman, 1980). In recent studies, Kohara and Kamiya (2016) show that employed mothers in Japan purchase fewer time-consuming food ingredients and spend less time on home cooking. Men also allocate less time to home cooking when they increase their labour supply. For example, Dunn (2015) shows that a 10-hour-per-week increase in labour supply among single adult men was associated with 33.8 fewer minutes per week allocated to home cooking in the United States of America.

Time spent on home cooking and eating has been linked to healthy food consumption behaviour. Monsivais et al. (2014) show a positive association between individuals who spend more time preparing food at home and consuming meals with higher proportions of fruits and vegetables in the United States of America. Further, a higher home-cooking frequency was associated with lower energy-dense-diet intake, sugar and fats (Wolfson & Bleich, 2015). Eating speed has also been linked to overweight and obesity (Ohkuma et al., 2015). Slower eating can reduce the risk of obesity and BMI (Hurst & Fukuda, 2018).

The time cost component of the total cost of home food production can be substantial. The total cost of home food production is the sum of the cost of food inputs and time input. Using the 2003 American Time Use Survey (ATUS), Davis and You (2010) found that the time cost component of the total cost of home food production can be as high as 30 percent for individuals who work both in the labour market and at home and about 49 percent for individuals who do not work in the labour market. These high time costs as a percentage of the total cost of food production are a disincentive for home food production. Using the 2003-2009 ATUS dataset and the opportunity cost approach to estimate the time cost of food production, Raschke (2012) corroborated the findings of Davis and You (2010).

Even with the benefits of home food preparation and slower eating speed, time scarcity is a challenge for urban households. The opportunity cost of time is costlier for urban households, and therefore, they employ time-saving mechanisms (convenience) to adapt (Reardon et al., 2021). Venn and Strazdins (2017) show that time and income scarcity (e.g. due to the nature or type of employment) negatively affect people's healthy eating and physical activity and, thus, can compromise the household food environment. The scarcity of income and time increases the tendency of people to eat out, reduces fruit and vegetable consumption and increases people's consumption of fast and convenient foods (Seidu, 2019; Venn & Strazdins, 2017; Bauer et al., 2012). These evolving urban lifestyles and eating habits, coupled with a higher opportunity cost of time (AGRA, 2020), will affect household malnutrition status.

4.3 Conceptual framework

An extract from the general conceptual framework presented in Chapter 1 of this study will be applied in this chapter. The conceptual framework for this study is presented in Figure 4.1. The general underlying assumption of this framework is that the household is situated within a food system, and the household interacts with the food system to produce outcomes, including malnutrition. This interaction is bidirectional. The focus of this chapter is to explore the effect

of the employment status of female household head and spouse of male-headed household and family structure on household time spent on food preparation and, ultimately, its effect on the household double burden of malnutrition.

As presented in section 4.2.3, time spent on food consumption is critical in the daily activities of urban households. The employment status of the household head (mostly men) and especially of the spouse (wife), who is the primary "food manager", and the structure of the household (number of children and adults, and female proportion of household members) are essential to the food decisions made in the household. Depending on the type of work undertaken by the household head and the spouse, and whether they are both employed, will influence how much income they make from the labour market and the time available for household activities, including food preparation and leisure. If the couple earns more money from the labour market, the opportunity cost of time allocated to food preparation at home becomes costlier. Conversely, if the couple earns less money from the labour market, the opportunity cost of time allocated to food preparation at home becomes less costly. However, individuals in the low-wage labour market work many hours to earn adequate wages (Dütsch & Bruttel, 2021; Butcher & Schanzenbach, 2018). So, they are constrained by both time and low wages. Therefore, the household's food consumption choice depends on how much utility they derive from these options.

In addition, the number of children and their age categories affect the amount of care required, influencing time allocation decisions of the household. For example, a household with younger children will require more time for food preparation (Senia et al., 2017). This is because a household with younger children will require more childcare time and specialised foods that may not be readily bought outside. Thus, more time will be required to prepare this food at home compared to a household with older children and adults who will have more options with food away from home.

These decisions influence the balance between households' decision to prepare home-cooked food, the time allocated to food preparation, and how much to spend on food away from home. Evidence in the literature (Mills et al., 2018; Mills et al., 2017; Tiwari et al., 2017) shows that home-cooked meals are likelier to be healthier and less expensive than healthy food away from home. The cost of healthy food purchased outside the house is generally high and outside the reach of many poor households (FAO et al., 2020). In many parts of sub-Saharan Africa, the cost of a healthy diet is unaffordable. Of the four sub-regions in sub-Saharan Africa, three

(west, east and middle Africa), except southern Africa, have a healthy diet cost between 1.4 and 2.2 times higher than the average household food expenditure (FAO et al., 2020). So poorer households may, because of convenience, consume food away from home, but the quality may not be guaranteed. Thus, the time allocation decisions of households to the source (home or outside the home) of food consumed affect the malnutrition status of the household.

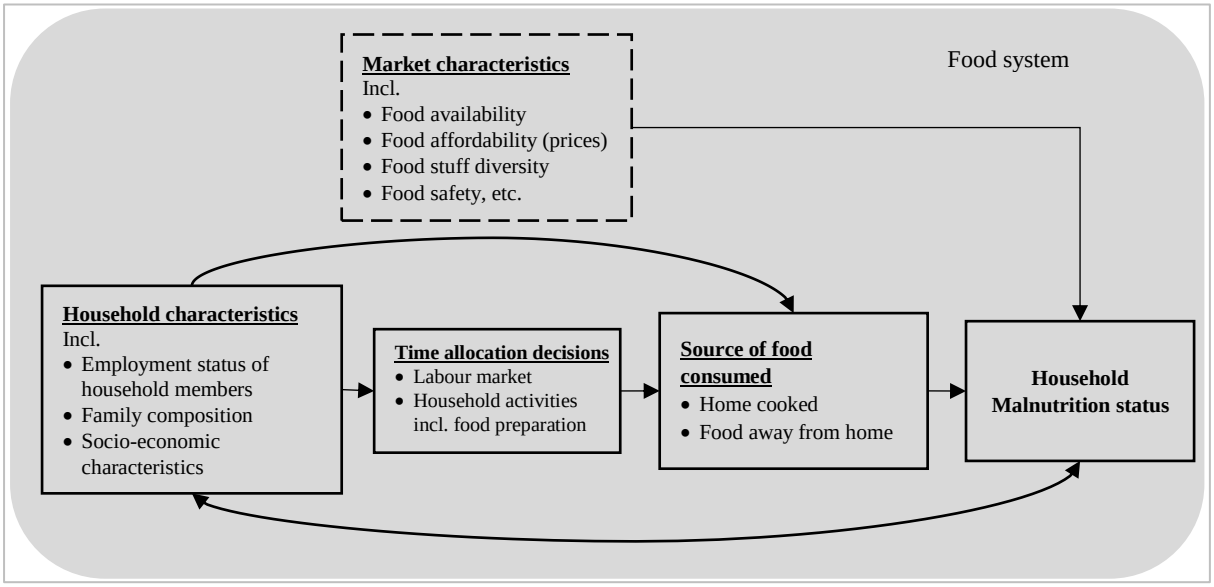


Figure 4.1: Conceptual framework showing the effect of employment status on household malnutrition

Source: Author's construction, 2021

4.4 Data sources and variables of interest

4.4.1 Data source

The data used in this chapter is from the Ghana Socioeconomic Panel Survey (GSPS). This data set is a nationally representative panel survey conducted by the Economic Growth Centre at Yale University, the Global Poverty Research Lab at Northwestern University and the Institute of Statistical, Social and Economic Research (ISSER) at the University of Ghana. The study commenced in 2009 and will last 15 years, with a survey conducted every three years. So far, three (3) rounds of data collection have been completed: 2009/2010, 2013/2014 and 2017/2018. The uniqueness of this data set is that after the first round, subsequent rounds will track individuals and households who have relocated from their original locations where they were first enumerated as much as possible. About 5000 households were enumerated in the first round. This figure may increase depending on the formation of new households by individuals who were members of previously sampled households (ISSER, 2020). Since the analysis focuses on urban household DBM, urban multiple-membered households with

complete anthropometric information were selected. The procedure for selecting the final sample sizes is shown in Table 4.1 and Figure 4.2.

Table 4.1: Selection of sample size based on availability of anthropometric data

	Round 1 (2009/2010)	Round 2 (2013/2014)	Round 3 (2017/2018)
Total households	5009	4774	5669
Exclude rural households	*(2999)*	*(3075)*	*(3978)*
	2010	1699	1691
Exclude households not in all three rounds	*(493)*	*(182)*	*(174)*
	1517	1517	1517
Exclude single membered households	*(398)*	*(406)*	*(433)*
	1,119	1,111	1,084
*Exclude households with missing age data; missing, implausible, cut-off anthropometric data**			
Final sample size			
Final sample size for stunting	304	249	231
Final sample size for underweight	327	272	261
Final sample size for wasting	272	229	189
Final sample size for underweight (5-19 yrs)	695	588	540
Final sample size for adult BMI	1020	996	964

*the number will vary based on the number of under-5 years, 5-19 years and adults in a household with complete anthropometric data

Source: Author's computation based on GSPS data

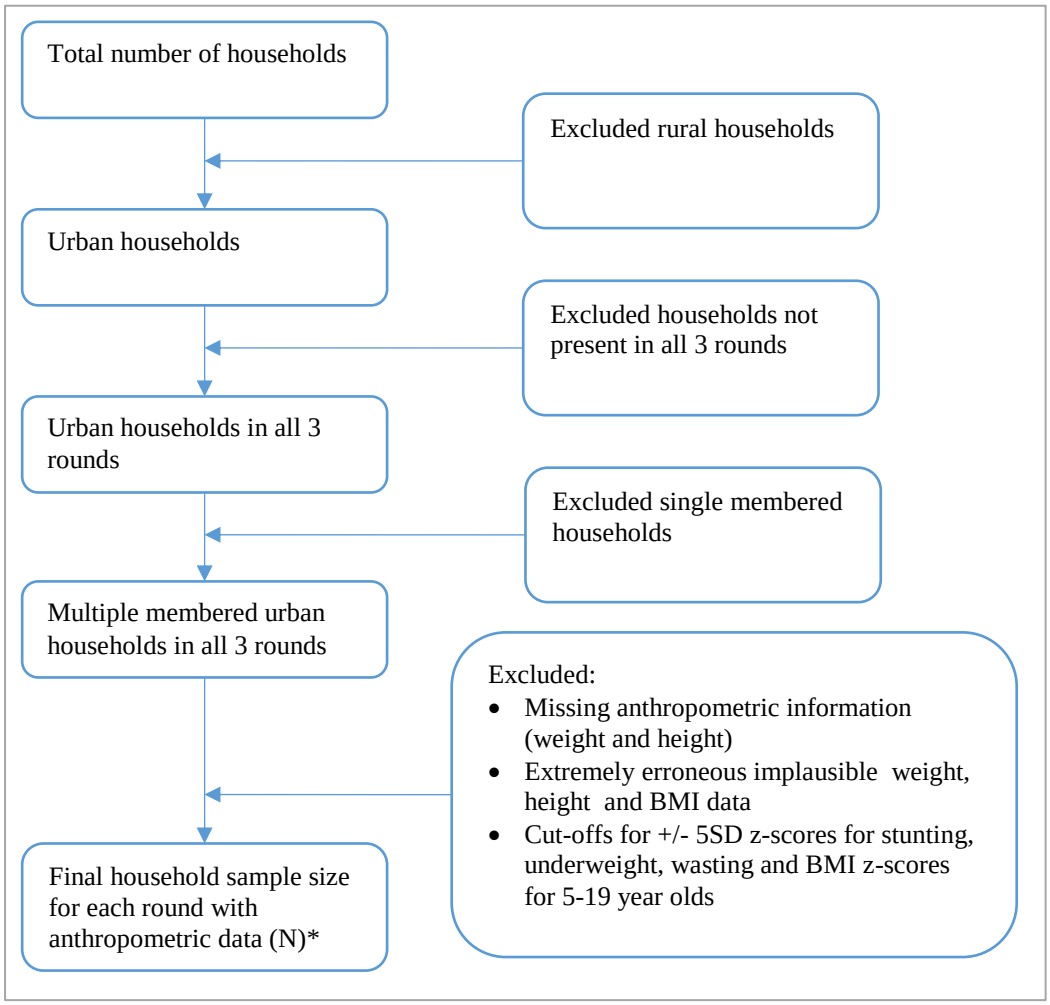


Figure 4.2: Flow chart of anthropometric indicators sample size selection

All three (3) rounds of data were used for the analysis. The data collected in these surveys cover a broad spectrum of economic, demographic, health, social networking, and development variables. For analysis, the variables of interest include; household demographic characteristics, malnutrition status of household members (anthropometry), time use on household activities, household food consumption behaviour, housing characteristics, health status and outcomes, and economic activities and employment status of household members.

4.4.2 Outcome variable and covariates of interest

4.4.2.1 Outcome variable

The main dependent variable is household DBM. A household is defined to have DBM if, in the same household, there is at least one qualified female who is overweight/obese (OW/OB) and at least a child who is undernourished. A qualified female is a female household head or the spouse of a male-headed household of reproductive age (20-49 years). An undernourished child is a child who has any combination of stunting, underweight and wasting. The definition

of household DBM captures most forms of malnutrition in children and adults. Micronutrient deficiency is not directly accounted for in the operational definition of household DBM. However, this form of malnutrition ultimately leads to health conditions that could result in other forms of malnutrition (Mrimi et al., 2022). Also, the combination of overweight/obese mother (woman) and undernourished child is the most common definition of DBM used in the literature (Davis et al., 2020).

To compute household DBM for children less than five years (0-59 months), we computed standardised z-scores based on the WHO standard of growth measurement height-for-age z-scores (HAZ), weight-for-age z-scores (WAZ) and weight-for-height z-scores (WHZ). Based on these scores, we defined stunting (HAZ), underweight (WAZ) and wasting (WHZ) as z-scores below -2 standard deviations (<-2 sd) of the median of the WHO child growth reference (Black et al., 2013; Vidmar et al., 2013; WHO, 2006b). The z-scores (HAZ, WAZ, WHZ) for children less than five years were automatically considered missing and excluded if the z-value has an absolute value greater than or equal to five (≥5 SD).

For children and adolescents (5-19 years), we computed body mass index (BMI)-for-age z-scores (BAZ) to determine those of them underweight. Children with BAZ z-scores below (<-2sd) are moderately and severely underweight, and those between (-2sd≤BAZ<-1sd) are defined as mild underweight (Abarca-Gomez et al., 2017; Vidmar et al., 2013; de Onis et al., 2007). We excluded implausible BMI values (BMI<7kg/m^2 and BMI>80kg/m^2) for children aged 5-19 years (Abarca-Gomez et al., 2017). Adults' (> 19 years) malnutrition status was based on their BMI levels. Adults were classified as underweight (BMI<18.5kg/m^2), overweight (25kg/m^2 to 30kg/m^2) and obese (≥30kg/m^2) based on the WHO reference standard (Pomati et al., 2021; WHO, 2000). For adults, we excluded missing values, erroneous and implausible weight (weight<25kg or weight>200kg), height (height < 1m or height >2m) and BMI values (BMI<10kg/m^2 and BMI>80kg/m^2) (Abarca-Gomez et al., 2017; Corsi et al., 2012). Although overweight and obesity were computed for all adults, qualified female adults were used for further analysis.

