The epidemiology and drivers of healthy, sustainable diets in sub-Saharan Africa

By

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Acknowledgements

"Weeping may endure for a night, but joy comes in the morning."

Psalm 30:5

The journey towards completing this thesis has been laborious and challenging, despite being an exceptional learning curve. The obstacles along the way were many and so huge that I sometimes felt there was no end in sight. Nonetheless, the strength to forge on each morning has been magical. Ultimately, however, it has been worthwhile and an exceptional learning curve. I thank the Almighty God for life, grace, and a renewed strength each morning throughout this journey.

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Author contributions

Study component one (Systematic review 1): Searches, screening and quality appraisal, data extraction, and meta-regression analysis were undertaken by Daniel Opoku Mensah (DOM). Tahir Bockarie (TB) screened titles and abstracts of search results. Oyinlola Oyebode (OO) screened full-text articles, contributed to quality appraisal, extracted data, and provided supervisory guidance. Ana Raquel Nunes (ARN) screened full-text articles, performed quality appraisal, and contributed to data extraction.

Study component two (Systematic review 2): Searches, screening and quality appraisal, data extraction, and narrative review were undertaken by DOM. Faustina Mintah (FM) screened titles and abstracts of search results, conducted quality appraisal, and contributed to data extraction. OO provided guidance.

Study component three (Geo-mapping & assessment): DOM development mapping and assessment tools. University of Ghana (UG) Youth Mappers volunteered to assist with food outlet mapping and assessment, with support from FM and Sylvia Adoma Oteng (SAO). Technical guidance and theoretical guidance were respectively provided by Gideon Yeboah (GY) and OO.

Study component four (Qualitative studies): The coding framework was developed by DOM and reviewed by OO. FM and SAO took turns in assisting DOM with field notes during interviews. FM assisted in coding a transcript.

Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. It has been composed by me, except where indicated, and has not been submitted elsewhere in any previous application for any degree. Parts of this thesis have been published by the author (listed in Section 9.7).

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Abstract

Background: The food environment in sub-Saharan Africa (SSA) has transformed rapidly in recent decades to increase the availability of unhealthy food options. Dietary changes are significantly contributing to adverse environmental impacts and a rapidly increasing burden of obesity and diet-related noncommunicable diseases (NCDs) co-existing with unresolved undernutrition and communicable disease prevalence. Trends in the consumption of foods, the characteristics of the prevailing food environment, and how individuals interact with their food environment to contribute to the double malnutrition burden in SSA are less understood. The aims of this PhD were to examine secular trends in consumption of food groups important for health in SSA; examine the food environment characteristics in a case study elite urban community in Ghana; investigate how residents of the urban community interact with their food environment to shape dietary behaviours; and explore their willingness and attitudes towards the adoption of healthy and sustainable diets.

Methods: A mixed methods approach was adopted as follows: (1) evidence synthesis of literature reporting meat, fruit, and vegetable (MFV) consumption in SSA and (2) of literature reporting ultra-processed foods consumption in SSA; (3) Geographic Information Systems (GIS) tools were used to collect data on the characteristics of the food environment within University of Ghana campus including the location, count, and distribution of food outlets. An adapted food classification tool was utilized to categorise outlets as NCD-health, NCD-intermediate or NCD-unhealthy; and (4) qualitative focus group discussions (FGDs) and dyadic interviews with best friend pairs (or best friend pair interviews-BFPIs) were used to collect students' perspectives of their interaction with their food environment and how it impacts their dietary practices. The FGDs and BFPIs also gathered students' attitudes to dietary change in relation to health and environmental sustainability.

Results: Study components 1 and 2 highlighted that MFV consumption has seen upward trends in SSA populations over the last 38-year period between 1977 and 2015, although fruit and vegetable consumption remain significantly below WHO recommendations. Richer SSA countries are consuming more meat (ß =36.76, p=0.04) and vegetable (ß =43.49, p=0.00) than poorer countries. Further, it suggested that ultra-processed foods (UPFs) consumption in SSA populations has gone up and highlighted key gaps in the UPFs consumption literature in SSA. Urban residents and females appeared to be consuming more UPFs than rural dwellers and males. Study 3 showed that the characteristics of the food environment is suggestive of an obesogenic one, dominated by more NCD-unhealthy than NCD-healthy food-outlets (50.72% vs 39.86%). Food outlets were unevenly distributed over the university foodscape, with more NCD-unhealthy outlets clustering closer to residential than departmental buildings. This difference was statistically significant for food outlets within 100-meter buffer (p=0.00) of residential structures and those within 100 and 500 meters from departmental buildings/lecture halls (p=0.05 and p=0.00, respectively). Study component 4 (n=46) identified a complex interplay of individual and social level factors interacting with food environment characteristics to shape dietary behaviours.

Conclusion: The findings of this thesis provide detailed understanding of trends in consumption of food groups important for health and the environmental sustainability in Sub-Saharan Africa. It also provides in-depth understanding of how young adults interact with their food environment and how the food environment influences dietary behaviours, which could be used to inform context and culturally specific interventions.

Abbreviations

AOR:	Adjusted Odds Ratio
ASFs:	Animal source foods
BSREC:	Biomedical Sciences Research Ethics Committee
CI:	Confidence interval
CVDs:	Cardiovascular diseases
DBM:	Double burden of malnutrition
EPRC:	Ethical and Protocol Review Committee
FAOSTAT:	Food and Agriculture Organization Corporate Statistical Database
FSR:	Full-service restaurants
FV:	Fruit and vegetable
GBD:	Global Burden of Disease
GHG:	Greenhouse gas
GPS:	Global positioning system
GSS:	Ghana Statistical Service
HICs:	High-income countries
HMEs	High meat-eaters
HVPs:	High-value products
IARC:	International Agency for Research on Cancer
INFORMAS:	International Network for Food and Obesity/noncommunicable diseases Research, Monitoring and Action Network Support
IPCC:	Intergovernmental Panel on Climate Change
KFC:	Kentucky Fried Chicken
LICs:	Low-income countries
LMICs:	Low-and-middle-income countries
MDGs:	Millennium Development Goals
MFV:	Meat, fruit, and vegetable
NCDs:	Non-communicable diseases
NHANES:	National Health and Nutrition examination Survey
NR-NCDs:	Nutrition-related noncommunicable diseases

OOH:	Out-of-home
PAHs:	Polycylic aromatic hydrocarbons
PRISMA:	Preferred Reporting Items for Systematic Review and Meta-Analysis
QGIS:	Quantum Geographic Information System
QSR:	Quick service restaurants
QUAIDS:	Quadratic Almost Ideal Demand System
SD:	Sustainable Development
SDGs:	Sustainable Development Goals
SEM:	Socio-ecological models
SSA:	sub-Saharan Africa
SSBs:	Sugar-sweetened beverages
TFCs:	Transnational food companies
UNDESA:	United Nations Department of Economic and Social Affairs
UNESCO:	United Nations Educational, Scientific, and Cultural Organization
UNFCCC:	United Nations Framework Convention on Climate Change
UPFs:	Ultra-processed foods
UR:	University Restaurant
WaSH:	Water, Sanitation and Health
WHO:	World Health Organisation
WWAP:	World Water Assessment Programme

CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

This chapter gives the rationale and overview of the thesis, including the thesis structure. The first part introduces the research problem along with the research aim and research questions, and the rationale for the study. The next section outlines the philosophical and theoretical foundations of the research and introduces the rationale for the chosen methods. The final section puts the study in context, giving an overview of the study setting.

1.2 Introduction to the research problem

Feeding an ever-expanding population in a manner that supports both human and planetary health is one of the world's biggest challenges today. The coexistence of various forms of malnutrition—including undernutrition, overweight, and obesity—is the leading cause of ill-health and global deaths affecting every country (Afshin et al., 2019; GNR, 2018; Swinburn et al., 2019). According to the 2018 Global Nutrition Report (GNR), 88% of countries in the world are struggling with a coexistence of multiple malnutrition burdens (GNR, 2018), most of which is attributable to diets high in saturated fat, salt, sugar, meat, and highly refined foods, but containing low fiber, fruit and vegetable (FV) (Popkin et al., 2020). At the same time, food production and consumption activities are contributing significantly to unprecedented impacts on the Earth and its ecosystems. If food production activities and consumption preferences do not become more environmentally friendly, it is projected that anthropogenic climate change will further exacerbate malnutrition (Swinburn et al., 2019), hunger (FAO et al., 2018) and food security (McConnell & Viña, 2018), resulting in an even greater disease burden attributable to diets (Downs et al., 2020).

Population and planetary health researchers have recently described the three pandemics—obesity, undernutrition and climate change—as a global syndemic, given their co-occurrence in time and place, sharing common primary causes, and interacting to produce more complicated consequences (Swinburn et al., 2019).

The food environment, defined as "the types of food sources that are available to an individual and the food types consumers are exposed to in those environments (availability of healthy and unhealthy foods, food prices, promotions and marketing)" significantly influence food choice, dietary behaviours and nutritional health (Steeves et al., 2014:2). Since the 1990s, the food environment in sub-Saharan Africa (SSA) is said to have rapidly evolved in a manner that it now supplies more affordable, highly palatable, energy-dense, and ultra-processed foods (UPFs). UPFs, one of four categories of the NOVA food classification system (see Table 1.1), have been described as industrial formulations manufactured from substances derived from foods using a chain of physical, chemical, and biological processes (Monteiro et al., 2010, 2019). They typically contain minimal or no whole foods and are often manufactured with flavourings, colors, emulsifiers, and other cosmetic additives to make them highly palatable, addictive, and have longer shelf life. Typical examples of UPFs are outlined in Table 1.1. They are attractively and conveniently packaged, ready-to-eat or ready-to-heat, requiring little or no culinary skills to prepare, are heavily marketed, and relatively affordable and appealing to all social classes (Monteiro et al., 2019; Reardon et al., 2021). By nature, UPFs are high on sugar, salt, and saturated fats contributing to their high palatability, but are nutrient poor, low on fiber, and calorie-dense (PAHO/WHO, 2015). Their attractiveness and high palatability encourage overeating (Hall et al., 2019). The changing food environment in SSA is therefore implicated in an on-going nutrition and epidemiologic transitions resulting in high levels of undernutrition co-occurring with a growing burden of over-nutrition (overweight and obesity) and nutrition-related noncommunicable diseases (NR-NCDs) (de Araújo et al., 2021; Onyango et al., 2019; Popkin et al., 2020) both at the individual and household level (Acharya et al., 2020; Kosaka & Umezaki, 2017; Wojcicki, 2014).

Malnutrition, in all its forms, ultimately arise from inadequate nutrient intake (undernutrition) or positive energy balance over time (obesity/overweight). However, a complex interplay of factors lead to this inadequacy or imbalance. Butland et al. (2007) outlines over one-hundred factors that directly or indirectly impact under- or over-nutrition negatively or positively. These include modifiable factors at the individual and community level. Key amongst these are poor dietary practices, food choice, and physical (in)activity, for which the environment is a key determinant. In SSA, the observed changes in the food environment is said to be driven partly by rapid urbanization and socioeconomic transformation accompanied by rising incomes and more demanding occupations which play crucial roles in increasing preference for and consumption of diets high in ultra-processed and animal-based food products (Shisana et al., 2014). It has been argued that these trends are not sustainable, whether from the health, environmental or economic viewpoint (Lang, 2017).

According to the World Water Assessment Programme (WWAP), the food system consumes 70% of all freshwater[1] drawn for human consumption (WWAP, 2018). It also takes up over one-third of the Earth's productive land (Smith et al., 2014) and is responsible for nearly a fourth of global greenhouse gas (GHG) emissions (UNFCC, 2010) with livestock production alone accounting for 80% in each instance (Smith et al., 2014; UNFCC, 2010). In the 2017 Global Burden of Diseases, Injuries and Risk Factors Study, poor diets, including overconsumption of meat and low intake of FV, are a risk factor in one of five deaths worldwide and the second highest risk factor (after smoking) for premature deaths (Stanaway et al., 2018). This situation is projected to worsen in the absence of planned and directed dietary shifts as a growing, increasingly urban and wealthy global population adopt diets that are obesogenic (Tilman & Clark, 2014). These in turn increase the burden of non-communicable diseases (NCDs) (Afshin et al., 2019; Chen et al., 2020), emitting more GHG (Tilman & Clark, 2014), and potentially limiting the Earth's future capacity to supply safe and affordable food for all (Hedenus et al., 2014; Scheelbeek et al., 2018). This is particularly important for Africa where the largest population growth (UNDESA, 2017) and drastic future urbanisation, as well as the largest growth in NCD deaths (WHO, 2014) are expected to happen in the next few decades amid severe food insecurity issues.