After determining stunting, underweight and wasting of children and obesity of adults, we created a dummy variable for the different combinations of households with DBM. Table 4.2 shows the combinations of the DBM.

Table 4.2: Definition of household double burden of malnutrition

Double burden of malnutrition	Qualified female	At least a malnourished child
OW/OB_S	OW/OB	Stunted
OW/OB_U	OW/OB	Underweight[1]
OW/OB_W	OW/OB	Wasted
OW/OB_U5-19	OW/OB	Underweight

[1] children moderate and severely, and mildly underweight were combined

4.4.2.2 Covariates of interest

The covariates used in this study include; household size, education of household head, employment type, working away from home, household wealth status, the proportion of females in the household, and time spent on food preparation and food-related activities.

4.5 Empirical strategy

4.5.1 Evidence of double-burden of urban household malnutrition in Ghana

The prevalence of household DBM is calculated by first computing the z-scores and BMI of all household members (de Onis et al., 2007). Based on the z-scores and BMI values, we classify household members into different malnutrition categories based on the WHO standards. Then a dummy variable of household DBM (1=DBM; 0=otherwise) is created. Summary statistics will provide information on the prevalence of household DBM over the different rounds of data collection. We compute the prevalence of household DBM as follows:

$$Prevalence\ of\ household\ DBM = \frac{Number\ of\ households\ with\ DBM\ in\ sample}{Total\ number\ of\ households\ in\ sample}$$

4.5.2 Factors that affect cooking decisions and time spent on cooking

We calculate the factors that affect cooking decisions and time spent on cooking and food preparation. The dependent variable is time spent on food preparation (TAFP). In order to observe the actual time allocated to food preparation in the household, two stages are involved (Möser, 2010). The first stage is deciding whether to allocate time to food preparation. The second stage is the actual observed time allocated to food preparation. If the outcome of the first stage is positive ($D_i > 0$), then you can observe the second stage (actual time allocated) if the latent time allocated to food preparation is greater than 0 ($TAFP_{it}^{*} > 0$) (Möser, 2010). The decision to cook or not and the actual cooking time is based on the assumption that the household has the capacity (e.g. knowledge of cooking, money, cooking space and food availability) to prepare food. Therefore, the two-stage process can be mathematically expressed as follows:

$$TAFP_{it} = \begin{cases} TAFP_{it}^{*} & if\ D_i > 0\ and\ TAFP_{it}^{*} > 0 \\ 0 & otherwise \end{cases}$$

Where: $TAFP_{it}$ = observed time allocated to food preparation, $TAFP_{it}^{*}$ = latent unobservable variable of time allocated to food preparation, D_i = decision whether to allocate time to food preparation or not, i =individuals, t = Time trend

Time allocation data can have the problem of many zero observations for time spent on many activities (Stewart, 2013). A "no" (zero) response to whether an individual participates in an activity can either mean the individual never participates in the particular activity or only participates at a particular time or day. In this case, the different reasons for the "no" response are all transformed into and reported as a single value (censored data) (Stewart, 2013; Humphreys, 2010). The standard Tobit model can be used to address the censored data. However, it would yield biased estimates because the standard Tobit model assumes that a variable has the same effect on both stages of the two-part process and thus generates a single coefficient (Stewart, 2013; Möser, 2010). This assumption does not always hold: for example, the number of female household members may positively affect the decision to cook at home but negatively affect how much time a household member allocates to cooking.

The double-hurdle model introduced by Cragg (1971) is applied in this study because the time allocated to food preparation (TAFP) is both a two-stage process and a continuous variable. Our model considers the two-part process as independent and unique decisions. The decision to either prepare food at home or not (D_i) is based on the theory of time allocation developed by Becker (1965) and expanded on by Gronau (1986), which postulates that each good consumed by the household is produced by the combination of time and priced inputs. Therefore, the decision to prepare food or not depends on the opportunity cost of time for food preparation. Whether households allocate time simultaneously or sequentially is essential to how much time they spend cooking. In addition, cooking behaviours like cooking in bulk, types of meals cooked, and cooking frequency affect cooking time. The study did not control for these considerations and factors based on the data used for the analysis.

Since women primarily handle household cooking and food (Wolfson et al., 2021), the regressions focus on female household heads and female spouses of male-headed households. In the first stage (selection model) of the Cragg model, the decision of whether to cook by a female household head or spouses of male-headed households is modelled as a Probit function. In the second stage (output model), after the decision to cook or not is made, the actual time a

female household head or spouse of a male-headed household spends on cooking is modelled as a linear function. We use the same covariates in the first and second stages. The covariate variables used in the first and second stages are the household head's age, sex, marital status, educational status, ownership of a business, and employee status. The other household factors are household size, the proportion of females in the household, asset index and female household head or spouse employee status. The functional form of the model is as follows:

$$TAFP_{it} = \beta_0 + \beta_1 Emp_{it} + \beta_2 Ind_{it} + \beta_3 X_{it} + \varepsilon_{it}$$

Where: $TAFP_{it}$ = Time allocated to food preparation (continuous variable), Emp_{it} = Employment type of the female head/female spouse, Ind_{it} = other individual characteristics (eg. age, education, etc), X_{it} = household characteristics, β_i = Parameters, ε_{it} = Error term.

4.5.3 The effect of time spent on cooking on household DBM

In this section, we determine the effects of time allocated to food preparation on household DBM. We use the correlated random effects (CRE) approach to overcome; the incidental parameter problem when we apply fixed effects estimation to nonlinear panel data models with many cross-sectional units and a short time series, and the random effects' strong assumption that individual unobserved heterogeneity should be uncorrelated with the explanatory variables (Wooldridge & Zhu, 2020; Wooldridge, 2010). Specifically, we apply CRE Probit estimation since household DBM is a dummy variable. In section 3.5.2, we elaborated on the CRE Probit estimation. The Probit model estimates the probability of a change in household DBM when there is a change in explanatory variables like time allocated to food preparation by households.

Notwithstanding the use of CRE Probit, we do not control for all observed and unobserved variables, leading to unobserved heterogeneity and omitted variables issues. Malnutrition can affect a person's health and thus influence their employment status and cognitive abilities. Equally, a person's employment status can influence their eating habits, eating time, food choices and malnutrition status. The objective of the estimation is not to establish causality but to determine the association between time spent on food preparation and household DBM. Therefore, the model will control for potential endogeneity issues to the minimum. Variables like the number of women in the household will be included in the model to control for time spent on food preparation. Food preparation in Ghana is still perceived as a woman's activity. Therefore, the number of women in a household and cooking time allocation are directly

linked. However, the number of adult women in the household is not directly linked to the prevalence of household DBM. The general specification of the model is as follows:

$$MalN_{it} = \alpha_0 + \alpha_1 TAFP_{it} + \alpha_2 Emp_{it} + \alpha_3 X_{it} + \epsilon_{it}$$

Where: $MalN_{it}$= Household double burden of malnutrition status, $TAFP_{it}$= time allocated to food preparation, Emp_{it}= female head/female spouse employment status, X_{it}=other household characteristics, α_{it}=parameters, ϵ_{it}= error term

For robustness check, we run separate CRE Probit regressions on the four types of household DBM (OW/OB_S, OW/OB_U, OW/OB_W and OW/OB_U5-19) to highlight any differences between the effects of cooking time on specific types of household DBM. Further, we run a pooled Probit regression on the effect of cooking time on household DBM. Although pooled data can result in heterogeneity bias, its advantages include increasing the sample size for analysis and how a variable of interest has changed over time (Wooldridge, 2013).

4.6 Results and discussion

4.6.1 Results

4.6.1.1 Summary statistics

Table 4.3 shows the summary statistics of the study. Table A.17 shows the summary statistics of each survey round. From Table 4.3, men head about 59 percent of households, but over the three rounds of the survey, the proportion of male-headed households has decreased from 61 percent in round one to 58 percent in round three. The average age of a household head is 49 years. About 69 percent of household heads are married or living in a consensual union. The majority of household heads have some form of formal education. The share of household heads with no formal education is about 19 percent compared to 24 percent for spouses. The average household size of four has remained relatively constant over the three survey rounds. About 37 percent of household members are female within the age group of 15-64 years. The average household has most of its members in the productive age group (15-64 years). Only 9 and 7 percent of household members are under 5 and above 64 years respectively. About 39 percent of household heads own an off-farm business, while 48 percent of spouses own their off-farm businesses.

Table 4.3: Pooled summary statistics

Characteristic	Description	Mean or % (n)
Household head characteristics		
Age	Mean age (in years)	49.417 (3286)+
Gender (Male household head)	Gender (1=male; 0=female)	59.35 (3314)
Marital status	Marital status (1=married/ consensual union; 0=otherwise)	68.50 (3314)
Education		(n=3300)
1	None	18.67
2	Formal education but not certificate	20.03
3	MSLC/BECE/VOC/TECH	39.27
4	GCE A/SSCE/Prof. certificate	11.24
5	HND/Bach./Masters & above/Prof. qual.	10.79
Household structure		
Household size	Mean no. of household members	3.976 (3314)
Proportion of female household members	Mean proportion of female household members (>15 years & <65 years) to total household size	0.371 (3314)
Proportion of children less than 5 years	Mean proportion of number of children less than 5 years to total household size	0.090 (3314)
Proportion of members over 64 years	Mean proportion of number of adults over 64 years to total household size	0.070 (3314)
Labour force participation		
Ownership of off-farm business_head	Household head owns an off-farm business (1=Yes; 0=No)	39.08 (3309)
Ownership of off-farm business_spouse	Spouse owns an off-farm business (1=Yes; 0=No)	48.26 (1838)
Both head and spouse own different off-farm businesses	Head and spouse own different off-farm businesses (1=Yes; 0=No)	18.26 (1835)
Household head employee status	Household head is an employee (1=Yes; 0=No)	26.75 (3309)
Spouse employee status	Spouse is an employee (1=Yes; 0=No)	11:53 (1838)
Others		
Wealth status	Wealth status based on asset index	(n=3311)
1	Lower	21.14
2	Lower middle	19.60
3	Middle	19.36
4	Upper middle	21.02
5	Upper	18.88
Education of spouse++		(n=1836)
1	None	24.02
2	Formal education but not certificate	22.60
3	MSLC/BECE/VOC/TECH	40.03
4	GCE A/SSCE/Prof. certificate	8.82
5	HND/Bachelor/Masters & above/Prof. qual.	4.52

+the sample used for mean age of household head is less than 3314 because some ages were considered outliers or missing data

++where there are multiple spouses in a household, the spouse with the highest educational level is selected

4.6.1.2 Prevalence of household malnutrition and DBM

Table 4.4 and Table A.18 present sampled households' individual and household-level malnutrition status, respectively. From Table 4.4, stunting is the commonest form of

malnutrition, and wasting is the least common in children under 5 years. Children under 5 years suffering from stunting and wasting range between 25 to 31 and 6 to 18 percent across survey rounds. There is a decline in the prevalence of underweight and wasting among children under 5 years across rounds. Among children aged 5-19 years, underweight (moderate and severe plus mild underweight) prevalence ranges from 17.5 to 26.2 percent. Their average BMI in round 3 is 19.7, higher than in rounds 1 and 2. For women aged 20-49 years, there is a consistent rise in their BMI levels across rounds. The average BMI for women aged 20-49 years is 27.7. This implies that the average woman of reproductive age (20-49 years) in our sample is overweight. The proportion of women categorised as "normal" based on their BMI decreased from 38 percent in round 1 to 27 percent in round 3.

Table 4.4: Prevalence of household member malnutrition among sample households

Variable	Round 1	Round 2	Round 3	*p-value*
Children under 5 years				
Stunting % (n)	24.61 (382)	29.24 (301)	31.43 (280)	0.1331
Underweight % (n)	17.55 (416)	17.63 (329)	11.15 (323)	0.0291**
Wasting % (n)	18.37 (332)	14.55 (268)	6.33 (221)	0.000***
Children 5-19 years				
Moderate and severe underweight (%)	5.98	8.36	6.55	
Mild Underweight (%)	11.48	17.79	11.53	
Normal (%)	54.72	53.73	51.91	
Overweight (%)	17.18	11.77	14.47	
Obese (%)	10.64	8.36	15.54	
Mean BMI	19.003	18.426	19.665	0.0000***
Total N	***1071***	***1113***	***1023***	
Woman (20-49 years)				
Underweight (%)	3.39	1.93	2.35	
Normal (%)	38.36	37.3	26.71	
Overweight (%)	32.86	31.67	35.38	
Obese (%)	25.39	29.1	35.56	
Mean BMI	26.832	27.586	29.051	0.0000***
Total N	***709***	***622***	***554***	

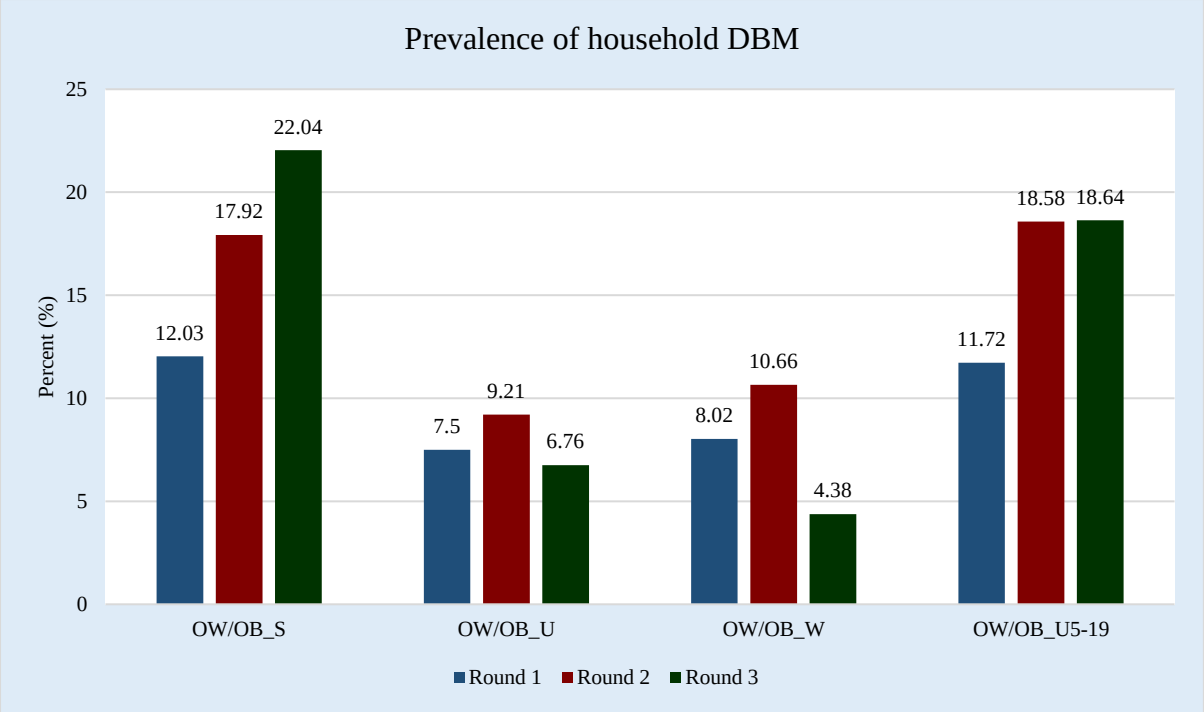
ANOVA conducted across rounds. *** p<0.01, ** p<0.05, * p<0.1

At the household level (Table A.18), households with stunted children ranged between 28 to 34 percent across rounds, while 7 to 20 percent of households had a child suffering from wasting. Households with children under 5 years who suffered from underweight declined from 20 percent in round 2 to 10 percent in round 3. Among children aged 5-19 years, the proportion of households with children suffering from underweight ranged from 25 to 36 percent, and children suffering from overweight/obesity ranged from 30 to 43 percent. About 59 to 72 percent of households with women aged 20-49 years have at least one woman who is overweight/obese. The trend is similar for adults (male or female). For adults (male or female)

aged 20-64 years, the average BMI ranges from 25.4 in round one to 27 in round three. Similarly, the proportion of adult household members who are either overweight/obese steadily increased from 45 percent in round one to 54 percent in round three. The results confirm that different forms of malnutrition exist within and between age groups within a household.