The importance of quantifying food consumption levels and identifying any accompanying secular trends as part of essential first steps towards evidence-based interventions is well-documented (Le et al., 2020; Mengesha, 2021). However, research quantifying food consumption levels in SSA, especially MFV and UPFs which have important implications for both human and planetary health is lacking (Godfray et al., 2018; Okop et al., 2019; WHO, 2005). Expert recommendations have also suggested the need for food environment research in SSA to enhance appreciation of "the socio-ecological processes that shape food acquisition, diets, nutrition, and health" (Turner et al., 2020:393). The Food and Agriculture Organisation (FAO, 2016) and the Global Panel on Agriculture and Food Systems for Nutrition have also highlighted the absence of research attention to the role people's everyday life and activities play in food acquisition and dietary practices in the sub-region (Haddad et al., 2016). Researching the socio-environmental variables that shape diets, human and planetary health is presented as representing a more effective approach towards interventions for tackling the

[1] **Freshwater** refers to all naturally occurring water except seawater and brackish water. Freshwater drawn for human consumption includes those that could be used for drinking, hygiene, agriculture, and industry.

global syndemic of overweight/obesity, undernutrition, NR-NCDs, and diet-related climate change (Clary et al., 2017; Freudenberg, 2007). Indeed, two recent extensive systematic reviews of food environment research in low-and middle-income countries (LMICs) found limited evidence and a nascent food environment research in SSA (Turner et al., 2020; Westbury et al., 2021). Given the pace, urgency, and scale of global environmental changes, the increasing prevalence of the double burden of malnutrition (DBM) and NR-NCDs in SSA, there is a growing need to address these research gaps.

1.3 Research aim and questions

The thesis aims to understand the epidemiology and drivers of healthy, sustainable diets in SSA. To achieve this, the thesis sought to answer the following research questions in four main study components:

1. What is the trend of fruit, vegetable, and meat consumption in SSA and does consumption vary between rural and urban communities or between other sub-populations?
2. What is the trend of UPFs consumption in SSA and does consumption vary between rural and urban communities or between other sub-populations?
3. What are the features of the current food retail environment in the case study of an urban SSA community (University of Ghana campus)?
4. In the case study, how do people interact with the urban food retail environment to impact on people's dietary patterns?
5. What are the factors that influence the consumption of UPFs, fruit and/or vegetable among educated emerging adults?
6. What are the perceptions and attitudes of educated emerging adults to dietary changes in relation to health and environmental sustainability (with reference to meat, UPFs, fruit and vegetable) and their awareness of the environmental sustainability and food nexus?

Table 1.1: The NOVA Food classification based on the extent and purpose of industrial processing (Monteiro et al., 2010, 2019)[2].

Food group	**Extent and purpose of processing**	**Examples**
Group 1: unprocessed or minimally processed foods	No processing, or mostly physical processes used to make single whole foods more durable, accessible, convenient, palatable, or safe.	Fresh, chilled, frozen, vacuum-packed fruits, vegetables, fungi, roots and tubers; grains (cereals) in general; fresh, frozen and dried beans and other pulses (legumes); dried fruits and 100% unsweetened fruit juices; unsalted nuts and seeds; fresh, dried, chilled, frozen meats, poultry, and fish; fresh and pasteurized milk, fermented milk such as plain yoghurt; eggs; teas, coffee, herb infusions, tap water, bottled spring water.
Group 2: processed culinary or food industry ingredients	Extraction and purification of components of single whole foods, resulting in producing ingredients used in the preparation and cooking of dishes and meals made up from Group 1 foods in homes or traditional restaurants, or else in the formulation by manufacturers of Group 3 foods.	Vegetable oils, margarine, butter, milk cream lard; sugar, sweeteners in general; salt; starches, flours, and "raw" pastas and noodles (made from flour with the addition only of water); and food industry ingredients usually not sold to consumers as such, including high fructose corn syrup, lactose, milk and soy proteins, gums, and preservatives and cosmetic additives.
Group 3: ultra-processed food products	Processing of a mix of Group 2 ingredients and Group 1 foodstuffs in order to create durable, accessible, convenient, and palatable ready-to-eat or to-heat food products liable to be consumed as snacks or desserts or to replace home-prepared dishes.	Breads, biscuits (cookies), cakes and pastries; ice cream; jams (preserves); fruits canned in syrup; chocolates, confectionery (candies), cereal bars, breakfast cereals with added sugar; chips, crisps; sauces; savoury and sweet snack products; cheeses; sugared fruit and milk drinks and sugared and "no-cal" cola, energy drinks, and other soft drinks; frozen pasta and pizza dishes; pre-prepared meat, poultry, fish, vegetable and other "recipe" dishes; processed meat including chicken nuggets, hot dogs, sausages, burgers, fish sticks; canned or dehydrated or powdered and packaged instant soups, stews, desserts, and pot noodle, salted, pickled, smoked or cured meat and fish; vegetables bottled or canned in brine, fish canned in oil; infant formulas, follow-on milks, baby food.

[2] According to the authors, the examples listed in their publications are not exhaustive and that many other food items can be included, based on the 'general principles' outlined in column two of the table.

1.4 Structure of the thesis

The thesis is organized under nine chapters as summarized in Table 1.2 below. The thesis begins with an introductory chapter (Chapter one) which gives a brief background to the study, outlines the research questions and the philosophy underpinning the research methods adopted. The Chapter also presents a brief overview of the setting for the study and an outline of the thesis. Chapter two then presents a review of existing literature relevant to the subject area of this study and the identification of the main gaps in the literature. Together with chapter one, they set the scene for the study.

The main body of the thesis consists of four main research components which make up six chapters of this thesis. The four main study components include: (1) a systematic review and meta-regression analysis; (2) a systematic narrative review; (3) geo-mapping and assessment of food retail environment; and (4) a three-part qualitative research study. The first three components are respectively reported as standalone chapters, with a summary of corresponding research questions, methods, findings, and comprehensive discussions including highlights of strengths and limitations for each. The fourth component (a three-part qualitative research) is reported in three separate chapters, along with a summary of individual research questions, results, and comprehensive discussions, while sharing a common method. The final chapter, Chapter eight, summarizes the main findings of the study, strengths, and limitations, and focuses on the implications of the findings for policy and further research. The thesis concludes in this chapter with conclusions and a list of scientific outputs from the study.

Table 1.2: Thesis map

Research component	Chapter number	Research question number	Title of chapter	Summary of content
Setting the scene for the study	1.		General introduction, literature review	• Purpose of the study • Research questions • Profile of study setting • Methodology • Ethics and governance
	2.		Literature review	• Literature review • Research gaps in literature •

Study component 1	3.	Q1	Meat, fruit, and vegetable consumption in sub-Saharan Africa (SSA): a systematic review and meta-regression analysis	Systematic synthesis of evidence on the secular trend of meat, fruit, and vegetable consumption in sub-Saharan Africa (SSA) and how consumption varies in population subgroups.
Study component 2	4.	Q2	Ultra-processed food consumption in SSA: a systematic review and narrative synthesis.	Systematic review of evidence on the trend of ultra-processed foods consumption in SSA and any variations in consumption among population subgroups.
Study component 3	5.	Q3	Food environment on University of Ghana campus: a geo-mapping and classification of the food environment	Using GIS tools to map and characterize the university community food environment and assess the healthiness of food outlets using an adapted classification instrument.
Study component 4	6.	Q4	"We think about the quantity more": factors influencing emerging adults' food outlet choice in a Ghanaian university food environment: a qualitative enquiry.	Emerging adults' food outlet choice determinants and their perspectives of how they interact with their food environment to make food choice decisions.
	7.	Q5	Barriers and facilitators to ultra-processed foods, fruit, and vegetable consumption among emerging adults in a university food environment	Emerging adults' perspectives of factors influencing ultra-processed foods, fruit, and vegetable consumption in a university food environment.
	8.	Q6	"We're meat, so we need to eat meat to be who we are"—motivations to increase/ reduce meat consumption among emerging adults in the university of Ghana food environment.	Emerging adults' attitudes and perceptions of meat consumption and its link with environmental sustainability and health. Emerging adults' perspectives of factors influencing their consumption of meat.
	9.		Discussion and Conclusions	• Summary of main findings • Strengths and limitations

				• Recommendations for policy and further research • Conclusions and list of scientific outputs and conference presentations

1.5 Justification of the research

The current global food system although provides food for over 7 billion people, it is at the same time the source of poor diets which is the largest cause of ill-health and mortality. The food system is also the single largest consumer (70%) of freshwater drawn for human use (Ritchie & Roser, 2017), takes up over half of the world's habitable land (Ritchie & Roser, 2013), and accounts for 34% of global GHG emissions (Crippa et al., 2021; IPCC, 2019). In all of this, meat and dairy are the biggest culprits, responsible for 14.5% of global GHG emissions (Ritchie & Roser, 2020) and associated with increased risk of dying from numerous diseases including cancer, diabetes and heart disease, as well as "all other causes" of death (Potter, 2017). Key international health and sustainability ambitions—including the Sustainable Development Goals (SDGs) (UN, 2015b), the Paris Agreement (UNFCCC, 2016), the Aichi Biodiversity Targets (Convention on Biological Diversity, 2020) or the WHO Global Action Plan for the Prevention and Control of NCDs (WHO, 2013)—have therefore been linked to food systems. In many instances, achieving these goals may be impossible with the current food system (Clark et al., 2020). The role of the food environment, which is the interface at which people interact with the wider food system, has therefore received growing interest in relation to its contribution to the global syndemic of multiple malnutrition burden, NCDs and climate change in recent years.

In SSA, the food environment is said to have seen rapid transformations in recent decades, altering food availability and access, along with food choices (Popkin et al., 2020; Reardon et al., 2021b). These changes, including the increased presence of Transnational food companies (TFCs), 'Western-style' and 'copycat' fastfood outlets, and supermarket chains, are reported to have made more unhealthy food options such as energy-dense nutrient poor (EDNP), highly processed foods, rich in saturated fat (especially processed meat and dairy), and added sugars more available and easily accessible (Popkin et al., 2020; Reardon et al., 2021b). At the same time, a rapidly increasing prevalence of NCDs and multiple forms of malnutrition that overlap in different ways at the individual, household and/or community level (GNR, 2018) represent a looming danger for the already weak and overburdened healthcare systems in the sub-region. Between 1990 and 2017, the region experienced a rise of approximately 67% in NCD burden (Gouda et al., 2019). Recent evidence reports regional obesity prevalence of 20%, hypertension of 48%, and diabetes of 5.1% (Nyirenda, 2016). But NCDs are rising faster in urban SSA than anywhere else in the world (Hunter-Adams et al., 2017). In 2015 alone, four key NCDs—cancers, diabetes, cardiovascular, and chronic respiratory diseases, accounted for 72% of all global deaths, and 85% of this happened in LMICs, including countries in Africa (Forouzanfar et al., 2016). The WHO adds that, NCDs are projected to overtake infectious diseases to become the leading cause of morbidity and mortality in SSA by 2030 (WHO, 2016).

While the foregoing demonstrates the urgency of this research, my personal experience during my mother's battle with cancer in Ghana between 2013 and 2017 has had a significant influence on my decision to embark on this research. The physical, psychological, and emotional trauma, and the financial difficulties my mother (like many other chronic disease patients in SSA) and the family, a middle-class one, had to suffer within the period demonstrate how NCDs can further exacerbate poverty. Systematic reviews have showed that NCDs pose a heavy economic burden on households affected and represents a key barrier to care for many NCD patients in SSA (Kankeu et al., 2013; Mutyambizi et al., 2018). A study showed that, 10, 400 days and 5,100 days of healthy life are lost per 1000 persons per year in Ghana, respectively to cardiovascular disease and hypertension (Bosu, 2007). During such periods, patients are usually unable to engage in economic activities to earn money. Meanwhile, treating or managing chronic conditions in Ghana, like in most parts of Africa, is very expensive (Sanuade et al., 2021). Research has shown that, chronic disease treatment in Ghana and most of SSA far exceeds the average individual and household income (Abuosi et al., 2015; Tagoe, 2012; Wang et al., 2015) and many national health insurance schemes in SSA do not cover treatment costs for most NCDs (Abuosi et al., 2015; Sanuade et al., 2021). My personal interest in this research stems from the desire to contribute to the fight against NCDs in Africa, where prevention is likely to be more important than treatment.

Individual level factors (like genetics, poverty, etc.) alone may not adequately explain the observed nutrition and epidemiologic changes taking place in SSA. A growing body of evidence suggests that these changes are a natural response to the changing food environment—one that promotes unhealthy dietary behaviours, the intake of excess calories but little or no nutrients (Dake et al., 2016; Swinburn et al., 2011). Research evidence suggest differences between urban and rural food environments, dietary behaviour and health in LMIC settings. Compared to rural dwellers in SSA, urban residents are more likely to buy than grow food for subsistence and may face distinct barriers which may limit access to healthy food (Vilar-Compte et al., 2021). Dietary outcomes are thus more likely to be poorer in urban than rural SSA settings.

There is a strong consensus that shifts to diets high in plant-based foods, with less UPFs and animal-based food products, would offer dual health and environmental benefits (Clark & Tilman, 2017; Leip et al., 2015). Changing diets is therefore put forward as more effective than technological approaches for climate change mitigation, while ensuring availability of food that is safe and accessible for an increasing global population (Garnett, 2011). Recent evidence has highlighted that dietary shifts in Africa and other LMICs would offer the largest absolute health and environmental benefits (Springmann et al., 2016), given especially that urban SSA will be a significant source of global meat demand in the next few decades (Latino et al., 2020).

As a leading risk factor for NCDs and the DBM, unhealthy dietary behaviour, is typically established during emerging adulthood and sets the stage for NCDs later in life (Lambert et al., 2019; Nelson et al., 2009). While the development and scaling up of evidence-based, context-specific interventions to create health-promoting and sustainable food environments for young people in SSA are crucial strategies for addressing obesity, undernutrition, and NCDs, there is limited research in SSA monitoring secular trends in un/healthy dietary behaviours, how young adults interact with their food environment, and factors that motivate or inhibit them from following healthy and sustainable diets (Gissing et al., 2017). A recent systematic review of food environment research evidence in LMICs, for example, found only 8 of 74 studies included SSA populations (Westbury et al., 2021). To date, food environment research in SSA has predominantly been cross-sectional in nature, with few qualitative studies (Osei-Kwasi et al., 2020; Pradeilles et al., 2021). Both (the cross-sectional and the few qualitative studies) have focused on the general adult population and sometimes, children, with little attention to emerging adults (Osei-Kwasi et al., 2020), despite being a critical group. However, these are critical for SSA, which is home to the world’s youngest population and a rapidly expanding cohort of young people (UNDESA, 2015). Curbing unhealthy dietary behaviours among SSA’s young people is an important opportunity for tempering a potentially large and costly DBM and NCD epidemic in SSA in the future and mitigating adverse diet-related environmental impacts.

The aim of this research is therefore to enhance understanding of the epidemiology and drivers of healthy and sustainable diets in SSA. Four key contributions are expected as a result of conducting this research: (a) a better understanding of secular trends in MFV and UPFs consumption in SSA, and any subgroup variations in consumption over the years; (b) exploration of the barriers and facilitators to MFV and UPFs consumption; (c) enhanced understanding of how emerging adults interact with their food environment to make food choice decisions; and (d) identification of the barriers and facilitators to the adoption of sustainable diets among emerging adults in a case urban SSA community setting. The research advances the SSA food environment literature, provides empirical evidence to support context-specific policy action, and highlights important implications for practice and further research.

1.6 Theoretical framework: Socio-ecological models

The INFORMAS ecological model (Figure 2.2) of health behaviour as proposed by Swinburn et al. (2013) was used to position this study. Ecological models underscore the influence of the environment on health-related behaviours, while encompassing psychological, social and demographic factors (Sallis et al., 2008). This allowed the consideration of the multiple influences on health behaviour. The linkages between the food environment, food consumption behaviours, human and planetary health are an intricate web. The model served as a guide to ensure that the research captures, as much as possible, the most complete picture of the various factors within urban food environment shape diets and dietary-related health outcomes as well as environmental impacts. The study also adapts Clary et al.'s (2017) socio-ecological model (SEM) to capture how individuals interact with the food environment to make food choices, and Turner et al.'s (2018) model to integrate and visualize key findings from various components of the research. Table 1.3 summarises some of the socio-ecological dimensions of influence covered in this research.

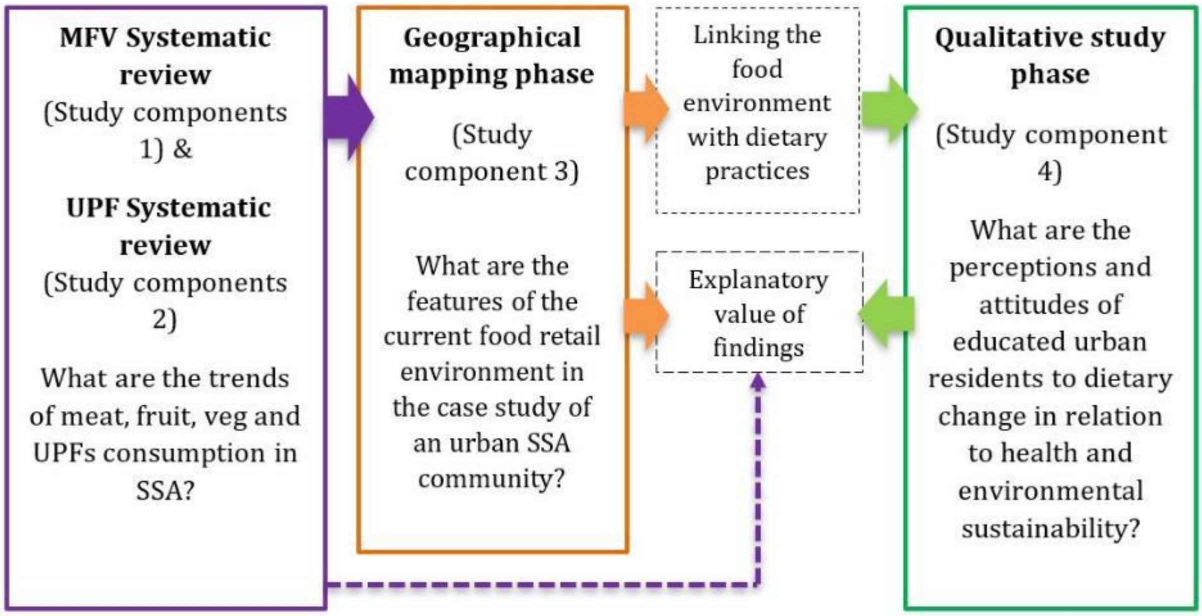
Table 1.3: Socio-ecological levels of influence covered in this research.

	Socio-ecological model	Examples
Microsystem and exosystem	Physiological level	Biology (allergies and food aversion), anthropometrics/body weight (findings in chapters 6, 7, and 8).
	Individual level (student)	Age, gender, religion, beliefs, knowledge, perceptions, preferences (findings and discussion in chapters 5, 6, 7 and 8)
	Family level	Home training/eating practices at home, parenting practices (findings and discussion in chapters 6, 7 and 8)
	Community level	Peers, food environment, availability (findings and discussion in chapters 5, 6, 7 and 8).
Macrosystem	Country level	Political, economic, societal, organizational factors including university level governance, media, and marketing (especially in the Discussion and conclusion chapter, 9).
	Cultural level	Wider cultural norms, campus-specific norms/lifestyle, religious practices (findings and discussion in chapters 6, 7 and 8)
Mesosystem	Connections and interactions between levels	Interactions between students and the food environment, between students and peers, etc. (findings and discussion in chapter 6, 7 and 8).
Chronosystem	Time	Changes over time (in the discussion under chapter 6).

1.7 Research design

As permitted under the pragmatic theoretical framework, the appropriate mix of quantitative and qualitative methods were employed to answer the study's research questions. Creswell (2014) describes six possible mixed methods designs. The Mixed Methods Sequential design (Bryman, 2016; Creswell, 2018) was employed to answer this study's questions: (1) an initial quantitative systematic review and meta-regression analysis (as study component 1) was followed by; (2) a systematic review and narrative synthesis; (3) a geo-mapping of the food retail environment in the study community (study component 3) and then (4) qualitative phase consisting of focus group discussions and dyadic interviews with best friend pairs to offer insights into findings from the quantitative and geo-mapping components was conducted at a slightly later stage (Creswell & Creswell, 2018). The rationale for this design was for the preceding phases to inform the design of the subsequent phases of the research. In addition, it was intended to, as much as possible, offer a deeper understanding of the research questions (Creswell & Creswell, 2018; Bryman, 2016).

Figure 1.1: The embedded (sequential) explanatory mixed methods design for this study



1.7.1 Philosophy of mixed methods approach

The pragmatist orientation was adopted as the philosophy for the research design, combining the most suitable set of approaches. The pragmatic philosophy breaks down the hierarchies of "concepts such as 'truth' and 'reality' and focuses instead on 'what works' [from both] as the truth regarding the research questions under investigation" (Tashakkori & Teddlie, 2003:713). The emphasis is on the research problem and question as the prime-determining factors of the research approach adopted (Creswell & Plano Clark, 2007). The pragmatist's orientation of enquiry is underpinned by the understanding that neither of the two main approaches to scientific enquiry (quantitative and qualitative) can solely offer answers to every question and thus on its own offer a complete understanding of the real world (Conant & Zeglen, 2003; Creswell & Creswell, 2018). One method may be best suited to answering a particular question than the other. Thus to the pragmatist, reality can be singular or multiple in nature, as the researcher is free to employ a combination of both deductive and inductive approaches in order to offer different perspectives of reality (Creswell & Plano Clark, 2007). In terms of methods, pragmatism offers the researcher the flexibility of choosing an appropriate combination of available approaches that best answers research questions not only to create knowledge, but also a complete understanding of the research problem (Creswell & Creswell, 2018).

Given the complex nature of the influences the food environment has on diets and dietary-related human and planetary health outcomes, a pragmatist orientation was deemed an appropriate means of inquiry for this research. The research aims to measure and explore the trend of dietary patterns and how the urban food environment influence consumption patterns, food-related health, and environmental sustainability outcomes. To achieve this, the pragmatist framework offers the means to thoroughly explore these dimensions to offer insight and explanations (from participants' perspective) to any trends that may be found. The most suitable way of doing this from a pragmatic orientation is to use a mixed methods embedded (sequential) explanatory design (Creswell & Creswell, 2018; Bryman, 2016).

1.8 Justification for Research Methods

1.8.1 Study components one and two: Quantitative Systematic Review and Meta Analysis

There is an overwhelming consensus in current nutrition literature on SSA of a nutrition transition towards unhealthy diets (Bosu, 2015); a pattern that appears to be unsustainable. Even though researchers acknowledge the large shifts in diets, the direction and nuances of this change is unclear as findings are divergent (Becquey et al., 2010; Galbete et al., 2017; Holmes et al., 2018; Sodjinou et al., 2009). Whereas the subject has gained research popularity, evidenced by a burgeoning list of studies, scientific synthesis and critical analysis of data from SSA is lacking. Systematic reviews have the prowess to objectively generate robust synthesis of evidence from multiple sources in ways that ensure methodological rigour and reproducibility, and enhance generalizability (Gough, Oliver, & Thomas, 2017). They are therefore regarded as the "gold standard" in evidence-based research (Bryman, 2016).

This phase of the research adopted a quantitative synthesis approach, meta-regression, in study component one. Quantitative synthesis was deemed best fit for data pooling, estimating trends such as disease prevalence over time (Picon et al., 2012) and quantifying data (Gopalakrishnan & Ganeshkumar, 2013). It offers the opportunity to more clearly capture differences among groups (Thomas et al., 2017), for instance, the dietary diversity between children and adults (Frempong & Annim, 2017). The effectiveness of quantitative synthesis in explaining and checking consistency of relationships can help in enhancing understanding of relationships (Gopalakrishnan & Ganeshkumar, 2013; Thomas et al., 2017) such as correlation between people's environment (urban or rural) and what or how much they consume (Oyebode et al., 2016). The sensitivity analysis component of the meta-regression allowed to assess and demonstrate robustness of review conclusions (Thomas et al., 2017), as opposed to a narrative synthesis.

1.8.2 Study component three: Geographical Mapping

Characteristics of the food retail environment of the study area were captured to create a map of the distribution and taxonomy of food retail outlets and centres using a combination of methods. This phase supported the examination of the influences or interrelationships between the urban food environment and people's diets (Glanz et al., 2005). While a variety of strategies for capturing the characteristics of food environments have evolved, existing approaches can be collapsed under one of three approaches: assessing archival data from government and business agencies, survey respondent report, and direct block-by-block observation (Brownson et al., 2010; Kelly et al., 2011).

Though survey respondent reports can provide useful information, relying solely on them will not capture the whole food environment (Brownson et al., 2010) as the technique depends on respondent memory. The Direct Observation technique, also known as Systematic Social Observation (SSO) is objective, valid and reliable as it involves a systematic scanning of community blocks for food outlets (Clarke et al., 2010; Kelly et al., 2011). However, due to its time-consuming, labor-intensive and expensive nature, its coverage is usually limited (Clarke et al., 2010).

Compared to direct observations, archival datasets have been widely employed in mapping community food retail environments, particularly in advanced countries due to the relative cost-effectiveness of this method (Cummins & Macintyre, 2009; Maguire et al., 2015). Despite its cost-effectiveness, archival or secondary datasets on their own often fail to capture some aspects of the food environment (Oltmans et al., 2013). Although GPS and GIS technology are currently being applied in many studies mostly in high-income countries to minimize such limitations (Cetateanu & Jones, 2016; Laska et al., 2010), in underdeveloped nations like Ghana, archival datasets on business and commercial listings are usually non-existent or outdated (Oltmans et al., 2013).

The study employed a systematic approach involving the combination of block-by-block observation, respondent reports, and Global Positioning System (GPS) to capture the characteristics of the food environment. This approach used a combination of collaborative satellite-imagery digitization and participatory mapping based on geospatial open-source technologies and the collaborative mapping platform, OpenStreetMap, to create a base map which guided block-by-block observation (Albuquerque et al., 2019). This systematic approach offered three main benefits: (1) the potential to save time, (2) comprehensive geographical coverage, and (3) mitigation for other inherent weaknesses of individual methods (Glanz et al., 2005). The block-by-block observation also offers the opportunity to concurrently conduct a thorough food environment assessment using the Nutrition Environment Assessment Measures Survey (NEMS) tool (Glanz et al., 2015; Glanz et al., 2007).

1.8.3 Study component four: Focus Groups and Dyadic interviews with best friends

Focus group research involves gathering information about the views and experiences of individuals on a topic through organized discussions in a group environment with selected (three or more) participants (Krueger & Casey, 2015). Dyadic interviews on the other hand involves two participants (in the same space and at the same time) interacting in response to open-ended research questions (Morgan et al., 2013). Focus groups are usually constituted in a way that achieves homogeneity in the background of participants, creating comfortable environments for free-flowing conversations (Acocella, 2012; Morgan, 1997). Gender, social class, age-cohort, and ethnicity are some of the background factors often considered. For this research, most participants were university students classified as adults. Similarly, constituting the pairs in dyadic interviews could be based on pre-existing relationships (such as family) or age, or other background and shared or differing experience factors.