From Figure 4.3, household DBM exists in urban Ghana. The prevalence of household DBM varies depending on the definition used. It can range from as low as 4.3 percent for an overweight/obese woman and a wasted child (OW/OB_W) to as high as 22.0 percent for an overweight/obese woman and a stunted child (OW/OB_S) in round 3. The average prevalence of the different forms of household DBM across the three rounds are 17.3, 7.8, 7.7 and 16.3 percent for an overweight/obese woman and a stunted child (OW/OB_S), an overweight/obese woman and an underweight child (OW/OB_U), an overweight/obese woman and a wasted child (OW/OB_W) and overweight/obese woman and an underweight child (5-19 years) (OW/OB_U5-19), respectively. The highest form of household DBM is an overweight/obese woman and a stunted child (OW/OB_S). It ranges from 12 percent in 2009/2010 (round 1) to 22 percent in 2017/2018 (round 3). Across the three rounds, OW/OB_S and OW/OB_U5-19 have consistently increased, and the increase across the survey rounds is statistically significant. However, OW/OB_U and OW/OB_W have recorded mixed patterns. OW/OB_U and OW/OB_W were higher in round 2 compared to round 1 but decreased in round 3 but not to the initial levels in round 1. The differences recorded in OW/OB_U were statistically significant while those in OW/OB_W were not statistically significant.

Similar patterns develop when the overweight/obesity status of an adult (male or female) household member is combined with an undernourished child. Table A.20 shows the prevalence of household DBM based on adult (male or female) household member and child combination. The overall prevalence levels of DBM are marginally higher for adult household member-child combinations compared to women of reproductive age-child combinations. However, no statistically significant difference is observed in the prevalence levels of adult overweight/obese and stunted child (aOW/OB_S) and adult overweight/obese and wasted child (aOW/OB_W) across survey rounds (Table A.19 and Table A.20).



Repeated-measures ANOVA conducted across rounds. The changes in DBM across rounds is statistically significant except for OW/OB_W

Figure 4.3: Prevalence of household DBM

4.6.1.3 Household factors that affect decision and time spent on cooking

From Table 4.5, women are the primary food handlers in the household. They constitute the highest proportion of food handlers and spend the most time preparing food. About 45 percent of female household heads or spouses of male-headed households are involved in household cooking compared to less than 10 percent of male household heads or spouses. This number has remained relatively constant over the three rounds. Specifically, between 5.7 and 7 percent of household heads or spouses involved in cooking and preparing food are male. A higher proportion of household heads are involved in cooking and other cooking-related activities. About 60 percent of household heads or spouses are involved in cooking and other related activities like food shopping and dishwashing.

Regarding time spent cooking, the results show that time spent cooking by household heads and spouses who cook has increased. However, female household heads and spouses still spend more time cooking than men. Female household heads and female spouses spend between 1.6 and 1.9 hours cooking compared to between 0.9 and 1.2 hours for male household heads and male spouses. The total time spent on cooking by household heads and their spouses has plateaued. The increase in total time spent on food preparation between round one and round

three is statistically significant. However, between rounds two and three, the marginal increase in total cooking time (0.04 hours ≈ 2.4 minutes) is not statistically significant.

Table 4.5: Household head or spouse cooking related activities and time use

	Round 1			Round 2			Round 3		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
No. of household head or spouse involved in:									
Cooking (%)	7.22	47.24	54.47	5.66	45.24	50.90	6.35	45.73	52.07
Cooking & rel. act. (%)+	14.45	48.19	62.64	10.77	46.32	57.09	13.86	48.06	61.92
No. of respondents (N)++		1052			1114			772	
Mean time (hrs) spent by respondent:									
Cooking	.92	1.57	1.49***	1.22	1.87	1.80***	1.23	1.92	1.84***
Cooking & rel. act.	1.29	2.91	2.54***	2.09	3.25	3.03***	1.49	3.08	2.72***

Welch t-test conducted on "mean time" based on sex within rounds. *** p<0.01, ** p<0.05, * p<0.1
Mean differences of "mean time" across rounds is statistically significant
+Cooking and related activities include food related shopping, cooking/food preparation and dishwashing
++Sample size based on households with both household head and spouse responses

Table 4.6 presents the results of the factors that affect a female household head or spouse of a male-headed household's decision to cook and the time spent cooking. From the results, the household head's age, gender, the proportion of female household members, and female household head or spouse employee status affect the decision of a female household head or spouse of a male-headed household to cook (col. 1). The household head's age, the proportion of female household members, and the female household head or spouse employee status negatively affect the decision of a female household head or spouse of a male-headed household to cook. However, a male-headed household positively affects the decision of a spouse to cook.

Among respondents who cook, the household heads' age and ownership of an off-farm business and the household asset index positively affect the time spent cooking by the female household head or spouse. A unit increase in the age of a household head is associated with 0.03 hours (1.8 minutes) increase in the time spent by a female household head or spouse on cooking. Older household heads (age squared) are negatively associated with time spent on cooking. Household heads who own an off-farm business spend 0.07 hours (4.2 minutes) more on cooking than those who do not. Similarly, female household heads or spouses in wealthier households spend more time cooking. A unit increase in the household wealth index is associated with 0.05 hours (3 minutes) increase in cooking time by female household heads or

spouses. Male-headed households are negatively associated with the cooking time of female household heads or spouses. Also, female household heads or spouses who are employees spend -0.14 fewer hours (-8.4 minutes) cooking.

Table 4.6: Time spent cooking by female household head or spouse (pooled sample)

Variables	(1) Decision to cook	(2) Time spent cooking (hours)	(3) AME (hours)
Age of household head	-0.0212***	0.0355***	0.0252***
	(0.00378)	(0.00984)	(0.0086)
Age of household head ^2		-0.000282***	-0.0002***
		(0.00009)	(0.0001)
Household head is male	0.746**	-0.416**	-0.0120
	(0.307)	(0.177)	(0.237)
Marital status of household head	-4.225	-0.107	-0.2542
	(111.1)	(0.254)	(0.2438)
Education of household head	-0.217	-0.00588	-0.0566
	(0.158)	(0.0687)	(0.0693)
Household size	-0.0365	-0.000799	-0.0102
	(0.0240)	(0.0121)	(0.0122)
Proportion of female household members	-0.536*	-0.197	-0.3102*
	(0.317)	(0.157)	(0.1588)
Household head owns off-farm business		0.0784*	0.0677*
		(0.0453)	(0.0392)
Household asset index	-0.00584	0.0565**	0.0473*
	(0.0607)	(0.0256)	(0.0272)
Female household head or spouse is an employee	-0.412***	-0.0431	-0.1447**
	(0.146)	(0.0673)	(0.0693)
Household head employee status	0.150		0.0379
	(0.115)		(0.0283)
Constant	6.511	1.310***	
	(111.1)	(0.382)	
Observations	1,467	1,467	1,467

Note: Results of Cragg hurdle regression. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
Note: AME is the Average marginal effects of time spent cooking.
Source: Author's estimation, 2023

The employee status of female household heads or spouses affects the decision to cook or not and how much time is spent on cooking (Table 4.6). A further analysis of female household heads or spouses' cooking time shows that in round three, women who are employees spend less time on cooking than their non-employee counterparts (Table 4.7). Female household heads or spouses who are employees spent about 0.24 hours (14.4 minutes) less on cooking than non-employees. In earlier rounds, the difference in time spent cooking by employee and non-employee female household heads or spouses was not statistically significant.

Table 4.7: Time spent on cooking by female household head or spouse by employee status

Survey rounds	Non-employee (n) [hours]	Employee (n) [hours]	Total (n) [hours]	Mean diff.+ [hours]
Round 1	1.5835 (428)	1.5123 (61)	1.5746 (489)	0.0712
Round 2	1.8477 (448)	2.0253 (56)	1.8675 (504)	-0.1776
Round 3	1.9446 (318)	1.7048 (35)	1.9208 (353)	0.2398**
Diff. across rounds (p-value)++	*0.0000*	*0.1451*	*0.0000*	

Sample size in parenthesis. Time is in hours. +Welch t-test conducted based on employee status within rounds. ++Repeated-measures ANOVA conducted across rounds. *** p<0.01, ** p<0.05, * p<0.1

4.6.1.4 Effect of time spent on cooking on household DBM

Table 4.8 shows the effect of cooking time on household DBM. We did not observe any statistically significant relationship between the cooking time of female household head or spouse of male-headed households on household DBM (col. 1). A sub-sample analysis based on the types of household DBM (col. 2-col. 5) also shows no statistically significant effect of cooking time of female household head or spouse of male-headed households on household DBM. However, we observed that household size has a statistically significant positive relationship with household DBM. All things equal, an additional household member increases the probability of a household having DBM by about 7.4 percent. The sub-sample analysis also shows that an additional household member increases the probability of OW/OB_U (overweight/obese woman and underweight child) and OW/OB_U5-19 (overweight/obese woman and underweight child between 5 and 19 years) by 3 percent and 4 percent, respectively. Also, we observed a positive relationship between the household asset index and OW/OB_U5-19. All things equally, an additional increase in the household asset index increases the probability of OW/OB_U5-19 by almost 9 percent (col. 5).

For robustness check, we run a pooled Probit regression. For the pooled Probit regression results (Table A.21), we observe a statistically significant positive relationship between the cooking time of female household heads or spouses of male-headed households on household DBM. All things equal, an increase in cooking time by a female household head or spouse of a male-headed household increases the probability of household DBM by almost 4 percent. The results of the sub-sample analysis show that the signs of the coefficients of cooking time of the CRE Probit and pooled Probit regressions are the same, although the magnitudes are different. However, unlike the CRE Probit results, the effect of cooking time on OW/OB_U5-19 is positive and statistically significant. All things equal, an increase in cooking time by a female household head or spouse of a male-headed household increases the probability of OW/OB_U5-19 by about 3 percent. Furthermore, consistent with the results of the CRE Probit,

the pooled Probit shows that an increase in household size increases the probability of household DBM by almost 3 percent. However, the magnitude of the CRE Probit regression is higher (7 percent). The pooled Probit regression results also show that household DBM increased by a probability of almost 8 percent in 2018 compared to 2010 (Table A.21).

Table 4.8: Effect of time spent on cooking on household DBM

VARIABLES	1	Types of DBM 2	3	4	5
	DBM	OWOB_S	OWOB_U	OWOB_W	OWOB_U5-19
Time spent cooking	0.032	0.011	-0.006	-0.023	0.021
	(0.025)	(0.034)	(0.016)	(0.123)	(0.026)
Age of household head	-0.004	-0.016	-0.000	0.012	0.014*
	(0.011)	(0.018)	(0.009)	(0.009)	(0.008)
Sex of household head (male)	0.007	0.053	0.039	-	-0.238
	(0.112)	(0.104)	(0.035)		(0.181)
Education of household head	-0.087	-0.492**	-0.383	-0.517	-0.100
	(0.164)	(0.196)	(0.383)	(0.386)	(0.142)
Household size	0.074***	0.032	0.033*	-0.032	0.044**
	(0.023)	(0.038)	(0.018)	(0.022)	(0.022)
Proportion of female household members	-0.036	-0.487	-0.176	-0.706	0.079
	(0.298)	(0.417)	(0.264)	(1.100)	(0.267)
Household head ownership of off-farm business	-0.078	-0.063	-0.009	-0.002	-0.050
	(0.049)	(0.079)	(0.059)	(0.522)	(0.051)
Household asset index	0.032	-0.081	-0.020	0.018	0.087**
	(0.041)	(0.070)	(0.025)	(0.042)	(0.041)
Female household head or spouse employee status	0.081	0.031	0.012	-0.010	0.163
	(0.125)	(0.060)	(0.022)	(0.067)	(0.177)
Year_dummy_2014	0.043	0.090	-0.021	-0.055	0.043
	(0.067)	(0.120)	(0.056)	(0.193)	(0.056)
Year_dummy_2018	0.047	0.161	-0.072	-0.132	-0.026
	(0.110)	(0.222)	(0.076)	(0.094)	(0.077)
Time varying averaged regressors	Yes	Yes	Yes	Yes	Yes
Observations	828	417	438	370	683
Number of unique household	485	306	314	284	420

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Note: Coefficients are Average Marginal Effects (AME) based on CRE Probit regression; Reference year (Year) is 2010; DBM = (all four types of household double burden of malnutrition), OW/OB_S = (overweight/obese woman and stunted child), OW/OB_U = (overweight/obese woman and underweight child), OW/OB_W = (overweight/obese woman and wasted child), OW/OB_U5-19 = (overweight/obese woman and underweight child between 5 and 19 years)

4.6.2 Discussion

From the analysis of the individual and household malnutrition status, there are multiple forms of malnutrition in urban households, and DBM exists in urban Ghana. The levels of the different forms of malnutrition and their rate of increase or decrease are heterogeneous. The rate of increase in the level of overweight and obesity among adults is higher than the rate of decrease in undernutrition among the same group. The high BMI of women of reproductive

age (20-49 years) is inimical to their long-term health and wellness status. Undernutrition among children under 5 years continues to be high, especially stunting. The proportion of underweight and wasting among children have declined over time. However, the levels of malnutrition in urban Ghana are a growing public health challenge. The heterogeneous nature of malnutrition observed within and among households in urban Ghana is consistent with the global picture. Adult obesity is rising, and the incidence of undernutrition among children, especially in developing countries, has either stagnated or worsened (FAO et al., 2021).

Further, the high prevalence of "overweight/obese woman and a stunted child" observed in the study is consistent with the work of Popkin et al. (2020), who studied household DBM in about 123 low- and middle-income countries. They observed that out of the four combinations of DBM, overweight women and children with stunting have the highest prevalence levels and growth rate (Popkin et al., 2020). Therefore, the high prevalence of "overweight/obese woman and a stunted child" and "overweight/obese woman and an underweight child (5-19 years)" observed in this study may be explained by the high proportion of children under 5 years who are stunted and children between 5 and 19 years who are underweight, respectively, whilst fewer children under 5 years are underweight or wasted. The malnutrition status of sampled individual household members is presented in Table A.18.

A significant proportion of household heads and their spouses are involved in cooking and cooking-related activities in the household. Over 50 percent of household heads or their spouses are involved in cooking on a typical working day. Notwithstanding, a disproportionately higher number of women (approx. 47%) continue to cook and spend more time on cooking activities in urban areas. This result is consistent with the global situation where more women are involved in cooking and cook more frequently than men. Even though there is a narrowing of the gap in time spent on domestic activities by couples in urban areas (de Bruin & Liu, 2020), women still consider cooking to be a core responsibility (Miranda, 2011; Lupton, 1996) and therefore, female spouses will decide positively to cook for the household. In countries with supportive social policies for the family, the gender disparity in cooking frequency is lower compared to other regions that lack these policies (Wolfson et al., 2021; Holm et al., 2021).