Focus groups for this research were therefore segmented by age-cohort and location of residence, whiles dyadic interviews were constituted based on pre-existing best friend relationships among students While both approaches create a congenial environment for free-flowing discussions, the best friend pairs may create a more comfortable atmosphere especially for participants who would be uncomfortable in the presence of 'strangers' in the case of FGDs (with other participants they do not know) or one-to-one interviews with the interviewer. In both the FGD and best friend pair interviews (BFPI), the congenial environment facilitates the use of everyday language that may offer deeper insights into people's behaviours, lived experiences and perceptions than responses in traditional interviews and surveys (Bryman, 2016; Morgan, 1997). The opportunity for participants to freely express views relating to the topic is further enhanced as the researcher exerts minimal control during discussions (Krueger & Casey, 2015). What is common to both FGD and BFPI is the process of sharing and contrasting each other's responses as participants respond to research questions (Morgan et al., 2013). It is therefore particularly useful in exploring the level of unanimity and divergence among participants on a given issue (Gibbs, 1997). This will not only facilitate the generation of insights into shared views and perceptions of, for instance, the environmental impacts of dietary choices, but also of the different nuances.

Focus groups therefore offer participants the congenial atmosphere to bring to the fore explanations of issues for which data were gathered in the quantitative phase of the research. For example, how the food environment around them impacts their dietary choices. The detailed information that is gleaned from focus groups will therefore be used to ground, as well as enhance understanding of results from the quantitative phases of the research. Another reason for choosing focus groups is the 'co-construction' of responses to the research topic. effective focus groups eliminate inconsistent responses from participants as occurs in traditional one-to-one interviews where researchers are seldom able to challenge participant views (Bryman, 2016). Focus groups encourage debate, allowing participants to contest each other's opinions, reflect and adjust individual views (Kitzinger, 1995). Thus focus groups are able to glean more realistic information from participants (Acocella, 2012; Bryman, 2016).

1.9 Ethical clearance

Ethical approval was obtained from the University of Warwick Biomedical Sciences Research Ethics Committee with approval reference: (REF.: BSREC 115/18-19) and the Ethical and Protocol Review Committee (EPRC) of the University of Ghana (REF.: CHS-Et/M2—4.12/2019-2020).

1.10 The research setting

1.10.1 Profile of SSA

The research focuses on SSA. Geographically, it is the area of the African continent that lies south of the Sahara and divided roughly into two by the equator. The UN defines the region to comprise all countries in the African continent located fully or partially south of the Sahara. While the UN and African Union's definitions of the sub-region do not agree on the inclusion of Sudan and Mauritania, the World Bank definition of SSA countries include both states. The World Bank therefore outlines countries in the SSA to include 48 out of 54 countries of the continent of Africa as "sub-Saharan" listed in Table 1.4. This study adopts the World Bank definition of SSA. As part of the African continent, which is the second largest and second-most-populous continent, it shares border with North Africa to the north. The remaining borders are surrounded by sea, except where the Isthmus of Suez connects it to Asia.

Table 1.4: Socio-demographic profile of SSA

Indicators		Source
Definition of SSA	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe.	https://data.worldbank.org/country/ZG
Population (2019)	1.1 billion Population growth rate: 2.3%	https://population.un.org/wpp/
Population density	45.21 per km^2	https://data.worldbank.org/indicator/EN.POP.DNST?locations=ZG
2050 Population projections	2 to 2.5 billion	https://www.un.org/development/desa/publications/world-population-prospects-2019-highlights.html
Urban population (2020)	41% of total population	https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=ZG
Urban population growth rate (2020)	4%	https://data.worldbank.org/indicator/SP.URB.GROW?locations=ZG

GDP per capita	$$1,599 (2019); $1,484 (2020)	(World Bank, 2021b) https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=ZG
Agric contribution to GDP	15.5% (2020)	(World Bank, 2021a) https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=ZG
Literacy rate	65 % in 2017	(UNESCO, 2017)
Religion	Christian: 62.9% Islam: 30.2%	(The Pew Forum, 2012)
Life expectancy at birth (2019)	61.63	https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=ZG
Human Development Index (HDI) (2015)	0.50	https://comstat.comesa.int/wiqcbkg/afdb-socio-economic-database-1960-2019?tsId=1583670

1.10.1.1 Climate and environmental conditions

The region has a variety of climate regimes and biomes (Haile, 2005; Kotir, 2011). Climate regimes range from humid climate in the tropics to arid and semi-arid climate in the sub-tropics (Haile, 2005). The location, size, and shape of the region play a key role in shaping its climate. The seasonal pattern of rainfall in the region is defined by the "north-south seasonal migration of the inter-tropical convergence zone (ITCZ) following the position of maximum surface heating associated with the meridional displacement of the overhead position of the sun." (Haile, 2005). Countries located around the equator (e.g., Gabon, Uganda, Kenya, etc.) experience bi-modal rainy seasons while those farther poleward (e.g., Namibia, Botswana, Malawi, etc.) experience a unimodal or mono-modal rainfall season. Similarly, the length of the rainy season which in turn determines the length of growing season varies depending on proximity to the equator (Haile, 2005; Kummu et al., 2014).

Evidence however shows climate and environmental conditions in SSA continue to exhibit significant changes. Across the sub-region, dramatic changes in rainfall, temperatures, and extreme weather events such as floods and droughts have been documented (Cogato et al., 2019; Vicente-Serrano et al., 2020). These changes are projected to persist for the next decades (Kotir, 2011; Niang et al., 2014).

1.10.1.2 Burden of disease profile

Details of the burden of disease in the sub-region are discussed in Section 2.2.3. However, Table 1.5 below summarises the leading 10 causes of death based on 2019 data from the WHO (Statistica, 2021).

Table 1.5: Top ten causes of death in SSA

Position	**Cause of death**	**Deaths per 100,000 population**
1.	Neonatal conditions	880
2.	Lower respiratory infections	774
3.	Diarrhoeal diseases	496
4.	HIV/AIDs	435
5.	Ischaemic heart disease	429
6.	Stroke	426
7.	Malaria	388
8.	Tuberculosis	378
9.	Road injuries	297
10.	Cirrhosis of liver	195

1.10.1.3 Food and food cultures

The SSA region is home to thousands of different tribes, ethnic and social groups, representing varied traditional food cultures, including food sources, the ingredients used and the preparation and cooking techniques. However, common to most traditional diets in the sub-region are meals with little meat, plenty of whole grains, legumes, and beans, and even more FV. In recent times, food and food cultures in the sub-region is said to have had Arab, European, American, and Asian influences leading to a combination of more refined local and foreign grains, fruit, local vegetable, milk, and meat products in many diets in the sub-region. More recent evidence also points to increasing presence of highly processed industrial food products in the diets of people in urban SSA (Reardon et al., 2021). As discussed in Section 2.3.1 of the literature review chapter, different countries in the sub-region are at different levels of experiences these changes in the content of diets. While most countries in the region are at early stages of the nutrition transition, countries like South Africa, Ghana, Gabon, Cape Verde, and Senegal are at more advanced stages in experiencing these changes (Abrahams et al., 2011; Bosu, 2015). In the primary research components of this study, the research therefore narrows the focus to Ghana as case study country in attempts to answer research questions (3 to 6) outlined in Section 1.3.

1.10.1.4 Ghana: country profile

The primary study (reported in Chapters 5 to 8) narrows down to urban Ghana as a case study country aimed at answering research questions 3 to 6. Located on the West coast of Africa, Ghana is one of the sub-region's fastest urbanizing and fastest growing economies at an average annual GDP growth rate of 5.6% between 1984 and 2014 (World Bank, 2016). Table 1.6 shows Ghana's demographic profile. This has been attributed to the introduction of its economic recovery program and the assumption of a market-oriented approach in 1983 (Ecker & Fang, 2016). Ghana was the first African country to ratify and execute the Structural Adjustment Programs (SAPs) in 1983, which liberalized trade and opened its market to imports and foreign direct investments (FDIs) (Opoku, 2010). FDIs paved way for the boom in the development of 'Western-style' food outlets in Greater-Accra and other urban areas in Ghana (Reardon et al., 2004). The country's value-added share of the service sector increased from 37% to 42.6% between 1984 and 2020 at the expense of the share of the agricultural sector (from 52% to 17.61%) (World Bank, 2021). In 2012, the country attained a lower middle-income country status (World Bank, 2016).

Table 1.6: Summary of socio-demographic profile of Ghana

Indicator	Score/information	Source
Borders	North: Burkina-Faso; East-Togo; West: Cote d'Ivoire; South: Gulf of Guinea	(Ghana Statistical Service, 2014a)
Population (2019)	30.4 million	https://data.worldbank.org/country/ghana
GDP growth rate	0.4% (2020); 6.5% (2019)	https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=GH
GDP per capita	$2328	https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=GH
Urban population	57.3% (2020)	https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=GH
Urban population growth rate	3.3% (2020)	https://data.worldbank.org/indicator/SP.URB.GROW?locations=GH
Literacy rate (adult) Youth (15 to 24 years)	79% (2018) 92.5% (2018)	https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?locations=GH
Life expectancy at birth	64% (2019)	https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=GH
HDI	0.611 (2019)	(UNDP, 2020)

As often associated with such structural economic growth, Ghana's urban population increased from 33% to 54% during the same period (UNDESA, 2016), with Accra and Kumasi being the main pull cities (Ghana Statistical Service (GSS), 2014). By 2010, Accra and Kumasi, respectively had 91% and 61% of their population living in communities classified as urban (GSS, 2014). Rural-urban migration has been a major contributor. Rural-urban movements have contributed to great challenges to the country's environmental resources, agricultural and food production system, making Ghana more reliant on food imports. On the other hand, urbanisation comes with a growing middle-class with high purchasing power resulting from increased disposable incomes (GSS, 2014). The impressive economic progress and transformation played a significant role in the country's remarkable achievements in the Millennium Development Goal targets of halving extreme poverty and halving child underweight prevalence before the deadline (UN, 2015a).

1.10.1.5 Disease burden profile- Ghana

Ghana is experiencing a double burden of communicable disease and NCDs. Table 1.7 below is a summary of the top ten causes of death and how this has changed over a ten-year period between 2009 and 2019.

Table 1.7: Top 10 causes of death, changes between 2009 and 2019

Position	Top 10 causes (2009)	Top 10 causes (2019)	% Change 2009-2019
1.	Malaria	Malaria	-33.9%
2.	HIV/AIDs	Stroke	25.2%
3.	Neonatal disorders	Lower respiratory infections	-0.5%
4.	Lower respiratory infections	Neonatal disorders	-18.6%
5.	Stroke	Ischemic heart disease	37.6%
6.	Tuberculosis	HIV/AIDS	-32.6%
7.	Ischemic heart disease	Tuberculosis	-12.0%
8.	Diarrheal diseases	Diarrheal diseases	-13.1%
9.	Cirrhosis	Diabetes	24.6%
10.	Diabetes	Cirrhosis	12.3%

Key: Green colour= Communicable disease; Blue colour= NCDs
Source: Global Burden of Disease report 2019 (Abbafati et al., 2020)

In terms of risk factors driving deaths and disability in Ghana, the top ten risk factors include malnutrition as the topmost factor, followed by air pollution, unsafe sex, and high blood pressure according to the 2019 Global Burden of Disease (GBD) report (Abbafati et al., 2020).

Table 1.8 shows a summary of the leading ten risk factors for the most deaths and disability (put together) and how the risk factors have changed between 2009 and 2019 based on the 2019 GBD report (Abbafati et al., 2020).

Table 1.8: Top 10 risk factors driving the most death and disability combined

Position	Top 10 causes (2009)	Top 10 causes (2019)	% Change 2009-2019
1.	Malnutrition	Malnutrition	-23.3%
2.	Air pollution	Air pollution	-11.0%
3.	Unsafe sex	Unsafe sex	-21.8%
4.	Water, Sanitation and Health (WaSH)	High blood pressure	28.6%
5.	High blood pressure	High body-mass index	48.9%
6.	High body-mass index	WaSH	-15.3%
7.	High fasting plasma glucose	High fasting plasma glucose	23.5%
8.	Alcohol use	Alcohol use	14.5%
9.	Dietary risks	Dietary risks	27.0%
10.	Kidney dysfunction	Kidney dysfunction	31.4%

1.10.1.6 Food retail in Ghana

In Ghana, food retail has been described by studies using direct observation, qualitative interviews and surveys to comprise of store/grocery store-type food and prepared food (or food service) outlets (Richmond Aryeetey et al., 2016; Omari & Frempong, 2016). Each of these has a formal and informal sector version. The formal retail store food outlets include convenience stores, chain supermarkets, and large wholesale and retail outlets (Agyei-Mensah & Aikins, 2010; Oltmans et al., 2013; Meng et al., 2014). The informal sector includes traditional open-air wet[3] markets, street vendors and hawkers, traditional corner kiosks and stalls. In terms of prepared-food outlets, the formal types include restaurants and American-style fast-food outlets (e.g., KFC, PizzaHut, Papaye, etc.). Informal prepared-food outlets have been described to encompass local restaurants (termed *chop-bars* in Ghanaian parlance), *check-check*[4] joints, stationary food trucks, and table-top food vendors (Agyei-Mensah & Aikins,

[3] The word *wet* relates to the continued wetting of the market floor resulting from the frequent spraying of food products and cleaning of meat and fish stalls (Field et al., 2010).