The results also show that urban household heads and their spouses spend more time cooking; their total cooking time increased throughout the three survey rounds, although the cooking time plateaued between rounds 2 and 3. The increase in total cooking time by couples could be

attributable to the high cost of eating healthy diets away from home. The cost of eating healthy food outside the home is very high for households, especially in developing countries (FAO et al., 2020), and is thus a reason for families to spend more time cooking at home. In addition, wealthier households (higher asset index) spent more time preparing food. The finding is concurred by Monsivais et al. (2014) and Wolfson et al. (2019) but at variance with Smith et al. (2013).

Smith et al. (2013) observed that although time spent on food preparation has reduced in the United States of America, low-income households spend more time on food preparation. However, compared to high-income households, the proportion of low-income households cooking declined the most from 1965-2008 because many are shifting to convenience foods due to money and time constraints (Smith et al., 2013). A positive association exists between high-income households and time spent cooking at home (Monsivais et al., 2014). As Wolfson et al. (2019) found, high-income households tend to cook more meals (e.g. breakfast, lunch and supper) than low-income households and, therefore, spend averagely more time cooking at home than low-income households. Additionally, low-income households are more likely to use packaged/boxed and frozen products (convenience foods), which saves them time (convenience motives) but may lack adequate nutritional quality (Reardon et al., 2021; Wolfson et al., 2019).

Our results that female household heads and female spouses spend between 1.6 and 1.9 hours cooking compared to between 0.9 and 1.2 hours for male household heads and male spouses is consistent with the gender disparity in cooking time in Ghana. In Ghana, women and men spend about 1.63 hours and 0.45 hours preparing and serving food (GSS, 2012). Unlike our findings, rural households in Ghana spend substantially more time cooking—between 2.4 and 2.76 hours (Prah et al., 2021). Similar to our findings, there is a wide gender disparity in cooking time across other African countries. For example, the cooking and food preparation time (in hours) for women from Burkina Faso, Tanzania, Guinea, Lesotho, Malawi, and Rwanda are 2.35, 2.41, 1.31, 3.73, 1.34 and 3.21 compared to 0.10, 0.28, 0.04, 1.48, 0.20 and 0.08 for men, respectively (IEA, 2017; Kammila et al., 2014). We are mindful of comparing cooking time from different studies because the definition may vary. In addition, improved cooking fuels and efficient cooking technologies discount the cooking time (Uchenna & Oluwabunmi, 2020). Therefore, households with efficient cooking technologies will spend less time cooking. Our study did not account for the type of cooking fuel and cooking technologies.

Furthermore, the evidence that male household heads and male spouses are spending more time cooking now than before is consistent with the findings of Taillie (2018), who showed that more men in the United States of America spend more time cooking now than before. The possible reasons include urbanisation and more women entering the labour force, so the domestic duties are shared between men and women (Bowers, 2000). Another reason could be that urban male household heads are embracing egalitarian gender roles and thus contributing more labour to domestic duties, including cooking (de Bruin & Liu, 2020; Davis & Greenstein, 2009).

The labour market pressure is evident in the difference in the average cooking time of employees and non-employees. The difference in the average cooking time of employee and non-employee female household heads or spouses recorded in round 3 indicates the growing demands in the labour market in urban areas. Moreover, it indicates the trade-off between cooking time and work outside the home. Employee couples (either man or wife is an employee) spend relatively less time cooking than those who are not. As a result, working women adopt convenient strategies like eating outside the home to cope with the demands of the labour market and their domestic activities (Reardon et al., 2021).

From the CRE Probit regression results, cooking time by female household heads or spouses of male-headed households does not significantly affect household DBM. Many factors determine household DBM that have a much more significant effect on household DBM, for example, diet quality (FAO et al., 2021; Miller et al., 2020) and consumption of ultra-processed foods (Reardon et al., 2021) than how much time is spent on cooking. Long-term factors like urbanisation and lifestyle changes affect household DBM (Reardon et al., 2021) more than short-term factors like cooking time. Therefore, public health and nutrition campaigns should go beyond just the consumption of home-cooked meals and encourage the consumption of healthy home meals (Smith et al., 2013) since quality diet outside the home is expensive, especially in developing countries (FAO et al., 2020).

Other factors like household size and household wealth index affect household DBM. The probability of household DBM was higher among households with many members. The nutritional requirements in terms of type and quantity differ for different household members like pregnant and lactating mothers, infants, children, adolescents and adults. Therefore, cooking the same food for all household members may not adequately meet the nutrient requirements of all members (Schneider, 2022). Also, the probability of household DBM (e.g.

overweight/obese woman and underweight child between 5 and 19 years (OWOB_U5-19)) was higher among wealthier households. This finding is consistent with the findings of Seferidi et al. (2022), who, in their study of 55 low-income and middle-income countries (LMICs), found that the probability of DBM was higher among wealthier households in poorer LMICs whiles DBM was higher among poorer households in richer LMICs. Households in poorer LMICs are inclined to consume ultra-processed foods as their economic positions improve: this can cause overnutrition outcomes, including overweight and obesity, but also, because of its poor nutritional value, ultra-processed foods can cause undernutrition, including stunting, wasting and underweight among children and adults (Seferidi et al., 2022; Reardon et al., 2021).

4.7 Conclusion

In this chapter, we focused on the prevalence of household DBM and time spent on cooking and their association in urban areas in Ghana. Malnutrition and DBM is a multifaceted global public health challenges inhibiting people's quality of life. DBM can be at the individual, household, community or global level. Malnutrition is due to undernutrition or overnutrition. Factors like food quality and quantity and food consumption behaviour drive household malnutrition. Urbanisation, sedentary lifestyles and demanding labour markets exacerbate the drivers of urban household malnutrition. Households must decide between time spent in the labour market to earn an income and the time spent on food consumption. The food handlers in the home must make food consumption decisions that will meet the nutritional requirements of all household members. This is a major decision for urban households, especially people experiencing poverty because they suffer from income and time scarcity. Therefore, urban households face the dilemma of how much time is spent in the labour market and adopting convenience strategies to either cook at home or eat outside and its potential effect on the malnutrition status of the household.

Therefore, using the GSPS data, the chapter answered three basic questions on household DBM and time spent on cooking by urban households in Ghana. Specifically, the chapter first determined the existence and prevalence of household DBM in urban Ghana. Second, the factors that affect the decision to cook and the actual time spent on cooking by female household heads and spouses of male-headed households who are employees. Third, the association between cooking time by female household heads or spouses of male-headed households and household DBM. A household is determined to be suffering from household DBM when there exists at least one overweight/obese female household head or spouse of a

male-headed household of reproductive age (20-49 years) and an undernourished (stunting, underweight and wasting) child (0-59 months) or school-aged child or adolescent (5-19 years). Household DBM was computed using household members' anthropometric information (height and weight) to compute z-scores for children and adolescents and BMI for adults. We classified the scores and values obtained into stunting, underweight, wasting and overweight/obesity based on WHO's reference standards for children (0-59 months), school-aged children and adolescents (5-19 years) and adults. We then created a dummy variable for households with DBM and those not. The prevalence of household DBM was computed as a ratio of households with DBM to the total sampled households. Factors affecting household cooking decisions and time spent on cooking were estimated using the Cragg hurdle model. The effect of time spent on cooking on household DBM was estimated using the CRE Probit model.

Our conclusion is that household DBM exists in urban Ghana irrespective of the type of overnutrition of an adult and undernutrition of a child combination applied. The prevalence of household DBM is increasing. However, the level of prevalence of household DBM varies depending on the type of DBM. An overweight/obese woman of reproductive age and a stunted child is the most typical form of DBM among households with an under 5-year child. In addition, overweight and obesity are generally increasing among children aged 5-19 years and adults.

Further, urban household heads and spouses spend about 1.8 hours cooking at home. The time spent by men on cooking is increasing. However, women spend the most time preparing food in households, although the time spent cooking has plateaued. Also, those who work outside the home spend less time cooking than those who do not work outside the home. Female employees devote lesser time to food preparation compared to non-employee females. Although the proportion of female household members negatively affects the decision to cook by female household heads or spouses of male-headed households, the time spent on cooking does not affect household DBM. Other factors like household size and household wealth status affect household DBM.

The home continues to be a critical food environment. As households continue to spend significant time on cooking, although this has plateaued, public health policies and programs should channel their education to the home food environment. With the appropriate education and innovation, household heads and their spouses can prepare more affordable and healthy

home meals within the current average cooking time. These interventions will contribute to improving the malnutrition status of households. Additionally, global interventions like double-duty actions for nutrition should be intensified to slow down household DBM. Programmes like maternal nutrition and antenatal care, exclusive breastfeeding and school feeding for pupils can mitigate household DBM (WHO, 2017d).

Chapter 5: General conclusions and policy implications

5.1 Introduction

This chapter presents the study's general summary, conclusions and policy implications. The first sub-section presents the summary results of each analytical chapter. The second sub-section focuses on general conclusions based on the findings of the analytical chapters, and the chapter ends with policy implications and issues for further research.

5.2 Research summary and key findings

As of 2021, most people in Ghana live in urban areas (GSS, 2022). Urban households face peculiar issues as urban dwellers regarding their food needs. They rely primarily on food markets to meet their food needs. These food markets are a component of the more extensive urban food system—constrained in many ways. So, regarding urban food issues, urban households face some critical food-related issues, including food safety and DBM.

Food safety is a public good that the government must regulate to enhance its efficient delivery. Foodborne pathogens are the primary cause of many unsafe foods in developing countries. Unfortunately, these foodborne diseases are linked to poor sanitation and hygiene conditions, which are prevalent in open-air markets in many developing countries. Furthermore, weather seasonality (precipitation and temperature changes) affects the prevalence of these foodborne diseases and their impact on households. Therefore, as urban households patronise these markets, their exposure to unsafe food consumption is heightened. The home can become a barrier or an avenue for the spread of foodborne diseases. Therefore, households must adopt appropriate food safety behaviour to minimise risks—knowledge and skills of food handlers in the home influence appropriate food safety behaviour. However, knowledge does not always translate into proper behaviour. Factors like convenience, food safety, availability and accessibility influence food handlers' attitudes towards where they buy food and the type of food consumed.

Urban households also face the "nutrition transition" in Sub-Saharan Africa—the result of rapid urbanisation (Hawkes et al., 2017; Popkin, 1999), consumption of more convenient foods high in sugar, salts and fats (Baker et al., 2020; Popkin et al., 2020), sedentary lifestyles (Jezewska-Zychowicz et al., 2018), working away from home (labour market dynamics) (Popkin, 1999), and socioeconomic changes (Islam et al., 2020; Van de Poel et al., 2008). The nutrition transition has contributed to overnutrition. The growing incidence of overnutrition in developing countries (WHO, 2019a), coupled with existing undernutrition and micronutrient

deficiency, has led to the incidence of DBM at the national, regional/state, household and individual levels (Popkin et al., 2020; WHO, 2017b).

The urban household is also constrained by the time allocated to domestic activities because of the high demands of the labour market. Therefore, convenience and time-saving strategies drive their decisions regarding food preparation and consumption (Reardon et al., 2021). There are potential trade-offs between convenience, food safety and malnutrition. Time spent on food preparation and cooking decisions influences dietary diversity (Venn & Strazdins, 2017; Davis & You, 2010) and malnutrition status. Households may also buy food from open-air and street markets to save time on food shopping and cooking rather than go to food outlets far from home but operating in more hygienic conditions. Households also face the dilemma of paying more at safer food outlets or risking their health to purchase food from potentially unsanitary places. Urban households face complex food decisions and choices. Therefore, this study answered the following research questions:

1. What is the effect of food safety and nutrition knowledge on urban households' food purchasing and cooking behaviour?
2. What is the effect of seasonality on household dietary diversity and food safety-related short-term health status?
3. What is the effect of time used for household food preparation on the prevalence of household DBM in urban Ghana?

We used both primary and secondary data. We used primary data from household and market surveys and food microbial data. Primary data was used to analyse research questions one and two. The household and market survey data were collected from Accra, Kumasi and Tamale, major cities in Ghana. The data for the food microbial analysis was collected from the Agbogbloshie market in Accra. The GSPS data (rounds 1-3) is the secondary data used to analyse research question three. The GSPS data is a nationally representative household data set. Research questions one, two and three were addressed in chapters two, three and four.

The first analytical chapter analysed the effect of food safety and nutrition knowledge on household food purchases and cooking practices/behaviour. Higher food safety and nutrition knowledge does not necessarily translate into better food purchasing and cooking practices/behaviour. Using SEM models, we computed households' food safety and nutrition knowledge, attitudes and practices. Also, we analysed urban households' choice of food markets and the underlying considerations. The key findings of chapter two showed that food

safety did not rank high on the reasons households consider in the choice of food market. Only 18 percent of households considered food safety one of their top three considerations for choice of food market compared to over 68 percent who consider convenience as their primary consideration. Supermarket patronage among surveyed households was low, especially for fresh foods, fruits and vegetables, and some local food commodities, because of the availability of more diversified fresh food products in traditional open-air markets. Also, although households are knowledgeable in food safety handling practices, neither food safety knowledge nor attitude had a statistically significant effect on food safety cooking practices/behaviour of urban households in Ghana. The behaviour of urban consumers underscores the need for public policies and regulations like the Public Health Act and the NFSP to regulate the actors and their activities in the food system to protect consumers.

In the second analytical chapter, we tested the presence of selected foodborne pathogens in the Agbogbloshie market. In addition, we analysed whether household food safety status changed across seasons by analysing the effect of seasonality on urban household food safety—measured as the incidence of diarrhoea/vomiting. We also analysed the effect of seasonality on dietary diversity score and food expenditure per capita. Most urban dwellers rely on food markets to meet their food needs, especially traditional open-air markets—which are prone to the risk of spreading foodborne diseases and are linked to domestic production systems which are rain-fed dependent. We estimated the results using fixed effects Poisson and Correlated Random Effects (CRE) Probit models. The findings showed the presence of *E. coli*, *Staphylococcus aureus, Enterococcus faecalis* and aflatoxins (AFB1) in selected fresh/raw food samples. The results also showed that food retailers' food safety knowledge is mainly related to practices that will increase the shelf life of the food products. Furthermore, the incidence of diarrhoea/vomiting among households is higher in the dry season. Also, although HDDS and food expenditure per capita were lower and higher in the dry (harvest) season, we did not observe a statistically significant effect of seasonality on HDDS and food expenditure per capita.

The final analytical chapter focused on household DBM and its association with cooking time. Given the growing rate of urbanisation, economic growth, changing lifestyles and labour market dynamics, households' food choices are equally changing and ultimately manifesting in their malnutrition status. DBM is the co-existence of undernutrition and overnutrition at the national, community, household and individual levels. Using the three rounds of the GSPS data, we determined the presence of household DBM in urban Ghana and analysed household

cooking time and its association with household DBM. We used the Cragg hurdle and CRE Probit models to address the research objectives. The key findings show that there is household DBM in urban Ghana. An overweight/obese woman and a stunted child is the most common form of household DBM. Concerning cooking time, men are spending more time cooking, although women continue to be the primary food handlers in the household. However, household heads and their spouse's cooking time has plateaued. Also, women who are employees (work away from home) spend less time cooking than those who are not. We did not find a statistically significant association between household food preparation time and household DBM. However, household size and wealth status showed a positive and statistically significant association with household DBM.