[4] *Check-checks:* copy-cat fast-food outlets that operate in kiosks and are usually located along busy roads.

2010; Dake et al., 2016; Omari et al., 2013). It also includes petty traders or hawkers including mobile food trucks and street hawkers (Meng et al., 2014) but will not be included in this study. Table 1.9 summarises the taxonomy of food outlets.

Table 1.9: Taxonomy of food retail outlets in Ghana

Store or grocery-store-type food outlets		Prepared food outlets	
Formal	Informal	Formal	Informal
Convenience stores	Traditional open-air or wet markets	Restaurants	Chop-bars (Local restaurants)
Chain supermarkets	Street vendors and hawkers	American-style fast food outlets	Check-check joints
Large wholesale outlets	Traditional corner kiosks		Stationary food trucks
Large retail outlets	Stalls/table-top operators		Table-top food vendors
	Corner/ provision stores		Mobile food trucks/hawkers

The taxonomy of outlets in Ghana as outlined here is markedly distinct from that of high-income countries (HICs). According to mixed methods studies, open-air/wet markets (hereafter traditional/conventional markets) are the dominant food retail outlets in Ghana, especially in urban areas (Richmond Aryeetey et al., 2016; Omari & Frempong, 2016). This was corroborated by another study employing utility-maximization models using survey data collected in 2011 from three large cities—Accra, Tamale, and Takoradi (Meng et al., 2014). Corner stores, convenience and provision stores or grocery shops are usually small-and medium-sized and more common in urban localities (Oltmans et al., 2013). Meng et al.'s (2014) study also found stalls, table-top vendors, kiosks, and street hawkers are popular in both urban and rural settings (Meng et al., 2014) with kiosks, stalls and table-top vendors usually located within the neighbourhood.

In the last three decades, the food environment in Ghana has changed significantly. This has involved the spread of supermarkets and fast food outlets (Reardon et al., 2004) particularly in urban centers like Accra, Kumasi, Takoradi, and Cape-Coast. The development of supermarkets in Ghana, like other SSA countries is not new. They have been around in SSA since the 1940s (Louw et al., 2008). However, in the last 30 years, the expansion of modern supermarkets in the sub-region has been dramatic, spreading from Eastern and Southern Africa to West Africa, especially in Ghana and Nigeria (Das Nair & Dube, 2017; Reardon et al., 2004). Evidence indicates that expansion of modern supermarket sector continues in Ghana, even though the conventional food retail outlets such as open-air markets and street hawking remain essential (Meng et al., 2014; Taylor, 2017) in meeting the needs of low-income and rural households.

Supermarkets are larger self-service grocery stores (McClelland, 1962). This can also comprise large chain stores sited within shopping centers (Meng et al., 2014). Supermarkets usually have on sale an expansive product variety, including dry goods, baked goods, confectionaries, beverages, meat, dairy products, frozen foods and other UPFs, other food and non-food products. Supermarkets in Ghana also incorporate food processing services (Meng et al., 2014).

In Ghana, supermarkets and grocery stores stock imported food products (especially UPFs or high-value products (HVPs), though some high quality natural, organic foods such as fresh meats, fresh farm produce and freshly baked bread are also available. Both fresh and processed FV are also sold in supermarkets. In addition are large stocks of ready-meals including pizza, nuggets, fried rice, burgers, crisps, fried/grilled or roasted chicken (Meng et al., 2014). There is also an increasing stock of ultra-processed forms of traditional Ghanaian food products such as fufu powder, palm soup base, etc.

Rapid urbanisation, increasing disposable incomes, demanding work schedules, and a growing middle-class, coupled with increased car ownership have boosted the expansion of the supermarket sector in Ghana. Retail food spending reached $8 billion in 2015 and was forecasted to reach $11 billion in 2019 (Taylor, 2017). In addition, a growing E-commerce is also fueling the growth of door-to-door grocery delivery services currently restricted to Accra and Kumasi. This is anticipated to be boosted by the new Ghana Digital Addressing System. The key supermarket chain players, Shoprite (South African brand), Game, Melcom, Palace, and MaxMart are rapidly expanding their presence in Ghana's food retail market, accounting for 26% of sales for imported UPFs (Taylor, 2017). The Ghanaian food environment is thus attracting other competitors like Carrefour (the world' second largest retailer) indicating plans to enter Ghana and seven others in West Africa (Carrefour Group, 2013). The increased preference for HVPs in urban Ghana has also boosted growth in small grocery stores, corner stores and convenience shops, which have long existed in the food environment. They account for 36% of current total retail sales in Ghana (Taylor, 2017).

The food retail in Ghana has also seen a rapid growth in a large number of prepared food outlets, including fast food restaurants, sit-down down and carry-out types of restaurants. Restaurants have been in Ghana since the 1960s. However, the American style fast food industry has gained grounds more recently. This has its roots in fast foods served in hotels and supermarket delis in the 1970s and largely served the elite class (Agyei-Mensah & Aikins, 2010). At the beginning of the 1990s, the fast-food tradition was presented to a wider customer base, especially the youth and working class. This was spearheaded by Papaye restaurant in Accra with a variety of humburgers, fried rice, and chicken served with traditional pepper sauces and Coca-Cola range of drinks. The success of Papaye sparked the fast-food boom in Ghana (Agyei-Mensah & Aikins, 2010).

In their review, Agyei-Mensah & Aikins (2010) reported that, the plethora of fast-food outlets in Ghana included those based on the Papaye model and international franchises like Southern Fried Chicken, Pizza Hut, Starbucks, Nandos, KFC, and Bonjour. These restaurants are deliberately sited in shopping centers and malls, fuel stations, and in affluent communities, targeting the rich rather than the more deprived communities (Agyei-Mensah & Aikins, 2010) as is often the case in developed countries (Larson et al., 2009; McInerney et al., 2016; Smoyer-Tomic et al., 2008). Omari et al.'s (2013) mixed methods study in urban Ghana found a booming copycat fast-food vending business, referred to as *check-check*. Check-checks serve fried rice, *jollof rice*[5], and noodles with pepper sauce, fried chicken and cole slaw (Omari et al., 2013). Check-check outlets are relatively cheaper, operate in kiosks and are usually located along busy roads, public transport stations, and in open markets and appeal more to low-income urbanites (Meng et al., 2014; Omari et al., 2013). According to Agyei-Mensah & Aikins's (2010) review, there also are traditional restaurants that serve traditional Ghanaian dishes at affordable prices, along with soda, soft and alcoholic drinks. Local dishes usually on offer at traditional restaurants include *banku*[6], *fufu*[7], *omutuo*[8], and *kokonte*[9] (usually served with soups made from groundnut, oil palm fruits and assorted meat and fish); boiled yams and plantain,

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[5] *jollof rice*: a one-pot dish made with rice stewed in a rich spicy tomato sauce.

[6] *banku:* an even mixture of fermented corn and cassava dough made into dumplings.

[7] *fufu*: boiled cassava and plantain or cocoyam pounded into a dough.

[8] *omotuo*: boiled rice mashed and rounded into balls

[9] *kokonte*: mixture of cassava flour and water boiled into dumplings.

plain boiled rice (served with tomato or *kontomire*[10]sauce), *jollof rice*, and *kenkey*[11] (Dake et al., 2016; Omari, 2016). Meng et al.'s (2014) quantitative analysis and Agyei-Mensah & Aikins's (2010) review suggest that, together with American-style fast food outlets, they serve an increasingly time-poor population. Omari et al. (2013) identified 203 registered restaurants in the Greater Accra Region and this represents 61% of all licensed restaurants in Ghana. The use of E-commerce in the prepared-food outlet sector is more advanced in Ghana and boosts the sale of fast food. Jumia Food website and mobile phone app and recently, UBER Eats app, have enhanced online fast-food orders and door-to-door delivery in m urban centers of Ghana. Jumia App has a list of more than 100 fast food restaurants from which can be placed (Jumia Food, 2017).

The open-air wet market is still a vibrant retail food outlet in Ghana and integral to the food retail system (Field et al., 2010). It is a public marketplace with many wholesalers and retailers but each specializing in the sale of one food product or a limited variety. Ghana is famous for its open markets (Meng et al., 2014). The majority of locally produced foods such as fresh fruit, vegetable, meat, fish and other seafood, starchy roots and tubers are sold here. Interestingly, open markets in Ghana are also a hub for the wholesale and retail of Ghanaian staples such as rice, vegetable oil, tomato sauce, fish, and other packaged goods. Wholesalers and retailers throughout Ghana converge in, for example, the Agbobloshie, Kaneshie, Kantamanto and Makola open markets to source, especially imported HVPs and return to their respective hometowns to sell (Taylor, 2017). Open markets appeal to both low-income and high income buyers as they offer competitive prices, freshness of produce (domestic) and travel convenience (Meng et al., 2014). Hotels, restaurants, other prepared-food outlets, and industries procure their food supply from open markets. Major importers and distributors of HVPs indicate that more than 80% of their business is with open-air markets, as traditional market operators tend to make instant payment for deliveries while supermarkets defer payments (Taylor, 2017).

1.11 Conclusion

This chapter set the scene for the research, highlighting the need to exploring the characteristics of the current food environment in a case study urban community in SSA, how residents

[10] *kontomire:* cocoyam leaves

[11] *kenkey*: corn husk-wrapped cassava and corn dough mixture steamed into dumplings.

interact with their food environment, and how the food environment supports or inhibit healthy dietary behaviours.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents a non-systematic review of existing literature relevant to the topic to set the theoretical context of the study. It initially presents literature on the changing food environment and its consequences, including nutrition and epidemiological transitions, and environmental impacts. It also introduces and positions UPFs and MFV as key food products playing a central role in nutrition and epidemiological transitions in SSA with large environmental impacts. The next section reviews literature on concepts and determinants of food environments, and the food environment-diets-health nexus. The final section introduces emerging adulthood and narrows down to what is known about campus food environments in SSA and Ghana and emerging adults' dietary behaviours. The review concludes with summary of gaps in the existing literature.

2.2 The changing global food environment

The global food environment has constantly evolved since agriculture began. Every change has brought with it advantages and disadvantages. Science and technological advancements in recent decades, spearheaded by transnational 'Big food' and beverage corporations (called Transnational Food companies-TFCs), have brought significant changes to the way that food is grown, processed, preserved, and transported—constituting the broader system. The food environment is part of a broader system defined to include the "activities, infrastructure, and people involved in feeding the global population (e.g., the growing, processing, distribution, consumption, and disposal of foods)" is referred to here as the food system (Popkin, 2017). Central to all food systems is the "food supply chain" or "food value chain" through which food transitions from farm to fork.

Researchers using food balance sheets of 171 countries on 18 food groups have noted 'clear shifts' in the global food environment between 1961 and 2013 (Bentham et al., 2020). Animal-source foods (ASFs) (such as meat and eggs) and sugar, starchy root and fruit, vegetable, and seafood and oilcrops food groups accounted for 90% of cross-country variation in food supply. The largest changes were observed in three Asian countries—South Korea, China and Taiwan—in the 50-year period, with ASFs and sugar, seafood and oilcrops, and vegetable becoming more available in the food environment. On the contrary, HICs like Australia, USA and UK had seen declines in ASFs and sugar in food supply, with remarkably limited change observed across SSA countries (Bentham et al., 2020).

However, other researchers have reported unprecedented increases in the availability of processed and packaged foods and the proliferation of multinational food companies and supermarket chains in the SSA retail food environment, especially in urban centers (Reardon et al., 2004, 2021; Nelia P. Steyn & Mchiza, 2014; Tschirley et al., 2015; Weatherspoon & Reardon, 2003). Indeed, research suggests that these supply changes are happening at a faster rate in SSA than it occurred in HICs (Vorster et al., 2011). In addition to 'big fast food and supermarket brands', evidence exists of a proliferation of cloned or copycat fast-food joints in urban and peri-urban SSA settings (Agyei-Mensah & Aikins, 2010; Meng et al., 2014), and a growth in local industrial processing of traditional staple foods (Andam & Silver, 2016). In recent evidence, Popkin (2017) highlights that these changes in food supply have already begun to penetrate rural boundaries in SSA.

Economic growth, urbanisation, and a growing middle-class population in the sub-region and other low-and-middle-income countries (LMICs) are believed to be creating a large market for more processed and packaged food products (Popkin et al., 2020; Reardon et al., 2021b). In the face of declining demands in HICs for UPFs and ASFs in favour of FV(Bentham et al., 2020), and a saturation of the processed and fast-food market in HICs, SSA and other LMICs have become more attractive markets for TFCs and supermarket chains for the supply of hyper-processed and packaged foods given the rapid urbanisation and population growth rates (UNDESA, 2015).

2.3 Consequences of the changing food environment

2.3.1 Nutrition transition

Public health experts have reported that this rapid surge in obesity and NCDs are partly due to the current food environment that encourages excess calorie intake (Popkin et al., 2020; Reardon et al., 2021b). The current obesogenic food environment is partly a consequence of economic development, which in turn, has fueled a nutrition transition (Popkin et al., 2020; Reardon et al., 2021b; Steyn & Mchiza, 2014). The nutrition transition, as expounded by Popkin (1994) is a descriptive term for changes in dietary patterns, from periods of food shortage to an era of dietary-related degenerative diseases when, at the community or population level, there is an adoption of modern lifestyles during economic and social development, urbanisation and acculturation (Amine et al., 2003; Steyn & Mchiza, 2014; Vorster et al., 2011). SSA's rapid urbanisation has co-occurred with an unprecedented availability of 'Western-style' foods such as sweetened and carbonated beverages, fast and convenience foods, especially in cities (Reardon et al., 2021b; Steyn & Mchiza, 2014) . The nutrition transition in SSA has been reported in Ghana (Ecker & Fang, 2016), Cape-Verde (Abrahams et al., 2011) and South Africa (MacIntyre et al., 2002; Vorster et al., 2011) and is likely present across many other countries without documentation in the literature.

Nationally representative cross-sectional studies in SSA like the Transition and Health during Urbanisation of South Africans (THUSA) study have confirmed most of the broad adverse shifts in dietary patterns that characterize the nutrition transition as described by Popkin (1994) (MacIntyre et al., 2002; MacIntyre et al., 2012; Vorster et al., 2007). The THUSA study found reduced intakes of fibre-rich starchy staples and protein from vegetal sources compared to increased intakes of ASFs rich in saturated fats, snacks, sweetened carbonated beverages, and increased use of sugar, fats and oils for cooking over a two year period (MacIntyre et al., 2002; Vorster et al., 2011).

In their 2001 paper, Luke and colleagues described West Africa as being in the preliminary stages of the nutrition transition on the basis of its comparatively low intake of fat and processed foods. Congruently, obesity prevalence was low and undernutrition more common before 2001 (Luke et al., 2001). Abrahams et al. (2011) applied a six-indicator-based scoring system to examine the extent of nutrition transition in 40 SSA countries just over one decade ago. The scoring system was based on the assumption that countries at advanced stages of nutrition transition would show high intakes of dietary energy and fat, low infant mortality rates, high adult obesity levels, low stunting in children and a smaller proportion of the population living on less than US$1. Their results indicated that the majority of West African countries were in the early stages of the transition. In the SSA region however, of the four countries at advanced stages of transition, two were West African (Ghana and Cape Verde), one was in southern Africa (South Africa), and another in Central Africa (Gabon). Senegal and Gambia were at the intermediate stage. It is likely that since these data were collected, additional countries are experiences later stages of the transition.

Sodjinou and colleagues (2009) found that nearly two-thirds of adults in Cotonou, Benin ate "traditional" diets, whereas a third consumed "transitional" diets. Adults on transitional diets ate higher amounts of pasta and white bread, nuts and seeds, roots and tubers, milk and milk products, white meat, red meat, and eggs, fats, and sweets. Compared with the traditional diet, the transitional diet was more diversified but less healthy with 79% higher cholesterol contents (136.6 vs 76.1mg/day) and 17% lesser in dietary fiber content (29.8 vs 34.9 g/day). Transitional diet was found among those in the high socioeconomic class or those born in the city.

While the foregoing is consistent with other research that has sought to examine the nutrition transition in SSA (e.g.: Becquey et al., 2010), these are studies that were conducted one to two decades ago. More recent studies are depicting diets with processed foods content. Galbete et al. (2017) for instance found two dominant dietary patterns in Ghana. A "rice, pasta, meat and fish" pattern similar to "transitional diets", which was characterized by increased intakes of dairy products, red and processed meat, legumes, rice and pasta, meaty-mixed dishes and sugar-sweetened snacks and beverages. The second pattern— "roots, tubers, and plantain" akin to "traditional diets" was associated with rural people, whiles transitional diets were eaten in urban areas. Additionally, Holmes and colleagues' recent study based on cross sectional data from four distinct SSA population groups—urban South African, peri-urban Ugandan, rural Ugandan, and urban Tanzanian (Holmes et al., 2018) identified a predominant "Mixed Diet" pattern characterized by high intakes of processed cold cuts and refined grains combined with unprocessed foods such as vegetable and fresh fish. The other pattern—Processed Diet pattern characterized by high intakes of cold cuts of meat, canned fish, chips, soda and sweets was significantly associated with obesity in both men and women.

Although, dietary changes have been integral to developmental history (Popkin, 1993), it has been recently underscored that these shifts are happening at a more rapid rate in Africa and at earlier stages of economic and social development (Popkin et al., 2013). While initially these changes were thought to be limited to the urban high-income class, recent evidence shows that these trends are becoming common among the urban poor (Amugsi et al., 2017). This has been attributed to the unprecedented availability, affordability, and acceptability of unhealthy foods such as UPFs in SSA, which are markedly cheaper than fresh foods, especially in urban SSA settings, including FV.

The consumption of UPFs is increasing globally (Baker et al., 2020; PAHO/WHO, 2015; Vandevijvere et al., 2019), eroding dietary regimes based on fresh or minimally processed food cultures. Nationally representative cross-sectional studies have consistently found UPF as a major component of diets in the USA (Juul et al., 2018), France (Julia et al., 2018), Australia

(Machado et al., 2019), and Brazil (Louzada et al., 2018) contributing up to 36%, 42% of total energy intake in France and Australia, respectively. In Africa, the region's economic prospects make it attractive for UPFs, the consumption of which is reported to be growing at a much higher rate in LMICs than in HICs (Moodie et al., 2013; Stuckler et al., 2012).

2.3.2 Rising Obesity, NCDs and multiple burden of disease

The nutrition transition, chiefly resulting from a changing food environment, is accompanied by demographic and epidemiologic transitions (Popkin, 1994; Omran, 1971). The former represents a shift towards low fertility and mortality resulting from improved socioeconomic development (Omran, 1971). The latter, epidemiological transition, exhibits shift in disease profiles from infectious diseases to lifestyle and NR-NCDs. The simultaneous occurrence of the nutrition and demographic transitions in an all-time highly obesogenic food environment contributes to rapid shifts towards increased prevalence of obesity/overweight, and NR-NCDs including diabetes, CVDs, osteoporosis, and certain cancers.

Until recently, SSA had been in the global media for undernutrition and food insecurity. The 2015 Global Disease Burden (GDB) study for instance reports how child malnutrition was a leading risk factor for premature deaths and disability in the sub-region between 1990 and 2015 (GDB report, 2016). In contrast to a global decline in undernourishment, the number of undernourished persons in SSA increased by nearly 8% between 2000 and 2016. SSA and South-East Asia account for 63% of all undernourished people globally (UN, 2017). Ninety percent of underweight children were housed in SSA and South-East Asia at the conclusion of the Millennium Development Goals (MDGs) (UN, 2015a). Of the under-five children in the African sub-region, about 39% were stunted, 10% wasted, and 25% underweight, according to the 2015 MDG report.

Global obesity rates have tripled in the last four decades (WHO, 2017). While rates in HICs seem to have plateaued in the past few years, prevalence in SSA and other low and middle-income regions are rising steeply (GNR, 2020). LMICs like Mexico and Chile in Latin America, one of the highest UPFs consumption regions, have some of the highest prevalence (73% (overweight/obese) and 34.4% (obese) respectively) in the world (Ministerio de Salud., 2017; OECD, 2019b). Today, there are more obese and overweight children in LMICs than in HICs (WHO, 2016). In SSA, childhood obesity has doubled since 1990 and is currently home to 25% of obese children worldwide (WHO, 2016). Among SSA adults, prevalence had more than doubled (114%) by 2007 (Abubakari et al., 2008) in a continent where 243 million people are hungry (WHO, 2018). The common perception has been that in richer countries one finds higher obesity rates in rural areas and among the poor—the opposite of what is seen in poorer countries (Ziraba et al., 2009). New evidence, however, appears to suggest that these trends are changing (Amugsi et al., 2017). In countries like Ghana reported to be going through a nutrition transition, the overall prevalence of overweight/ obesity increased from 29.3% (in women) and 14.4% (in men) in 2000 to 41% (in women) and 22.1% (in men) in 2016 (GNR, 2019). The country has not made progress towards achieving obesity targets. Similarly in young people (5 to 19 years), overweight/obesity prevalence has risen steadily from 5.5% in 2000 to 10.7% in 2016 (GNR, 2019).

Trends in obesity have also had implications for NCD prevalence in the sub-region. Approximately 80% of all NCD deaths occur in LMICs, with CVDs accounting for the most deaths, followed by cancers, respiratory diseases, and diabetes. These four NCDs account over 80% of all premature deaths, 85% of which happen in LMICs (WHO, 2021). In 2008 about 715,000 new cancer cases and 542 cancer deaths were recorded in Africa (Jemal et al., 2012). Between 1990 and 2017, overall NCD burden in SSA increased by approximately 67% in NCD burden, which accounted for 29.8% of the total burden of disease in 2017 across the subregion (Gouda et al., 2019) and 24% of global disease burden (IFC World Bank Group, 2019). NCD deaths are projected to be highest in Africa and 25% higher than the projected global average. By 2030, they are projected to be the largest sources of deaths in Africa (WHO, 2016). In Ghana, NCDs have become a public health concern, responsible for 43% of all deaths (WHO, 2018). Of these NCD deaths, CVDs accounted for the highest (19%), followed by cancers (5%), diabetes (3%) and chronic respiratory diseases (2%) (WHO, 2018).

Today in SSA, healthcare systems are faced with the most complex health problems from the multiple burden of undernutrition (stunting, wasting and micronutrient deficiencies), overnutrition (overweight, obesity), and NR-NCDs. Within the same household, community or even an individual in SSA, it is not uncommon to find the coexistence of undernutrition and obesity (GNR, 2020). Despite the increasing prevalence of such a complex diet-related disease burden, research to understand how individuals interact with the food environment to make dietary decisions in SSA has received little attention. Further compounding this is the fact that the DBN is co-existing with a longstanding high infectious disease prevalence—a mixed epidemic of communicable and NCDs (Agyei-Mensah & Aikins, 2010; Doku & Neupane, 2015). HIV/AIDs, malaria and tuberculosis are still big killers in the sub-region (Levitt et al., 2011).

It is important to note that unhealthy diets are a leading risk factor for obesity, undernutrition and major NCDs, and evidence exist of the importance of the inclusion/exclusion of MFV or UPFs in the diet. For instance, although meat is an important source of protein, readily absorbable zinc and other essential minerals (iron, potassium and selenium), amino acids and vitamins (vitamins B3, niacin, B6, riboflavin, and B12) (Bradbury et al., 2017; McAfee et al., 2010; McNeill, 2014), important for combating micronutrient-deficiency, excessive meat consumption leads to excess intake of energy, saturated fats and cholesterol which are important risk factors for ischaemic heart disease (Boada & Henríquez-hern, 2016; González et al., 2020). This may partly explain meat's association with life expectancy or all-cause mortality in recent research (Ranabhat et al., 2020; Schwingshackl et al., 2015; Zhuang et al., 2021). While it is important for combating micronutrient-deficiency including iron deficiency (leading to anaemia) in SSA, where prevalence is highest (Moschovis et al., 2018), meat (particularly red and processed meat) has been positively linked to some cancers, particularly, colorectal, pancreatic, stomach and prostate and other NCDs (IARC, 2018; Lo et al., 2020). Recent evidence corroborating this has suggested that every 50g meat consumed per day increases the likelihood of developing colorectal cancer by about 18% (Bouvard et al., 2015; IARC, 2018).

Epidemiological studies imply a convincing involvement of carcinogenic compounds such as polycylic aromatic hydrocarbons (PAHs) and N-nitro formed in meat during high temperature cooking in the development of some NCDs (Abu-Ghazaleh et al., 2021; Amine et al., 2003; Wang et al., 2010; Zur Hausen, 2012; zur Hausen et al., 2017). There is evidence that packaging materials for UPFs contain carcinogenic compounds and hormone-disrupting chemicals like bisphenol A (commonly called BPA) (Darbre, 2020)

The consumption of UPFs is also an important risk factor for obesity, consistently reported in recent research in 19 European countries (Monteiro et al., 2017); Brazil (dos Passos et al., 2020); in a longitudinal study in Spain (Mendonça et al., 2017); USA (Juul et al., 2018); Canada (Nardocci et al., 2020); and in a nationally representative sample in the UK (Chang et al., 2021; Rauber et al., 2020). In recent systematic reviews of observational and experimental studies from HICs and LMICs, UPFs consumption was found to be associated with increased risks of morbidity and mortality, obesity, all-cause mortality, CVDs, and breast and other cancers (Lane et al., 2021; Matos et al., 2021). It has also been linked with increased risk of hypertension among adults in a longitudinal study in Spain (Mendonça et al., 2017); type-2 diabetes and CVDs (Srour et al., 2020) and cancer (Fiolet et al., 2018) in cohort studies among adults in France; and mortality in nationally representative surveys among UK and French adults (Rauber et al., 2020; Schnabel et al., 2019)..

In contrast, high FV intake is proven to increase carotenoids and vitamin C, both of which possess antioxidant characteristics that may prevent the initial phase development of some NCDs (Aune et al., 2017; Miller et al., 2000; Rodriguez-casado, 2016; Zhang et al., 2015). The protective effect of dietary fiber contained in FV for some NCDs such as colorectal cancer is well documented (Boeing et al., 2012; Burkitt, 1971; Erkkila & Lichtenstein, 2006; Farvid et al., 2016; Halvorsen et al., 2021; Youngyo Kim & Je, 2017; Lockyer et al., 2016; Slavin & Lloyd, 2012). Low FV consumption is thus an important risk factor for NCDs, accounting for nearly 5.2 million deaths annually (World Health Organisation, 2017). Populations in SSA may be at a higher risk given that one in four lack adequate food (FAO et al., 2017) and as SSA diets shift towards EDNP foods, rich in saturated fat and added sugars at the expense of fresh vegetable, fruit, and staples.