5.3 General conclusions

The study's overall objective was to investigate urban households' food consumption decisions and behaviour towards food safety and convenience and how cooking time affects household DBM within an urban food system. Thus, the study relied on data from different segments (market/retail, household, food safety) of the urban food system to analyse the food environment of urban households. The overarching conclusion based on the results of the analytical chapters shows that the urban food system in Ghana as presently constituted is inadequate to provide sustainable, safe and healthy foods for urban households.

It is evident from the microbial food analysis that not all fresh/raw food products in urban open-air markets are safe for consumption because they contain some harmful foodborne microbes and aflatoxins. Most urban households are exposed to unsafe food products because they source them from traditional open-air markets, which can be unsanitary. This is compounded by the fact that many retailers in these markets have limited food safety knowledge of the products they sell. Most food retailers' food safety knowledge is about basic sanitation and hygiene that will prolong the shelf life of their products. Further, there needs to be stronger local institutions to enforce regulations and byelaws, as evidenced by the seldom inspection visits made by health/sanitation officers to the retailers.

Due to the busy urban life, convenience (proximity to food market and high product diversity in one location) is important for urban dwellers, and its importance is expected to increase. On the other hand, food safety is not a top priority consideration for the choice of food market among urban households. This indicates that households want to spend minimal time on food consumption (quality and safety); therefore, public institutions in charge of food safety must

ensure the safety of the food sold in the market to protect households from consuming unsafe foods. It is incumbent on the government to guarantee and earn the public's trust in providing safe food for consumption. Also, household food safety knowledge and attitudes do not translate into appropriate food safety cooking practices/behaviour. However, household wealth status positively affects food safety practices/behaviour. Practising appropriate food safety behaviour has associated costs like spacious and clean cooking spaces, clean cookers and fuels, utensils and tools—the lack of which can hinder the practice of appropriate behaviour.

Furthermore, weather seasonality affects urban households' food safety through the incidence of diarrhoea/vomiting. The incidence of diarrhoea/vomiting could be attributable to poor WASH behaviour among households due to intermittent water supply in homes during the dry season and unsanitary and unhygienic market conditions. Unlike the effect of weather seasonality on the incidence of diarrhoea/vomiting, weather seasonality did not significantly affect urban households' HDDS. Complementary to this finding, most food retailers do not shift from their primary raw food products sold to other food products throughout the year. We can infer that they can get food products to sell throughout the year. Therefore, food availability is not a challenge, but due to price fluctuations, food affordability is the challenge urban households face.

As the findings show, convenience is a top priority for households, and convenience motives drive urban households' food consumption decisions because of time constraints faced by urban households. Therefore, they will likely allocate minimal time to domestic activities and maximise their time in the labour market. These decisions can affect households' food behaviours, contributing to household DBM status. There is a high prevalence (12-22%) of an overweight/obese woman of reproductive age and a stunted child in urban households in Ghana. Further, although women are still the primary food handlers in the household, working-away-from-home women (employees) spend less time on food preparation than non-employees. However, we did not find strong evidence of cooking time by female household heads and spouses of male-headed households affecting household DBM. Thus, cooking time does not guarantee correct need-based food allocation, healthy diets and better nutrition status of the household.

5.4 Policy implications

Our study shows that there are lapses in food safety measures along the food supply chain, and households do not consider food safety highly and do not practice enough food safety

knowledge in the home. Further, although urban households still spend significant time cooking, the prevalence of household DBM is growing. Households are driven by convenience motives in their food consumption considerations. Therefore, we need specific interventions tailored to promote food safety, healthy diets and sustainable food systems to manage the changing dynamics in urban areas. Specifically, as most consumers continue to source their raw food products from traditional open-air markets, we must prioritise food safety along the entire food supply chain. Ghana's national food safety, nutrition and health policies and the Public Health Act provide a policy and regulatory framework to tackle the complex and challenging food safety and malnutrition issues.

The current food and nutrition policies and regulations proffer strategies that, if adequately implemented, can address the challenges identified in this study. For example, the National Health Policy (NHP) focuses on preventive healthcare by emphasising nutrition and lifestyle changes. Therefore, contained in the National Nutrition Policy (NNP) are strategies like strengthening households' capacity to increase the production and consumption of nutrient-dense foods, improve the capacity of consumers to demand high food safety standards and bio-fortification of crops, especially staple foods (MoH, 2016). A look at the diets consumed by households showed that starchy staples (maize, rice, yam, cassava and plantains), fats and oils, and sugar and honey are the significant food groups consumed. It is commonplace for all household members to consume the same food. However, different age demographics in the household have different food and nutrition requirements. Therefore, it is appropriate to promote nutrient-dense meals (Schneider et al., 2021) for the whole family to save cost and time on cooking rather than preparing separate meals for each group within the household to meet their nutrition requirements.

Another conclusion of this study is to improve the behaviour of households towards food safety. We recommend promoting educative programmes to nudge consumers into having a positive attitude towards food safety and a high consideration and practice for food safety. Consistent with our recommendation, the current NFSP, besides its extensive market failure correcting strategies, has a strategy to implement a social behaviour change communication (SBCC) strategy to nudge consumers into improving their food safety behaviour. Currently, that strategy has yet to be rolled out, and therefore, the content of such a strategy is not available for analysis. We recommend that such a strategy target every relevant demographic group but emphasise children and young adults who are more amenable to behaviour change.

5.5 Further research focus

This study explored the different forms of household DBM in urban Ghana and the effect of cooking time on household DBM. However, this study has not addressed several aspects of household DBM and its interaction with urban labour market dynamics. In this study, the variable "women who are employees" is used as a proxy to show women working away from home, but in future, actual time spent by women at the workplace can be used, and other workplace conditions like child-care and flexible working hours should be added to the model. Also, with appropriate data, the same woman-child should be tracked over a more extensive period (15 years is the intended period of the project) to capture the effect of cooking behaviour on household DBM.

The role of local government authorities in ensuring food safety in the market should be explored further. According to Ghana's Public Health Act (Act 851), the Metropolitan, Municipal and District Assemblies (MMDAs) are mandated to enact, regulate and enforce food safety laws and by-laws in all food spaces within their jurisdiction. Issues like the institutional capacity of these institutions to implement their mandate in terms of policy framework, political economy analysis, infrastructure, and technology should be analysed. The role of these critical institutions in the success of a food system should be explored further.

Urban households source most of their food products from markets and thus are exposed to food accessibility difficulties, especially for the urban poor. The urban household's food insecurity risk is increased by covariate shocks like Covid-19, which disrupts the food system. Developing countries like Ghana, without elaborate formal social safety nets to support households, are at a higher risk of food insecurity, given the deteriorating economic conditions caused by the pandemic. The measure of urban households' resilience and social safety nets to protect the vulnerable against food insecurity needs to be studied.

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Appendix

Table A.1: Summary of classification of determinants of food choices

Broad categories	Specific factors	Reference
Natural factors	Climatic seasonality, water-related problems, natural disasters and extreme of heat and cold, pests and disease-related risks	Ergashev, 2017+
Policy factors	Inadequate infrastructure and regulatory frameworks, competing government priorities	
Supply factors	Food system, international trade, lack or outdated production system, inadequate marketing facilities, marketing strategies	
Economic factors	National/community wealth, household income, prices of products	
Demographic changes	Change in employment and lifestyle with urbanization, immigration,	
Personal food preferences	Lack of food awareness/knowledge, convenience (eating out, processed foods), taste and eating habits	
Social and cultural factors	Cultural misperceptions affecting dietary preferences, family eating habits and cooking practices	
Epigenetic and environmental	Knowledge, preferences and behaviour, lifestyle and eating habits-healthy eating	Leng et al., (2017)
Physiological mechanisms	Signals to the brain from gastrointestinal tract and adipose tissue which hunger, satiety, motivation to eat	
Economic factors	Prices, marketing, labelling, affordability, availability, accessibility	
Cognitive-affective factors	Perceived stress, health attitude, anxiety, depression	
Dietary component	Palatability, alcohol, etc	
Cultural and social pressures	Shape information environment, media	
Familial and genetic		
Biological Genetic Physiological Psychological and personality-related		Monteleone, et al., (2017)
Socio-cultural	Preferences, behaviour, choice	
Psychobiologic core	Genetics, pleasure, physiology	Booth et al., (2001)
Cultural	Values, life experiences, beliefs, habits	
Social	Social roles, life stage, socioeconomic status, interpersonal relations	
Enablers of choice	Social trends, seasonality, convenience, cost, time, safety, knowledge	
Behavioural settings	Home, food stores, workplace, religious groups, community, NGOs	
Proximal leverage points	Family, local government, developers, shopping malls, health care providers	
Distal leverage points	Food industry, health care industry, government, information industry, transportation system	

+ adopted and modified. Study focused on determinants of uptake of fruits and vegetables

Source: Author's compilation from other studies, 2019

Table A.2: Households' knowledge of safe food handling

Construct	Items	Correct answers (%)			
		Accra	Kumasi	Tamale	Total
Keep clean					
	It is important to wash hands before handling food	98.86	100.00	99.07	99.34
	Wiping cloths can spread microorganisms	77.14	83.03	88.43	83.25
Separate raw and cooked					
	The same cutting board can be used for raw and cooked foods provided it looks clean	23.43	19.72	8.80	16.91
	Raw food needs to be stored separately from cooked food	75.43	83.03	89.81	83.25
Cook thoroughly					
	Cooked foods do not need to be thoroughly reheated	42.29	38.53	11.11	29.89
	Proper cooking includes meat cooked to 40 °C	51.43	42.20	58.80	50.74
Keep food at safe temperatures					
	Cooked meat can be left at room temperature overnight to cool before refrigerating	26.86	21.10	15.28	20.69
	Cooked food should be kept very hot before serving	90.29	87.16	95.37	90.97
	Refrigerating food only slows bacterial growth	73.14	77.52	83.33	78.33
Use safe water and raw materials					
	Safe water can be identified by the way it looks	20.00	13.76	27.31	20.36
	Wash fruit and vegetables	93.71	95.41	99.54	96.39
Total respondents		175	218	216	609

Table A.3: Households' food safety attitude

Construct	Items	Positive attitude (%)			
		Accra	Kumasi	Tamale	Total
Keep clean					
	Frequent hand-washing during food preparation is worth the extra time	85.14	83.49	83.80	84.07
	Keeping kitchen surfaces clean reduces the risk of illness	93.71	96.33	96.76	95.73
Separate raw and cooked					
	Keeping raw and cooked food separate helps to prevent illness	82.86	87.16	93.06	88.01
	Using different knives and cutting boards for raw and cooked foods is worth the extra effort	52.57	61.01	68.52	61.25
Cook thoroughly					
	Meat thermometers are useful for ensuring food is cooked thoroughly	22.29	28.44	40.28	30.87
	Soups and stews should always be boiled to ensure safety	93.71	94.95	94.44	94.42
Keep food at safe temperatures					
	Thawing food in a cool place is safer	62.86	69.27	55.09	62.40
	I think it is unsafe to leave cooked food out of the refrigerator for more than two hours	51.43	72.94	43.98	56.49
Use safe water and raw materials					
	Inspecting food for freshness and wholesomeness is valuable	94.86	94.95	94.44	94.75
	I think it is important to throw away foods that have reached their expiry date	93.71	95.41	79.17	89.16
Total respondents		175	218	216	609

Table A.4: Self-reported food safety cooking behaviour

Construct	Items	Practice always (%)			
		Accra	Kumasi	Tamale	Total
Keep clean					
	I wash my hands before and during food preparation	73.14	81.19	81.02	78.82
	I clean surfaces and equipment used for food preparation before re-using on other food	54.29	66.97	65.74	62.89
Separate raw and cooked					
	I use separate utensils and cutting-boards when preparing raw and cooked food	30.86	43.12	33.33	36.12
	I separate raw and cooked food during storage	39.43	50.00	53.70	48.28
Cook thoroughly					
	I check that meats are cooked thoroughly by ensuring that the juices are clear or by using a thermometer	35.43	39.91	44.91	40.39
	I reheat cooked food until it is piping hot throughout	45.14	47.25	45.83	46.14
Keep food at safe temperatures					
	I thaw frozen food in the refrigerator or other cool place	25.71	36.70	30.09	31.20
	After I have cooked a meal I store any left-overs in a cool place within two hours	30.29	42.66	34.72	36.29
Use safe water and raw materials					
	I check and throw away food beyond its expiry date	67.43	76.15	67.59	70.61
	I wash fruit and vegetables with safe water before eating them	69.71	72.48	93.52	79.15
Total respondents		175	218	216	609

Table A.5: Households' healthy diet knowledge

	Items	Correct answers (%)			
		Accra	Kumasi	Tamale	Total
	Eat moderate amounts of fats and oils				
1	It's better to use unsaturated vegetable oils (eg. Olive, soy, sunflower or corn oil) rather than animal fats or oils high in saturated fats (eg. Butter, ghee, lard, coconut and palm oil)	76.57	88.99	97.22	88.34
2	White meat (eg. Poultry) and fish are better than red meat because they are lower in fat	79.43	81.19	93.06	84.89
3	Eat only limited amounts of processed meats because these are high in fat and salt	84.00	91.74	91.20	89.33
4	People who eat too much saturated fat and trans-fat are at higher risk of heart disease and stroke	74.29	87.61	91.67	85.22
	Eat less salt and sugars				
5	When cooking and preparing foods, limit the amount of salt and high-sodium condiments (eg. Soy sauce, fish sauce, cubes)	91.43	94.95	97.22	94.75
6	Avoid foods (eg snacks) that are high in salt and sugars	88.00	94.50	94.44	92.61
7	Limit intake of soft drinks or soda and other drinks that are high in sugars (eg. Fruit juice, cordials and syrups, flavoured milks and yogurt drinks)	93.71	95.41	92.13	93.76
8	Choose fresh fruits instead of sweet snacks such as cookies, cakes and chocolate	87.43	88.99	92.13	89.66
9	People who eat too much salt have a greater risk of high blood pressure which can increase their risk of heart disease and stroke	81.71	88.07	94.91	88.67
10	People who eat too much sugar have a greater risk of becoming overweight or obese, and an increased risk of tooth decay.	77.71	84.40	90.74	84.73
	Breastfeed babies and young children				
11	From birth to 6 months of age, feed babies exclusively with breast milk (i.e. give them no other food or drink), and feed them "on demand" (i.e. as often as they want, day and night)	88.57	89.91	99.54	92.94
12	At 6 months of age, introduce a variety of safe and nutritious foods to complement breastfeeding, and continue to breastfeed until babies are 2 years of age or beyond	89.71	93.12	99.07	94.25
13	Do not add salt or sugars to foods for babies and young children	69.14	77.06	85.65	77.83
14	Exclusively breastfed babies have better resistance against common childhood illnesses such as diarrhoea, respiratory infections and ear infections.	90.86	88.99	87.04	88.83
	Eat a variety of foods				
15	It is better to eat a combination of different foods, including staple foods, legumes, vegetables, fruits and food from animal sources than just focusing on a particular food	92.57	97.25	96.30	95.57
16	Eating a healthy, balanced diet is especially important for young children's growth and development	92.57	94.50	98.15	95.24
17	Eating a variety of whole (ie unprocessed) and fresh foods every day helps children and adults to obtain the right amounts of essential nutrients.	93.71	95.87	94.44	94.75
	Eat plenty of vegetables and fruits				
18	Eat a wide variety of vegetables and fruits	92.00	95.87	98.15	95.57
19	For snacks, choose raw vegetables and fresh fruit, rather than foods that are high in sugars, fats or salt	83.43	85.78	91.20	87.03
20	Avoid overcooking vegetables and fruit because this can lead to the loss of important vitamins	70.86	79.82	91.20	81.28
	Total respondents	175	218	216	609

Table A.6: EFA with factor loadings of items used in SEM

Indicators (Xs)		Factor loading
	Knowledge	
X_K1	Raw food needs to be stored separately from cooked food.	0.6092
X_K2	Proper cooking includes meat cooked to 40 °C.	0.4777
X_K3	Cooked meat can be left at room temperature overnight to cool before refrigerating.	0.6632
X_K4	Refrigerating food only slows bacterial growth.	0.5778
	Attitude	
X_A1	Frequent hand-washing during food preparation is worth the extra time.	0.4961
X_A2	Keeping raw and cooked food separate helps to prevent illness.	0.7022
X_A3	Using different knives and cutting boards for raw and cooked foods is worth the extra effort.	0.4940
X_A4	Meat thermometers are useful for ensuring food is cooked thoroughly.	0.5682
X_A5	Thawing food in a cool place is safer.	0.5443
X_A6	I think it is unsafe to leave cooked food out of the refrigerator for more than two hours.	0.5246
	Self-reported behaviour	
X_B1	I wash my hands before and during food preparation.	0.6834
X_B2	I use separate utensils and cutting-boards when preparing raw and cooked food.	0.7131
X_B3	I separate raw and cooked food during storage.	0.7617
X_B4	I check that meats are cooked thoroughly by ensuring that the juices are clear or by using a thermometer.	0.5697
X_B5	I thaw frozen food in the refrigerator or other cool place.	0.5051
X_B6	After I have cooked a meal, I store any leftovers in a cool place within two hours.	0.7574
X_B7	I check and throw away food beyond its expiry date.	0.6838
X_B8	I wash fruit and vegetables with safe water before eating them.	0.4592
	Knowledge of Healthy diets	
1	It is better to use unsaturated vegetable oils (eg. Olive, soy, sunflower or corn oil) rather than animal fats or oils high in saturated fats (eg. Butter, ghee, lard, coconut and palm oil)	0.8264
2	White meat (eg. Poultry) and fish are better than red meat because they are lower in fat	0.7524
3	Eat only limited amounts of processed meats because these are high in fat and salt	0.4360
4	People who eat too much saturated fat and trans-fat are at higher risk of heart disease and stroke	0.6309
5	Choose fresh fruits instead of sweet snacks such as cookies, cakes and chocolate	0.6210
6	People who eat too much salt have a greater risk of high blood pressure which can increase their risk of heart disease and stroke	0.6071
7	People who eat too much sugar have a greater risk of becoming overweight or obese, and an increased risk of tooth decay.	0.7976
8	From birth to 6 months of age, feed babies exclusively with breast milk (i.e. give them no other food or drink), and feed them “on demand” (i.e. as often as they want, day and night)	0.8236
9	At 6 months of age, introduce a variety of safe and nutritious foods to complement breastfeeding, and continue to breastfeed until babies are 2 years of age or beyond	0.5784
10	Exclusively breastfed babies have better resistance against common childhood illnesses such as diarrhoea, respiratory infections and ear infections.	0.6035
11	Eat a wide variety of vegetables and fruits	0.7963
12	Avoid overcooking vegetables and fruit because this can lead to the loss of important vitamins	0.4526

Source: Authors’ computation, 2021

Table A.7: Correlation between healthy diet knowledge and food safety cooking practice

Healthy diet knowledge	Food safety cooking practice					
	Keep clean		Separate raw and cooked		Cook thoroughly	
	I wash my hands before and during food preparation	I clean surfaces and equipment used for food preparation before re-using on other food	I use separate utensils and cutting-boards when preparing raw and cooked food	I separate raw and cooked food during storage	I check that meats are cooked thoroughly by ensuring that the juices are clear or by using a thermometer	I reheat cooked food until it is piping hot throughout
It's better to use unsaturated vegetable oils (eg. Olive, soy, sunflower or corn oil) rather than animal fats or oils high in saturated fats (eg. Butter, ghee, lard, coconut and palm oil)	0.087**	0.039	0.018	0.044	-0.014	-0.013
White meat (eg. Poultry) and fish are better than red meat because they are lower in fat	-0.039	-0.020	-0.045	0.077*	0.039	0.004
Eat only limited amounts of processed meats because these are high in fat and salt	0.107***	0.120***	0.083**	0.057	0.035	0.085**
People who eat too much saturated fat and trans-fat are at higher risk of heart disease and stroke	0.135***	0.102**	0.121***	0.060	0.079*	0.042
When cooking and preparing foods, limit the amount of salt and high-sodium condiments (eg. Soy sauce, fish sauce, cubes)	0.058	0.063	-0.022	0.080**	-0.001	0.011
Avoid foods (eg snacks) that are high in salt and sugars	0.084**	0.134***	0.056	0.122***	0.079*	0.085**
Limit intake of soft drinks or soda and other drinks that are high in sugars (eg. Fruit juice, cordials and syrups, flavoured milks and yogurt drinks)	0.049	0.055	0.010	0.073*	0.060	0.075*
Choose fresh fruits instead of sweet snacks such as cookies, cakes and chocolate	-0.044	-0.004	0.098**	0.145***	0.060	0.076*
People who eat too much salt have a greater risk of high blood pressure which can increase their risk of heart disease and stroke	0.030	0.058	0.085**	0.055	0.073*	-0.022
People who eat too much sugar have a greater risk of becoming overweight or obese, and an increased risk of tooth decay.	0.003	0.033	0.044	0.008	0.145***	-0.010
From birth to 6 months of age, feed babies exclusively with breast milk (i.e. give them no other food or drink), and feed them "on demand" (i.e. as often as they want, day and night)	-0.002	-0.013	0.060	0.061	0.096**	-0.015
At 6 months of age, introduce a variety of safe and nutritious foods to complement breastfeeding, and continue to breastfeed until babies are 2 years of age or beyond	0.027	0.044	0.009	0.055	0.002	0.045

Do not add salt or sugars to foods for babies and young children	-0.006	0.007	0.064	0.112***	0.053	-0.045
Exclusively breastfed babies have better resistance against common childhood illnesses such as diarrhoea, respiratory infections and ear infections.	0.059	0.149***	0.104**	-0.044	0.154***	0.098**
It is better to eat a combination of different foods, including staple foods, legumes, vegetables, fruits and food from animal sources than just focusing on a particular food	-0.014	0.066*	0.062	0.064	0.096**	0.055
Eating a healthy, balanced diet is especially important for young children's growth and development	-0.022	0.020	-0.024	0.046	0.027	0.006
Eating a variety of whole (ie unprocessed) and fresh foods every day helps children and adults to obtain the right amounts of essential nutrients.	-0.014	0.048	0.039	0.095**	0.104**	0.115***
Eat a wide variety of vegetables and fruits	-0.014	0.066*	0.029	0.112***	0.080**	0.103**
For snacks, choose raw vegetables and fresh fruit, rather than foods that are high in sugars, fats or salt	-0.033	0.027	0.087**	0.148***	-0.061	0.004
Avoid overcooking vegetables and fruit because this can lead to the loss of important vitamins	0.029	-0.029	0.142***	0.118***	-0.068*	-0.130***

Note: Pearson correlation coefficients between healthy diet knowledge and food safety cooking practice, *** p<0.01, ** p<0.05, * p<0.1

Correlation between healthy diet knowledge and food safety cooking practice (*continued*)

Healthy diet knowledge	**Food safety cooking practice**			
	Keep food at safe temperature		**Use safe water and raw materials**	
	I thaw frozen food in the refrigerator or other cool place	After I have cooked a meal I store any left-overs in a cool place within two hours	I check and throw away food beyond its expiry date	I wash fruit and vegetables with safe water before eating them
It's better to use unsaturated vegetable oils (eg. Olive, soy, sunflower or corn oil) rather than animal fats or oils high in saturated fats (eg. Butter, ghee, lard, coconut and palm oil)	-0.054	-0.013	0.080**	0.078*
White meat (eg. Poultry) and fish are better than red meat because they are lower in fat	0.047	-0.006	0.120***	0.032
Eat only limited amounts of processed meats because these are high in fat and salt	0.003	0.029	0.116***	0.058
People who eat too much saturated fat and trans-fat are at higher risk of heart disease and stroke	-0.029	0.006	0.117***	0.082**
When cooking and preparing foods, limit the amount of salt and high-sodium condiments (eg. Soy sauce, fish sauce, cubes)	0.016	-0.006	0.155***	0.096**
Avoid foods (eg snacks) that are high in salt and sugars	0.055	0.057	0.148***	0.164***
Limit intake of soft drinks or soda and other drinks that are high in sugars (eg. Fruit juice, cordials and syrups, flavoured milks and yogurt drinks)	0.027	0.025	0.147***	0.051
Choose fresh fruits instead of sweet snacks such as cookies, cakes and chocolate	0.019	0.066*	0.136***	0.051
People who eat too much salt have a greater risk of high blood pressure which can increase their risk of heart disease and stroke	-0.072*	-0.053	0.088**	0.033
People who eat too much sugar have a greater risk of becoming overweight or obese, and an increased risk of tooth decay.	0.020	-0.040	-0.003	-0.027
From birth to 6 months of age, feed babies exclusively with breast milk (i.e. give them no other food or drink), and feed them "on demand" (i.e. as often as they want, day and night)	0.089**	0.008	-0.009	0.016
At 6 months of age, introduce a variety of safe and nutritious foods to complement breastfeeding, and continue to breastfeed until babies are 2 years of age or beyond	0.029	0.084**	0.135***	0.064
Do not add salt or sugars to foods for babies and young children	0.061	0.041	0.055	-0.011
Exclusively breastfed babies have better resistance against common childhood illnesses such as diarrhoea, respiratory infections and ear infections.	0.070*	0.051	-0.011	-0.002
It is better to eat a combination of different foods, including staple foods, legumes, vegetables, fruits and food from animal sources than just focusing on a particular food	0.059	0.080**	0.106***	0.027
Eating a healthy, balanced diet is especially important for young children's growth and development	-0.016	-0.008	0.093**	0.056
Eating a variety of whole (ie unprocessed) and fresh foods every day helps children and adults to obtain the right amounts of essential nutrients.	0.047	-0.037	0.139***	0.024
Eat a wide variety of vegetables and fruits	0.042	0.030	0.194***	0.125***
For snacks, choose raw vegetables and fresh fruit, rather than foods that are high in sugars, fats or salt	0.017	0.007	0.073*	0.018
Avoid overcooking vegetables and fruit because this can lead to the loss of important vitamins	-0.013	-0.041	0.005	0.002

Note: Pearson correlation coefficients between healthy diet knowledge and food safety cooking practice, *** p<0.01, ** p<0.05, * p<0.1

Table A.8: Laws with a bearing on food safety and standards in Ghana

	Laws and legislations	Year of enactment
1	Local Government Act, 2016 (Act 936)[+]	2016
2	Public Health Act, 2012 (Act 851)	2012
3	Tourism Act, 2011 (Act 817)	2011
4	Plants and Fertilizers Act, 2010 (Act 803)	2010
5	Fisheries Act, 2003 (Act 625)	2003
6	Food and Drugs (Amendment) Act, 1996 (Act 523)[+]	1996
7	Environmental Protection Agency Act, 1994 (Act 490)	1994
8	Local Government Act, 1993 (Act 462) and Establishment Instruments for Metropolitan/ Municipal/District Assemblies	1993
9	Ghana Standards Board (Food, Drugs and Other Goods) General Labeling Rules, 1992 (L.1. 1541)	1992
10	Weights and Measures (Amendment) Law,1992 (P.N.D.C.L. 301)	1992
11	Veterinary Surgeons Act, 1992, (P.N.D.C.L. 305C)	1992
12	Ghana Standards Board (Amendment) Decree,1979 (A.F.R.C.D. 44)	1979
13	Weights and Measures Act, 1975 (N.R.C.D. 326)	1975
14	Standards Authority Act,1973 (N.R.C.D 173)	1973
15	Ghana Standards (Certification Marks) Rules,1970 (L.1. 662)	1970
16	Ghana Standards (Certification Marks) (Amendment Rules),1970 (L.1. 664)	1970
17	Diseases of Animals Act, 1961 (Act 83)	1961
18	Legislative Framework on Controlling Pests affecting Plants (Prevention and Control of Pests and Diseases of Plants Act, 1965 (Act 307))	1965
19	Animals (Control of Importation) Act, No. 36 of 1952	1952

Note: [+]: Laws added by author

Source: Ministry of Health-National Food Policy (2022)

Table A.9: Characteristics of attrition group

	Accra	Kumasi	Total
Total households (N==63)	65.079%	34.921%	100.00%
Female headed households (N==63)	50.794%	20.635%	71.429%
Marital status of female headed households (%)			
Single	62.50	23.08	51.11
Monogamous married	6.25	53.85	20.00
Divorced	18.75	7.69	15.56
Separated	9.38	7.69	8.89
Cohabitation	3.13	7.69	4.44
N	*32*	*13*	*45*
Mean household size of female headed household	1.813	1.615	1.756
N	*32*	*13*	*45*
Mean household size of single female headed households	1.450	1.333	1.435
Mean household age (years) of single female headed households	29.071	29.750	29.159
N	*20*	*3*	*23*

Source: Authors' computation, 2020

Table A.10: Occupancy status of household dwelling

Occupancy status of dwelling		
Overall	N	%
Owned by relative/family house	246	40.39
Rented	196	32.18
Owned	148	24.30
Squatting	10	1.64
Others	9	1.48
Total	609	100.00
Accra		
Owned by relative/family house	83	47.43
Rented	53	30.29
Owned	28	16.00
Squatting	10	5.71
Others	1	0.57
Total	175	100.00
Kumasi		
Rented	108	49.54
Owned by relative/family house	70	32.11
Owned	32	14.68
Given by government/employer	6	2.75
Others	2	0.92
Total	218	100.00
Tamale		
Owned by relative/family house	93	43.06
Owned	88	40.74
Rented	35	16.20
Total	216	100.0

Source: Author's computation, 2020

Table A.11: Bartlett test of sphericity and Kaiser-Meyer-Olkin measure of sampling adequacy

Bartlett test of sphericity	
Chi-square	2118.383
Degrees of freedom	153
p-value	0.000
Ho:	Variables are not intercorrelated
Kaiser-Meyer-Olkin measure of sampling adequacy	
KMO	0.756

Note: Results based on 18 variables from round one of survey and sample size=609

Table A.12: Ownership of household assets and housing characteristics by SES quintiles