Although only a small proportion of the global population meets the WHO/FAO (2003) recommended daily minimum of 400g or five servings of FV (Micha et al., 2015), little is known about how much is consumed by populations in SSA. The World Cancer Research Fund International's recommendation of less than 500g (18oz) [or 71.43g per day] of meat per person per week (WCRF/AICR, 2018a) is also exceeded in many populations (Ritchie & Roser, 2018). While consumption trends seem to have plateaued in HICs in the last five decades, consumption trends across SSA are not clear (Ritchie & Roser, 2018). As SSA is on the path of an unprecedented wave of urbanisation (UNDESA, 2017), understanding UPFs, and MFV consumption trends in SSA and factors in the food environment that shape consumption are important precursors towards tailored intervention strategies to steer diets in SSA in a positive direction.

2.3.3 Environmental Impacts

The current food system produces in sufficient quantities to feed the global population, but equitable access to sufficient, nutritious, healthy, culturally acceptable, and environmentally benign food has become a challenge.

According to the FAO (2012: 7),

> “sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy, while optimizing natural and human resources”

The definition reinforces the interdependence of diets, human health, and ecosystem health, and none can be isolated. Thus, the impact of our diets on health and the environment are interconnected. It has been argued that trends in the current food system are not environmentally sustainable. Lang (2017: 14) stresses that food “consumption is the pull in the system” and that the current direction of diets needs addressing.

The environmentally destructive pressure for overproduction in industrial agriculture is what is feeding the world with abundant supply of ultra-processed and unhealthy diets (Lang, 2017). The health consequences are severe and have been discussed above. However, concurrent with these, there is a colossal environmental toll which was introduced in Section 1.5. Agriculture accounts for 14% of GHG emissions with methane emissions from livestock production alone accounting for 40% of the total emissions from agriculture (Tubiello et al., 2014). The production of meat and dairy foods contribute to nearly 15% of global emissions or up to 50% of food system emissions (Gerber et al., 2013; Ritchie & Roser, 2020). Emissions from the entire food system (including but not limited to land-use, fertilizer production, food processing, packaging, and distribution) is even larger, reported to be responsible for 21 to 37% of all emissions (IPCC, 2019). The environmental sustainability of meat-rich diets has become a global concern on grounds that meat production overexploits and degrades land and water resources. According to recent analysis, emissions for every gram of protein from meat is 250 times the GHG emissions from plant-based food (Tilman & Clark, 2014). Emerging literature indicates that meat uses 36 times more land than vegetarian protein (Poore & Nemecek, 2018), requires 11 and 6 times more water and fertilizer, respectively, than crops (Eshel et al., 2014). Additionally, one-third of global food crops are fed to livestock with only 12% returning as meat and other dairy products (Cassidy et al., 2013).

Similarly, UPFs have been reported to use large volumes of water (WWF, 2003). The National Geographic water footprint list suggests that over 2950 liters of water is used up in making every industrially-produced quarter-pound burger (Hoekstra, 2012) and about 200 liters of water required for the production of 200 millilitres of milk (Hoekstra & Chapagain, 2006).

Increased intakes of processed meat and dairy products, vegetable oils and other UPFs from supermarkets at the expense of fresh vegetable, fruit, and staples means increased GHG emissions, especially from meat and dairy production which are the largest sources of food sector GHG emissions (Ritchie & Roser, 2020).

Life Cycle Assessment studies also found that home-made meals prepared from fresh ingredients are associated with lower environmental impacts than their ultra-processed ready-to-eat meal equivalents (Hanssen et al., 2017; Rivera et al., 2014), which also produce more waste due to packaging and consume more energy (Hanssen et al., 2017). Although environmental impact assessments of processed and ultra-processed foods have not been comprehensive and focus on the effect of the production and demand of primary inputs, UPFs production is heavy on the use of plastic packaging, a primary culprit for solid waste generation and environmental impacts of disposal (Seferidi et al., 2020). Plastic packaging is responsible for about 50% of total plastic waste globally (UNEP, 2018c).

In SSA where waste management systems are fragile and solid waste is poorly managed, the environmental impacts of plastics from UPFs are severe. According to UNEP (2018a) 13% of municipal solid waste generated in Africa is plastic, with 90% of waste disposed of at uncontrolled dumpsites and landfills usually associated with open burning. Recent evidence shows that 25% of the top 20 highest contributors to global plastic marine debris are countries in Africa (GREENPEACE, 2018). Mismanaged plastic waste in Africa is projected to reach 11.5 million tonnes by 2025 from 4.8 million tonnes in 2010 as a rapidly growing middle class create large markets for consumer plastic goods and packaging (Lebreton & Andrady, 2019; Sambyal, 2018) as used in UPFs.

The UN 2030 Agenda for Sustainable Development set the path for achieving "integrated and indivisible" goals and targets spanning the three pillars of sustainable development: the social, economic and environmental (UN, 2015b). The current e consumption patterns driven by the current food environment appear to traverse the idea of "responsible consumption and production" in the SDG12 and may have direct knock-on effects on hunger and poverty reduction (SDGs 2 and 1 respectively). With less than half of the global population having a healthy body mass (body mass index ≥18.5 and < 25) and high micronutrient deficiencies in SSA countries and other LMICs further risks the prospects of achieving SDG2 and SDG3 (GNR, 2018). The food related GHG emissions outlined in the preceding paragraphs threaten global temperature targets, thereby risking the achievement of SDG 13 and the Paris

Agreement (UNEP, 2018b). More specific impacts from unsustainable rates of pesticides and fertilizer application, coupled with unsustainable water withdrawals for food production threaten biodiversity targets in SDG 14, SDG 15 and the Aichi Biodiversity Targets) apart from risking the ability to provide safe and adequate amounts of drinking water (SDG 6) (Gerten et al., 2020; Sánchez-bayo & Wyckhuys, 2019).

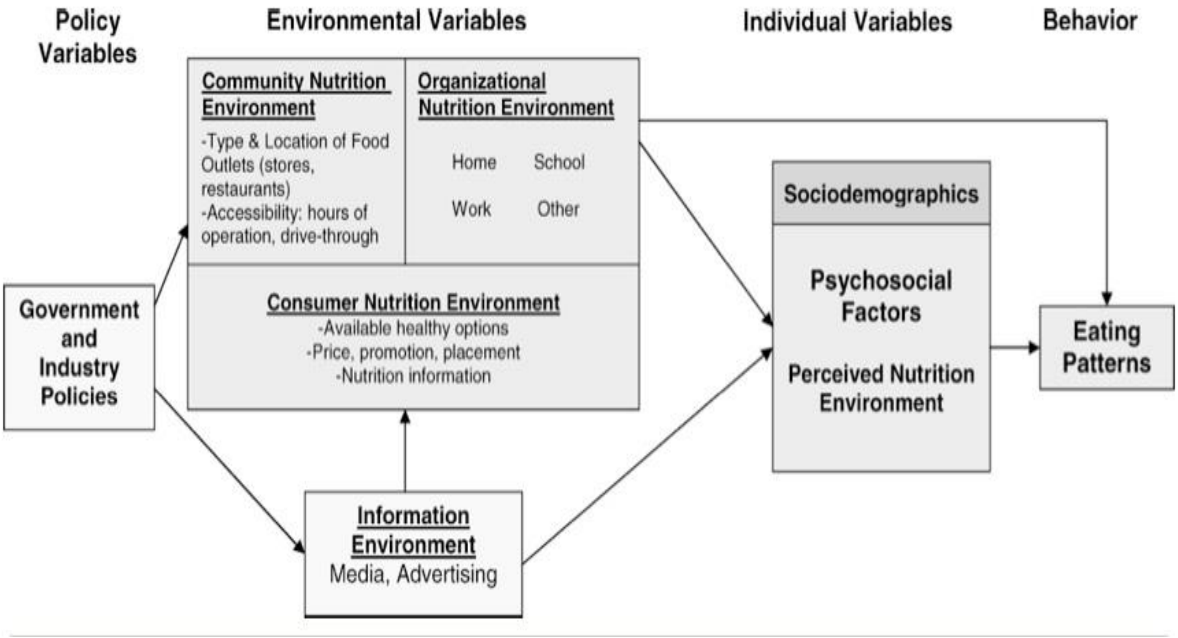
There is a strong consensus that dietary modifications from diets rich in UPFs, meat and dairy towards FV and other plant-based foods, could deliver major reductions in environmental impacts (Aleksandrowicz et al., 2016, 2019; Springmann et al., 2018; Xu et al., 2021), e.g. 70 to 80% of GHG emissions, 50% land use and 50% of water use, compared to 1995 levels (Aleksandrowicz et al., 2016). Evidence suggests that dietary modifications would offer the largest absolute health and environmental benefits (Springmann et al., 2016), highlighting the urgent need for research that informs context-relevant policy efforts to promote healthy and sustainable diets.

2.4 Concepts and determinants of food environments

Concepts of the food environment are frameworks that capture the various levels of factors that exert both distal and direct effects on food choice and dietary behavior and how these relate to obesity and chronic diseases. Swinburn and colleagues pioneered the use of a systems approach to map out environmental factors that drive obesity through food and physical activity pathways. They coined "obesogenic(-ity) environment" as a term to describe "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn et al., 1999). They developed a framework for analysing obesogenic environments at the micro and macro levels based on four broad factors physical, political, economic, and socio-cultural).

Glanz et al. (2005) developed a conceptual model for analyzing the food or nutrition environment. They propose four types of nutrition environments (community, organisational, consumer and information) that are shaped by government and institutional policies and intra-personal factors (perceptions and sociodemographic and psychosocial factors) (Figure 2.1). The community nutrition environment refers to the number, type, and location and accessibility of food outlets (such as stores, restaurants, etc.). Organisational nutrition environment was defined to include the home, school, workplace, churches and other institutional environments. Consumer environments represent what consumers encounter within and around food outlets, including price, promotions, nutritional quality, range of choices and nutrition information, among others. Based on this Héroux et al. (2012) have also conceptualised food retail environments to refer to the quantity and type of food retailers available to an individual.

Figure 2.1: Model of Community Nutrition Environments

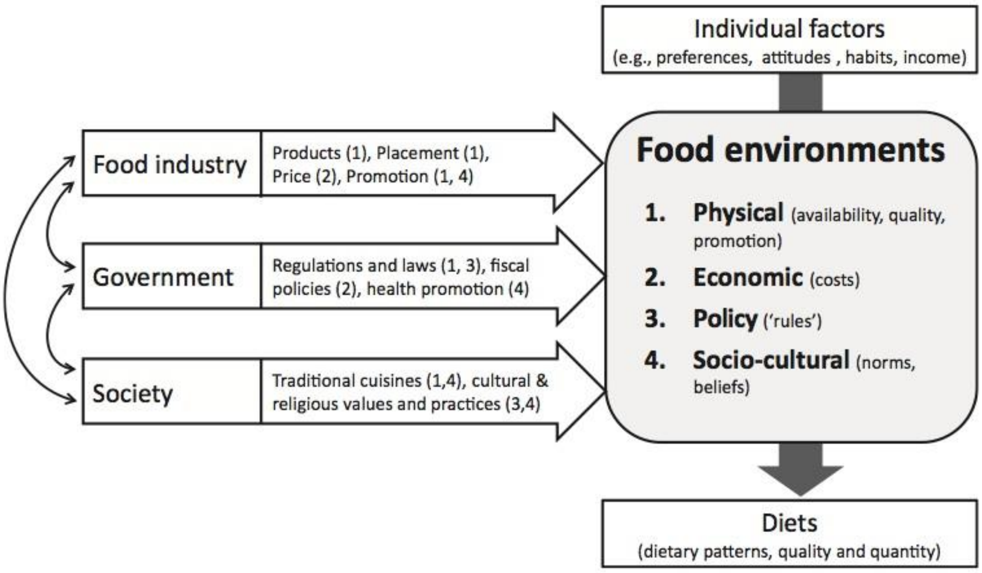


Source: Glanz et al. (2005)

The International Network for Food and Obesity/non-communicable diseases Research, Monitoring and Action Network Support (INFORMAS) has developed a comprehensive model of the determinants of the food environment (Swinburn et al., 2013). Their concept draws on previous models by Swinburn et al. (1999), Glanz et al. (2005) and (Story et al., 2008). INFORMAS is a global network of public-interest organizations and researchers that seeks to monitor, benchmark and support public and private sector initiatives to create healthy food environments and reduce obesity, NCDs and related outcomes. At the core of the concept is the argument that the creation of "healthy food environments" are prerequisites if obesity and nutrition-related health outcomes can be reduced. The INFORMAS define healthy food environments as those "…in which the foods, beverages and meals that contribute to a population diet meeting national dietary guidelines are widely available, affordably priced and widely promoted" (Swinburn et al., 2013:2). They categorize the food environment into four broad components (physical, economic, policy and socio-cultural) that are framed in various ways by four key factors namely: the government, food industry, society, and individual dynamics (see Figure 2.2).