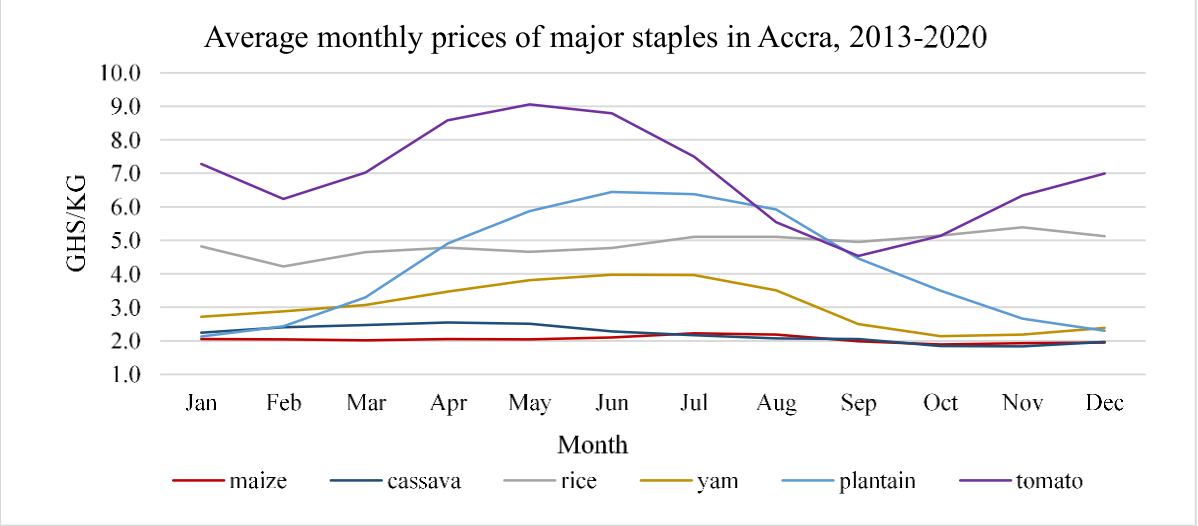
	Variables ***(binary variables)***	Overall (n=609)	Lower (n= 108)	Lower middle (n=130)	Middle (n=115)	Upper middle (n=127)	Upper (n=129)
	Non-productive assets (%)						
1	Radio	64.20	34.26	57.69	66.96	73.23	84.50
2	Television	81.94	27.78	83.85	95.65	95.28	100.00
3	Mobile phone	95.07	75.93	97.69	99.13	100.00	100.00
4	Bed	89.49	63.89	89.23	94.78	97.64	98.45
5	Refrigerator	58.46	3.7	28.46	69.57	85.83	97.67
6	Gas/LPG/Biogas stove	39.24	0.00	9.23	19.13	63.78	96.12
7	Satellite dish/cable tv	39.90	0.93	26.92	49.57	47.24	69.77
8	Laptop	10.18	0.00	0.00	3.48	9.45	35.66
9	Motorcycle	26.27	8.33	17.69	40.87	32.28	31.01
10	Residential land	15.44	8.33	13.08	19.13	15.75	20.16
11	Bank account	49.75	12.96	33.85	46.96	62.99	86.05
	Housing characteristics and amenities (%)						
12	Higher quality wall material	91.95	76.85	90.00	95.65	96.85	98.45
13	Higher quality floor material	90.31	74.07	89.23	89.57	96.06	100.00
14	House ownership	24.30	15.74	21.54	27.83	21.26	34.11
15	Improved housing	27.75	17.59	21.54	27.83	28.35	41.86
16	Improved toilet	47.95	24.07	28.46	35.65	62.2	84.5
17	Don't share toilet	14.29	0.93	2.31	6.96	12.6	45.74
18	Cooking fuel-LPG (gas)	28.24	0.00	5.38	10.43	43.31	75.97

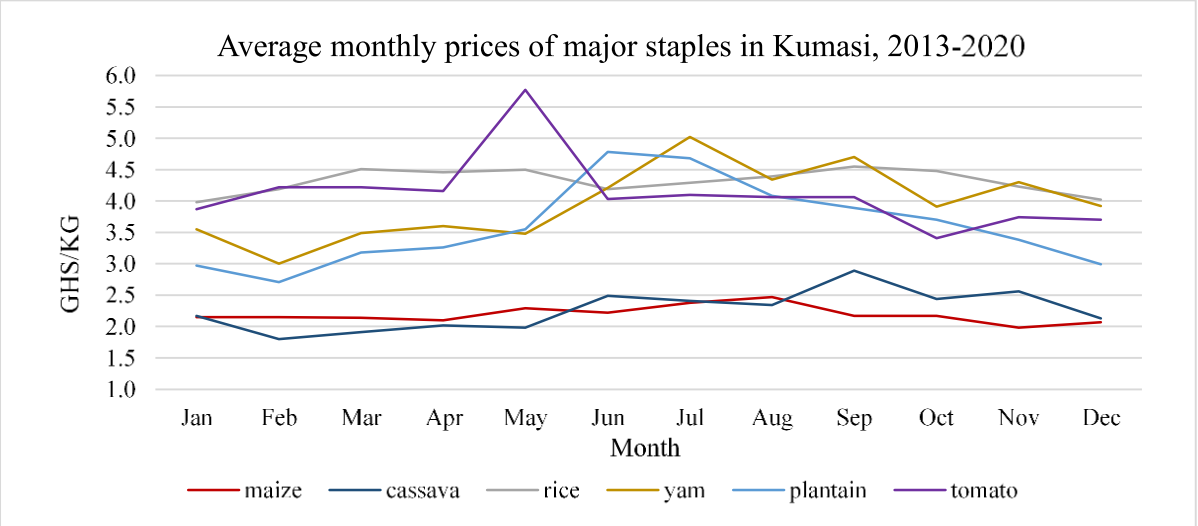
Source: Author's computation, 2020

Table A.13: Ownership of household assets and housing characteristics by SES quintiles and cities

Household assets and characteristics	Lower			Lower middle			Middle			Upper middle			Upper		
	Accra	Kumasi	Tamale	Accra	Kumasi	Tamale	Accra	Kumasi	Tamale	Accra	Kumasi	Tamale	Accra	Kumasi	Tamale
Radio	30.00	32.35	41.18	55.56	68.57	52.00	62.96	82.86	58.49	76.92	80.85	60.98	87.50	94.03	65.79
Television	25.00	26.47	32.35	80.00	85.71	86.00	92.59	91.43	100.00	94.87	91.49	100.00	100.00	100.00	100.00
Mobile phone	70.00	82.35	76.47	95.56	100.00	98.00	96.30	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Bed	60.00	64.71	67.65	86.67	88.57	92.00	92.59	91.43	98.11	100.00	95.74	97.56	95.83	98.51	100.00
Refrigerator	2.50	5.88	2.94	31.11	25.71	28.00	51.85	80.00	71.70	82.05	85.11	90.24	95.83	98.51	97.37
Gas/LPG/Biogas stove	0.00	0.00	0.00	20.00	8.57	0.00	48.15	22.86	1.89	84.62	80.85	24.39	100.00	98.51	89.47
Satellite dish/cable tv	0.00	0.00	2.94	13.33	22.86	42.00	22.22	17.14	84.91	30.77	19.15	95.12	58.33	56.72	100.00
Laptop	0.00	0.00	0.00	0.00	0.00	0.00	7.41	2.86	1.89	10.26	4.26	14.63	29.17	23.88	60.53
Motorcycle	0.00	0.00	26.47	2.22	0.00	44.00	0.00	0.00	88.68	10.26	2.13	87.80	8.33	4.48	92.11
Residential land	0.00	0.00	26.47	0.00	2.86	32.00	3.70	0.00	39.62	0.00	12.77	34.15	8.33	17.91	31.58
Bank account	12.50	14.71	11.76	44.44	37.14	22.00	59.26	42.86	43.40	61.54	59.57	68.29	87.50	83.58	89.47
Higher quality wall material	70.00	70.59	91.18	84.44	97.14	90.00	92.59	100.00	94.34	92.31	97.87	100.00	100.00	98.51	97.37
Higher quality floor material	75.00	82.35	64.71	95.56	97.14	78.00	96.30	100.00	79.25	97.44	100.00	90.24	100.00	100.00	100.00
House ownership	7.50	8.82	32.35	17.78	5.71	36.00	14.81	11.43	45.28	17.95	14.89	31.71	25.00	23.88	57.89
Improved housing	10.00	23.53	20.59	15.56	25.71	24.00	25.93	25.71	30.19	23.08	29.79	31.71	29.17	47.76	39.47
Improved toilet	30.00	41.18	0.00	35.56	51.43	6.00	44.44	71.43	7.55	53.85	87.23	41.46	70.83	92.54	78.95
Don't share toilet	2.50	0.00	0.00	4.44	0.00	2.00	11.11	11.43	1.89	5.13	19.15	12.20	20.83	49.25	55.26
Cooking fuel-LPG (gas)	0.00	0.00	0.00	11.11	5.71	0.00	22.22	17.14	0.00	69.23	48.94	12.20	91.67	83.58	52.63

Source: Author's computation, 2020





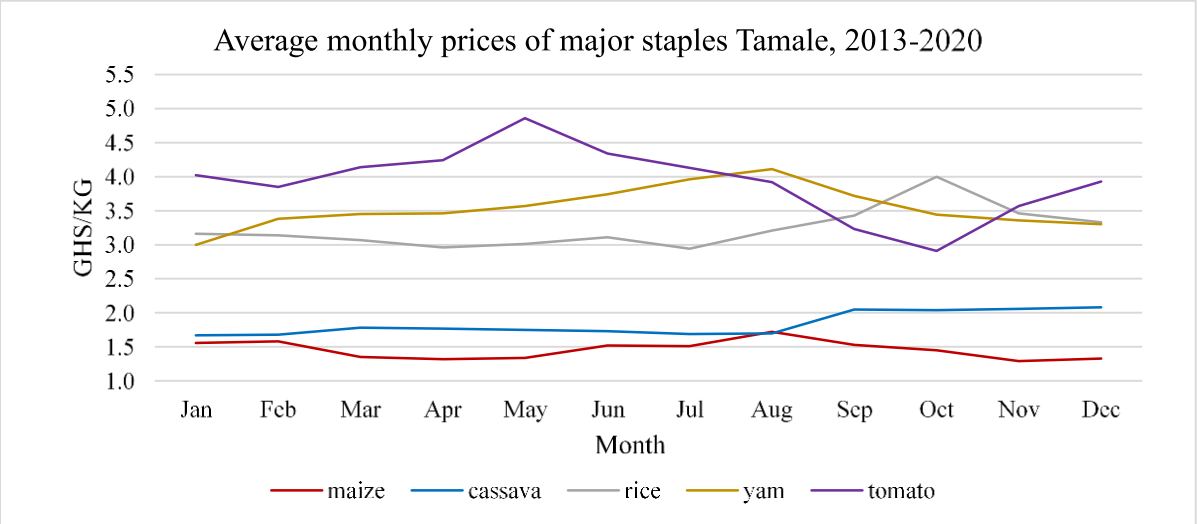


Figure A.1: Real price trends of major food staples in Ghana: 2013-2020
Source: Authors' construction, 2021. Data from ESOKO-Ghana. Real prices monthly price (CPI_base year-2018)

Table A.14: Effect of seasonality on households' incidence of diarrhoea/vomiting

Variables	1	2	3	4
Season (Dry)	0.019	0.096	4.561***	5.814***
	(0.020)	(0.275)	(1.727)	(2.112)
Characteristics of household				
Age of household head	0.001	0.009	-0.058	
	(0.001)	(0.010)	(0.074)	
Sex of household head (male)	-0.007	-0.126	-0.379	
	(0.026)	(0.316)	(1.216)	
Household size	0.011*	0.138**	0.155	0.123
	(0.006)	(0.069)	(0.282)	(0.162)
*Education of household head**				
Primary	0.004	0.419	-8.628***	
	(0.039)	(0.484)	(2.452)	
Secondary	0.038	0.490*	-5.183**	
	(0.024)	(0.265)	(2.403)	
Tertiary	0.005	0.116	-3.947	
	(0.032)	(0.374)	(3.360)	
Household wealth status				
Lower-middle	-0.023	-0.086	0.427	0.591
	(0.021)	(0.295)	(0.492)	(0.516)
Middle	-0.062***	-0.766**	0.017	0.370
	(0.017)	(0.320)	(0.561)	(0.535)
Upper-middle	-0.074***	-1.081***	-0.301	-0.456
	(0.017)	(0.358)	(0.638)	(0.585)
Upper	-0.033	-0.344	0.999	0.192
	(0.023)	(0.296)	(0.798)	(0.750)
Household food safety knowledge	0.0001	0.008	0.016	0.014
	(0.001)	(0.009)	(0.014)	(0.018)
Marital status				
Single	0.021	0.180	-2.308	
	(0.035)	(0.437)	(2.238)	
Monogamous	-0.017	-0.295	0.175	
	(0.028)	(0.351)	(1.498)	
Polygamous	-0.022	-0.467	7.868*	
	(0.042)	(0.603)	(4.123)	
Price of maize+	-0.063**	-1.029***	22.551**	30.229***
	(0.031)	(0.391)	(8.889)	(10.741)
Price of tomatoes+	-0.001	-0.043	0.387	0.474
	(0.005)	(0.065)	(0.336)	(0.453)
Employment status				
Employment status of household head	0.006	0.118	0.226	0.461
	(0.028)	(0.416)	(0.660)	(0.638)
Percent of household members employed	0.001*	0.007	0.018*	0.027**
	(0.000)	(0.005)	(0.011)	(0.012)
Self-reported covid-19 effect				
Affected price of staple foods	0.084**	0.820***	1.088**	0.895*
	(0.036)	(0.312)	(0.431)	(0.501)
Affected price of vegetables	-0.076***	-1.666***	-1.979***	-2.108**
	(0.016)	(0.487)	(0.638)	(0.866)
Constant		-1.918	-3.546**	-61.883***
		(1.317)	(1.707)	(21.724)
Type of dependent variable	Dummy	Count	Count	Count
Time varying averaged regressors	No	No	Yes	No
Number of observations	1212	1212	1212	190
Number of unique households			606	

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Col.1: Average Marginal Effects (AME) after Probit estimation (pooled data); Col. 2: Poisson estimation (pooled data); Col. 3: CRE Poisson estimation; Col.4: PPMLHDFE estimation

* Reference base for educational level is "No formal education"

+Real price of maize and tomatoes are computed based on ESOKO-Ghana December and June price averages from 2013-2020.

Table A.15: Effect of seasonality on HDDS

Variables	1 HDDS	2 HDDS
Season (Dry)	-0.055***	-0.024
	(0.017)	(0.120)
Characteristics of household		
Age of household head	0.001	0.005
	(0.001)	(0.006)
Sex of household head (male)	-0.037	0.156*
	(0.023)	(0.094)
Household size	0.022***	0.036**
	(0.005)	(0.017)
Education of household head[*]		
Primary	0.001	0.165
	(0.036)	(0.157)
Secondary	0.020	0.158
	(0.024)	(0.153)
Tertiary	0.058**	-0.176
	(0.029)	(0.291)
Household wealth index	0.034***	0.035***
	(0.004)	(0.009)
Household food safety knowledge	0.003***	0.003***
	(0.001)	(0.001)
Marital status of household head		
Single	-0.054	-0.598***
	(0.038)	(0.186)
Monogamous	0.019	-0.333***
	(0.027)	(0.082)
Polygamous	-0.009	-0.554**
	(0.044)	(0.271)
Price of maize[+]	0.095***	0.137
	(0.030)	(0.639)
Price of tomatoes[+]	0.008*	0.018
	(0.005)	(0.023)
Employment status		
Employment status of household head	0.030	-0.013
	(0.024)	(0.042)
Percent of household members employed	0.000	0.001*
	(0.000)	(0.001)
Self-reported covid-19 effect		
Affected price of staple foods	-0.048**	-0.031
	(0.019)	(0.030)
Affected price of vegetables	0.021	0.028
	(0.021)	(0.034)
Constant	1.446***	1.467***
	(0.100)	(0.126)
Number of observations	1,212	1,212
Number of unique respondents		606

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Col.1: Poisson estimation (pooled data); Col. 2: CRE Poisson estimation

* Reference base for educational level is "No formal education"

+Real price of maize and tomatoes are computed based on ESOKO-Ghana December and June price averages from 2013-2020.

Table A.16: Effect of seasonality on food expenditure per capita

	1 Log(Total food expend./capita)	2 Log(Total food expend./capita)
Season (Dry)	0.233***	0.216
	(0.044)	(0.300)
Characteristics of household		
Age of head	0.004**	0.016
	(0.002)	(0.012)
Gender of head (male)	-0.010	-0.343
	(0.065)	(0.226)
Household size	-0.167***	-0.217***
	(0.015)	(0.046)
Educational level[*]		
Primary	0.204**	1.808***
	(0.083)	(0.437)
Secondary	0.133**	0.585
	(0.054)	(0.500)
Tertiary	0.184***	1.666**
	(0.070)	(0.713)
Household wealth index	0.068***	0.067***
	(0.009)	(0.021)
Household food safety knowledge	0.006***	0.003
	(0.002)	(0.002)
Marital status		
Single	0.244***	0.727*
	(0.083)	(0.376)
Monogamous	-0.031	-0.090
	(0.073)	(0.174)
Polygamous	0.216*	-0.277
	(0.113)	(0.659)
Price of maize[+]	0.839***	1.464
	(0.069)	(1.660)
Price of tomatoes[+]	-0.001	-0.166***
	(0.011)	(0.051)
Employment status		
Employment status of household head	-0.025	-0.021
	(0.073)	(0.128)
Percent of household members employed	0.003***	0.000
	(0.001)	(0.002)
Self-reported covid-19 effect		
Affected price of staple foods	0.010	0.074
	(0.057)	(0.081)
Affected price of vegetables	-0.060	-0.200**
	(0.067)	(0.098)
Constant	2.866***	
	(0.250)	
Number of observations	1,212	606
R-squared	0.480	0.132

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Col.1: Pooled OLS estimation; Col. 2: First-differenced estimation

* Reference base for educational level is "No formal education"

+Real price of maize and tomatoes are computed based on ESOKO-Ghana December and June price averages from 2013-2020.

Table A.17: Summary statistics of each GSPS round

Characteristic	Description	Round 1	Round 2	Round 3
		Mean or % (n)	Mean or % (n)	Mean or % (n)
Household head x'tics				
Age	Mean age (in years)	46.909	49.299	52.137
		(1113)	(1099)	(1074)
Gender	Gender (1=male; 0=female)	61.30	58.69	58.03
		(1119)	(1111)	(1084)
Marital status	Marital status (1=married/ consensual union;	70.33	67.69	67.44
	0=otherwise)	(1119)	(1111)	(1084)
Education		(n=1113)	(n=1107)	(n=1080)
1	None	20.22	18.34	17.22
2	Formal education but not certificate	18.24	21.05	20.84
3	MSLC/BECE/VOC/TECH	39.44	39.29	39.26
4	GCE A/SSCE/Prof. certificate	12.13	10.75	10.83
5	HND/Bach./Masters & above/Prof. qual.	9.97	10.57	11.85
Household structure				
Household size	Mean no. of household members	4.074	3.886	3.967
		(1119)	(1111)	(1084)
Proportion of female household	Mean proportion of female household members	0.361	0.380	0.373
members	(<15 years & >=65 years) to total household size	(1119)	(1111)	(1084)
Proportion of children less than	Mean proportion of number of children less than	0.104	0.091	0.074
5 years	5 years to total household size	(1119)	(1111)	(1084)
Proportion of members over 64	Mean proportion of number of adults over 64	0.057	0.070	0.084
years	years to total household size	(1119)	(1111)	(1084)
Labour force participation				
Ownership of off-farm	Household head owns an off-farm business	36.28	42.10	38.87
business_head	(1=Yes; 0=No)	(1119)	(1107)	(1083)
Ownership of off-farm	Spouse owns an off-farm business (1=Yes;	41.97	54.04 (607)	49.15
business_spouse	0=No)	(641)		(590)
Both head and spouse own	Head and spouse owns different off-farm	12.48	21.19	21.53
different off-farm businesses	businesses (1=Yes; 0=No)	(641)	(604)	(590)
Household head employee status	Household head is an employee (1=Yes; 0=No)	31.19	27.10	21.79
		(1119)	(1107)	(1083)
Spouse employee status	Spouse is an employee (1=Yes; 0=No)	12.01	11.53	11.02
		(641)	(607)	(590)
Others				
Wealth status	Wealth status based on asset index	(n=1116)	(n=1111)	(n=1084)
1	Lower	22.94	20.25	20.20
2	Lower middle	17.65	20.34	20.85
3	Middle	19.44	19.62	19.00
4	Upper middle	20.52	22.23	20.30
5	Upper	19.44	17.55	19.65
Education of spouse*		(n=640)	(n=607)	(n=589)
1	None	26.41	22.90	22.58
2	Formal education but not certificate	18.75	26.52	22.75
3	MSLC/BECE/VOC/TECH	42.97	36.90	40.07
4	GCE A/SSCE/Prof. certificate	8.13	8.90	9.51
5	HND/Bachelor/Masters & above/Prof. qual.	3.75	4.78	5.09
Regions**	Administrative regions	(n=1119)	(n=1111)	(n=1084)
1	Western Region	7.33	7.02	6.09
2	Central Region	8.31	8.64	9.13
3	Greater Accra Region	21.09	21.15	21.68
4	Volta Region	7.06	7.11	6.73
5	Eastern Region	12.42	11.70	11.44
6	Ashanti Region	20.11	19.80	20.94
7	Brong Ahafo Region	10.36	11.43	11.16
8	Northern Region	9.92	9.81	9.96
9	Upper East Region	2.06	1.98	1.48
10	Upper West Region	1.34	1.35	1.38

Table A.18: Individual and household level malnutrition status of sampled households

	Round 1 (R1)		Round 2 (R2)		Round 3 (R3)	
Variable	Individuals+	Household++	Individuals+	Household++	Individuals+	Household++
Under 5 years						
Stunting % (n)	24.61 (382)	27.96 (304)	29.24 (301)	33.73 (249)	31.43 (280)	32.90 (231)
Underweight % (n)	17.55 (416)	19.27 (327)	17.63 (329)	20.22 (272)	11.15 (323)	10.34 (261)
Wasting % (n)	18.37 (332)	19.85 (272)	14.55 (268)	17.03 (229)	6.33 (221)	7.41 (189)
5-19 years						
Moderate and severe underweight (%)	5.98	9.79	8.36	13.10	6.55	10.74
Mild Underweight (%)	11.48	18. 68	17.79	27.89	11.53	19.26
Normal (%)	54.72	66.37	53.73	69.05	51.91	63.15
Overweight (%)	17.18	27.94	11.77	19.39	14.47	23.52
Obese (%)	10.64	17.79	8.36	13.44	15.54	23.70
Underweight		25.27		35.88		27.04
Overweight/obese (%)		40.75		29.93		42.59
Mean BMI	19.003		18.426		19.665	
Total	***1071***	***562***	***1113***	***588***	***1023***	***540***
Woman (20-49 years)						
Underweight (%)	3.39	3.45	1.93	1.95	2.35	2.37
Normal (%)	38.36	38.42	37.30	37.4	26.71	26.78
Overweight (%)	32.86	33.09	31.67	32.03	35.38	35.70
Obese (%)	25.39	25.76	29.10	29.43	35.56	35.88
Overweight/obese (%)		58.85		61.14		71.58
Mean BMI	26.832		27.586		29.051	
Total	***709***	***695***	***622***	***615***	***554***	***549***
Adults (20-64 years)						
Underweight (%)	4.70	7.94	4.81	7.43	4.48	7.57
Normal (%)	49.62	60.88	50.27	63.96	41.16	53.32
Overweight (%)	29.13	43.24	27.57	44.28	29.06	45.02
Obese (%)	16.56	25.69	17.34	29.02	25.30	36.93
Overweight/obese (%)		62.65		64.26		72.72
Mean BMI	25.408		25.534		27.063	
Total	***1830***	***1020***	***1828***	***996***	***1810***	***964***

Note: +individual household members with malnutrition; ++a household with at least a member with malnutrition; a household can have multiple forms of malnutrition present. Therefore, under household++, moderate and severe underweight + mild underweight ≠ underweight; overweight + obese ≠ overweight/obese.

Table A.19: Household DBM-Overweight/obese woman of reproductive age and malnourished child combination

	Round 1		Round 2		Round 3		p-value
	N	%	N	%	N	%	
Under 5 years							
OWOB woman and stunting child (OW/OB_S)	266	12.03	212	17.92	186	22.04	0.0806*
OWOB woman and underweight child (OW/OB_U)	280	7.50	228	9.21	207	6.76	0.0658*
OWOB woman and wasting child (OW/OB_W)	237	8.02	197	10.66	160	4.38	0.4431
5-19 years							
OWOB woman and Underweight* (OW/OB_U5-19)	435	11.72	436	18.58	413	18.64	0.0007***

Repeated-measures Anova test conducted across rounds. *** p<0.01, ** p<0.05, * p<0.1

Table A.20: Household DBM-Overweight/obese adult household member and malnourished child combination

	Round 1		Round 2		Round 3		p-value
	N	%	N	%	N	%	
Under 5 years							
OWOB adult and stunting child (aOW/OB_S)	297	15.49	241	20.75	227	22.91	0.1125
OWOB adult and underweight child (aOW/OB_U)	317	8.83	262	10.69	254	7.09	0.0488**
OWOB adult and wasting child (aOW/OB_W)	267	9.36	222	11.71	186	4.84	0.5325
5-19 years							
OWOB adult and Underweight* (aOW/OB_U5-19)	551	11.98	570	19.30	532	17.67	0.0059***

Repeated-measures Anova test conducted across rounds. *** p<0.01, ** p<0.05, * p<0.1

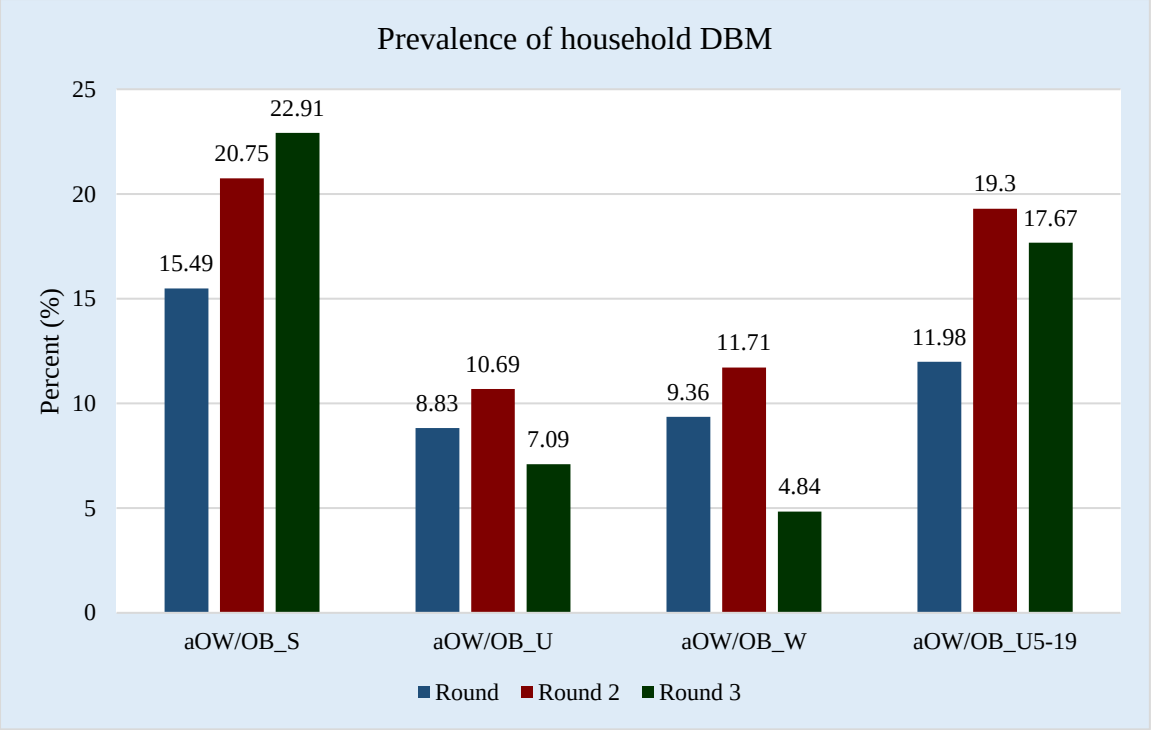


Figure A.2: Prevalence of household DBM (adult (male or female) household member (20-64 years) and undernourished child

Table A.21: Effect of time spent on cooking on household DBM (pooled sample)

VARIABLES	Types of DBM				
	1	2	3	4	5
	DBM	OWOB_S	OWOB_U	OWOB_W	OWOB_U5-19
Time spent cooking	0.038**	0.025	-0.004	-0.012	0.034**
	(0.018)	(0.023)	(0.014)	(0.014)	(0.017)
Age of household head	-0.001	0.004	-0.001	0.001	0.001
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Sex of household head (male)	-0.120	-0.132	-0.057	-0.095	-0.000
	(0.126)	(0.141)	(0.113)	(0.159)	(0.085)
Education of household head	0.060	0.035	0.046	0.049	0.035
	(0.046)	(0.057)	(0.032)	(0.032)	(0.047)
Household size	0.026***	-0.008	0.012*	0.013*	0.024***
	(0.008)	(0.011)	(0.006)	(0.007)	(0.007)
Proportion of female household members	-0.212	0.377*	-0.004	-0.146	-0.024
	(0.148)	(0.220)	(0.159)	(0.158)	(0.130)
Household head ownership of off-farm business	0.020	0.021	-0.007	0.010	-0.008
	(0.031)	(0.038)	(0.027)	(0.027)	(0.032)
Household asset index	0.017	-0.022	0.010	0.001	0.029*
	(0.018)	(0.022)	(0.015)	(0.014)	(0.016)
Female household head or spouse employee status	0.074	-0.042	-0.007	0.063*	0.065
	(0.047)	(0.054)	(0.036)	(0.035)	(0.049)
Year_dummy_2014	0.041	0.094**	0.016	-0.035	0.061*
	(0.035)	(0.044)	(0.029)	(0.030)	(0.034)
Year_dummy_2018	0.075**	0.147***	-0.005	-0.092**	0.048
	(0.037)	(0.049)	(0.032)	(0.037)	(0.036)
Observations	828	417	438	370	683

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Note: Coefficients are Average Marginal Effects (AME) based on pooled Probit regression; Reference year (Year) is 2010; DBM = (all four types of household double burden of malnutrition), OW/OB_S = (overweight/obese woman and stunted child), OW/OB_U = (overweight/obese woman and underweight child), OW/OB_W = (overweight/obese woman and wasted child), OW/OB_U5-19 = (overweight/obese woman and underweight child between 5 and 19 years)