The food industry determines food types on supply, promotes consumption, and contributes to formation of social norms and beliefs about food. Governments through policies, laws, and regulations, create the structures within which the food industry must operate. Society establishes cultural food norms and delicacies through its traditional, cultural, and religious beliefs and knowledge. The individual interacts with the food environment to make their food choices, which are framed by personal factors like preferences, income, and education.

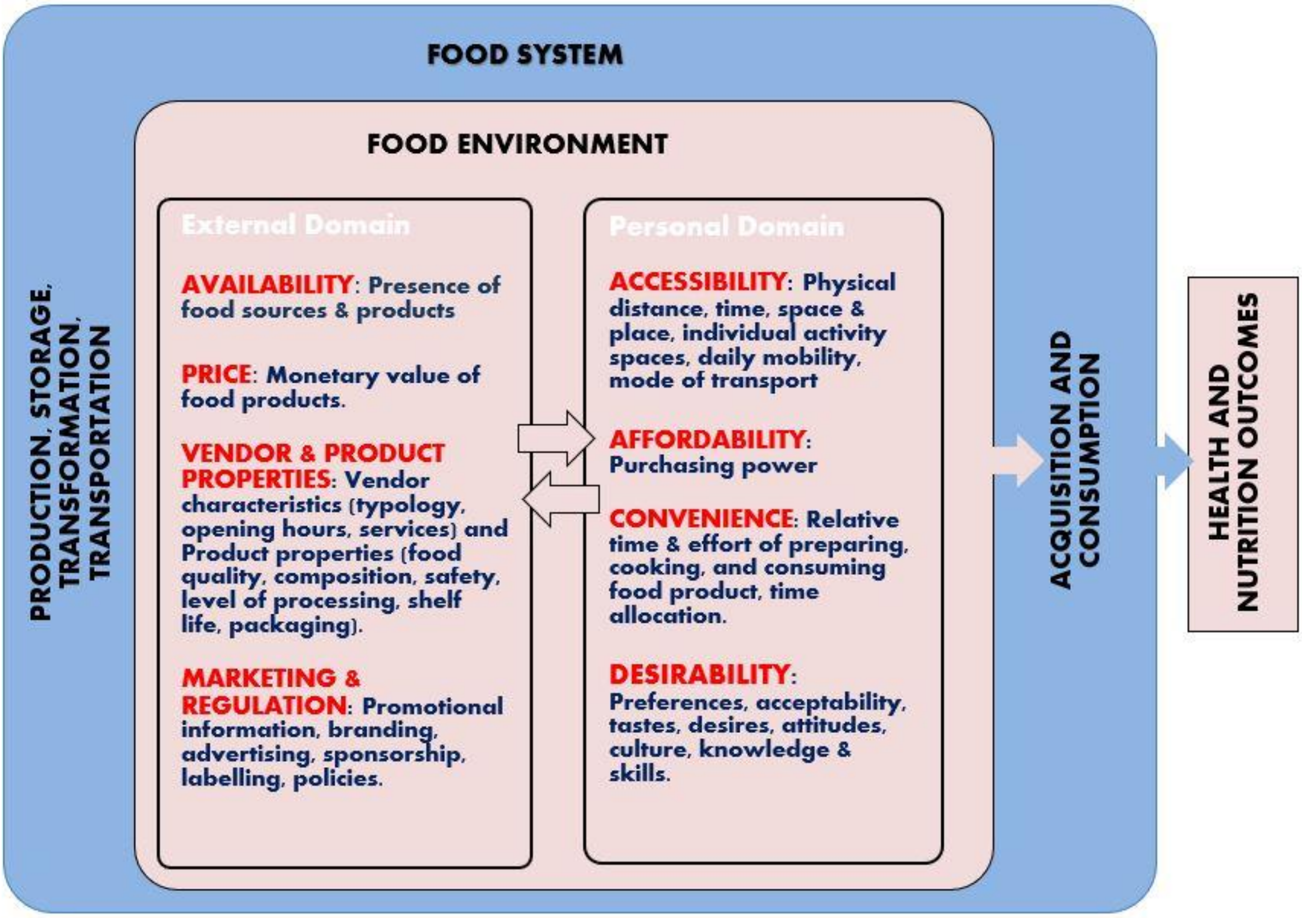
Figure 2.2: Food environments, components, and influences



Source: Swinburn et al. (2013)

A more recent framework conceptualizes the LMIC food environment intended to facilitate food environment research in LMIC settings. Through a series of iterative international expert panel discussions, Turner et al. (2018) draw on socio-ecological theory to conceptualise the dimensions of the food environment as two key domains: external and personal domains, to situate the food environment within the wider food system (see Figure 2.3). They identify four external dimensions (food availability, vendor and product characteristics, prices, marketing and regulation) and four personal dimensions (food accessibility, affordability, convenience, and desirability) which interact continuously in a complex way to shape food acquisition and consumption (Turner et al., 2018).

Figure 2.3: Theoretical framework for conceptualising the LMIC food environment



Source: Turner et al., 2018

Based on this conceptualisation, Turner and colleagues define the food environment to be "the interface that mediates people's food acquisition and consumption within the wider food system…" (Turner et al., 2018: 95). Conceptualising the food environment as an 'interface' and the focus on 'interactions' situates the food environment in relation to people's daily lives and activities that shape food acquisition and consumption. This maps to Clary et al.'s (2017) conceptual model of contextual factors that influence an individual's food choice, including food sources they encounter in their daily paths and trajectories.

2.5 Drivers of unhealthy food environments in SSA

The obesogenic food environment is driven by a complex interaction of factors including individual factors, trade policies and transnational food corporations (TFCs), urbanization, and rising incomes. These are discussed in turn.

2.5.1 Trade Liberalization, FDI and Transnational Food Companies

The key supply and macro environmental factor driving unhealthy eating in SSA is the industrialization and globalization of the food system. The last two decades have seen transnational supermarket, beverage and fast-food companies influx the SSA food market. In many SSA countries such as Kenya, Zimbabwe, South Africa, Cape Verde and Rwanda, multinational food corporations were found to be dominating the food market and were among the top three largest companies (Hawkes, 2005). Integral to this has been the ratification of trade liberalization and foreign direct investment policies as part of structural adjustment programmes in the 1990s in many African countries (das Nair, 2017; De Vogli et al., 2014; Hawkes, 2005). This has removed barriers to foreign investment and opened local SSA markets to food imports. In turn, this has facilitated the increasing availability, affordability and consequent consumption of hyper-processed, energy-dense, nutrition-poor foods and animal products in the sub-region.

TFCs have thus radically modified the SSA food environment and the choices consumers make, particularly in cities where they are concentrated (Schram et al., 2013). Their large comparative advantage allows the production and supply of hyper-processed foods at rates that can be cheaper than raw foods. This is further enhanced as these processed foods have longer shelf lives compared to unprocessed foodstuffs. Moreover, as competition among key players for market share intensifies, promotional campaigns lead to further price cuts (Hawkes, 2006), reaching a full range of income groups (das Nair, 2017). The marketing strategy often aims to influence consumer food habits, especially children, towards ultra-processed foods, fast foods, snacks and SSBs, which are fatty, sugary or salty and generally obesogenic (De Vogli et al., 2014).

The number of these transnational fast-food outlets has increased sharply in urban areas and are already multiplying beyond middle class big-city markets into smaller towns and poor urban areas (Bloem & de Pee, 2017; das Nair, 2017; Temple & Steyn, 2010; Weatherspoon & Reardon, 2003). In Southern and Eastern African countries like Kenya and South Africa where the first wave of transnational ‘Western-style’ food outlets were experienced, annual fast food outlet growth averaged 3% from 2009 and 2016 (Euromonitor International, 2017) and is proliferating beyond urban to rural markets (das Nair, 2017). ‘Western’ brand names like Kentucky Fried Chicken (KFC) alone has over 770 outlets across the sub-region (Veselinovic, 2015). In Botswana and South Africa about 30 to 40% of grocery demand is met by foreign companies such as Walmart. In Zambia and Zimbabwe, this is more than 55% and includes SPAR International, Game, Poundstretcher and Shoprite (das Nair, 2017). In West Africa, 'Western-style' supermarket and fast-food outlets are proliferating sharply in Ghana and Nigeria. According to the Euromonitor database, annual grocery retail sales in Nigeria between 2001 and 2012 increased by 38% (from US$10 billion 27 billion). The database indicates that the Nigerian food supply system is increasingly dependent on imports, including beverages, dairy products, honey and sugar products, and cereals and cereal products (Schram et al., 2013).

Increased exposure to fast food restaurants (Burgoine et al., 2014) and supermarket shopping (Demmler et al., 2018; Kimenju et al., 2015) have been associated with increased risks of obesity and NR-NCDs through changed diets. Supermarket purchases significantly increase total energy intakes from processed meat and dairy products, vegetable oils and other ultra-processed foods in Kenya at the expense of fresh vegetable, fruit and staples (Demmler et al., 2018). De Vogli and colleagues (2014) estimated that a unit increase in fast food intake per capita leads to an increase in age-adjusted per capita BMI of 0.23 kg/m2 in developed countries.

International food trade, especially the export of UPFs, are significant climate change contributors as they require mass production of the ingredients commonly used in their manufacture. They are cultivated industrially as mono crops and contributes significantly to agricultural pollution. Industrial farming consumes large volumes of water and requires and depletes land, including the leaching of chemicals (Wiedemann et al., 2016). Their contribution to plastic waste has been discussed above. In addition to previous widespread knowledge that exporting countries are the only ones that incur the environmental costs of exporting food to SSA markets by using land and other resources, a recent study has shown that international food trade can lead to environmental pollution in importing countries (Sun et al., 2018). An example is when a soybean importing country clears nitrogen-fixing soybean farms to cultivate nitrogen-demanding crops like corn or rice.

2.5.2 Urbanisation and income

More than half of the world population currently lives in urban environments, e.g., towns and cities. By 2050, this will increase to nearly two-thirds of the world population, with Africa and Asia accounting for 90% of the growth (UNDESA, 2014). Currently, Africa is urbanising rapidly and is projected to urbanize faster than any other region between 2020 and 2050

(UNDESA, 2014). In SSA, the sum of medium-size cities will more than double by 2030 (UN-Habitat, 2016).

Urbanization has probably been the greatest driver of the changes in the food environment (Kelly, 2016) in SSA. Urbanisation facilitates technological developments in communication that permit improved marketing and advertising (especially through mass media), better transportation, distribution, and storage infrastructure. These not only position urban areas to attract multinational supermarket corporations, but also, enhance access to foreign suppliers, which makes imports a significant part of local food supply chains in SSA (Hawkes, 2006). Multi-country studies have demonstrated the link between higher levels of urbanisation and increased intakes of animal-source products (Asfaw, 2008; Kimenju et al., 2015) and sweeteners and fats (Popkin, 1999; Popkin & Nielsen, 2003). Complementing these are studies that have used nationally representative data in time-series analysis to demonstrate significant effects of urbanisation on consumption of cereals (Huang & David, 1993) ASFs (Attard, 2015) in Asian countries.

Although urbanisation leads to increased urban dietary diversity, the marketing and advertising strategies employed present processed foods, which are typically high in fats, salt, and sugars, in ways that appeal to urbanites as more palatable and nutritious options than traditional foods rich in high complex carbohydrates, low in fats, and high fiber contents. In many SSA countries, such food options are perceived as desirable status symbols (Steyn & Mchiza, 2014). Processed foods are thus rapidly embraced by local populations and widely consumed. Reports have associated this trend with increased calorie intake among city dwellers (Popkin, Adair, & Ng, 2013). Combined with lower energy expenditure associated with urban lifestyles, due to increased access to motorized transportation, time- and labor-cutting technologies at home and in urban occupations (Appiah et al., 2014; Monda et al., 2008; Ng et al., 2012), being overweight and obesity and NR-NCDs are rife in urban Africa, especially in high-income groups (Appiah et al., 2014; Popkin & Slining, 2013). Another key feature of urban life is an ever-growing time poor consumer population that drives demand for processed or pre-prepared convenience foods (Gissing et al., 2017; Kelly, 2016; Pingali, 2007).

Unhealthy foods with longer shelf life can be cheaper to produce than healthier perishable foods and are increasingly becoming more appealing to the urban poor with limited access to refrigeration and storage space (Bloem & de Pee, 2017; Temple & Steyn, 2010). The obesity epidemic and NR-NCDs are thus reported to be shifting towards the urban poor in SSA

(Amugsi et al., 2017; Jones-smith et al., 2012; Ziraba et al., 2009). The implication in a business-as-usual scenario is a larger number of urban poor at the mercy of the effects of the nutrition transition.

Urbanisation often coincides with rises in income or wealth as a result of the concentration of better paid employment (Nelia P. Steyn & Mchiza, 2014). This is another important driver of unhealthy dietary patterns in SSA. Despite a few shortfalls, the region's GDP growth rate between 2000 and 2010 has averaged around 4%, accounting for a per capita income growth of about 2%, with more than 5% increase in the middle class population (UNDESA, 2011). In SSA, rising incomes has been associated with higher fat diets (Shisana et al., 2014). In that, the intake of animal-source products, processed foods, fast food, and eating-out have been perceived as markers of greater economic wellbeing and class, and thus desirable among most populations (De Vogli et al., 2014). Recent declines in the prices of ASFs and vegetable oils resulting from declining cost of production facilitated by technological advancement have also made these products more affordable to an increasing proportion of SSA consumers (Hawkes, 2005).

Higher wages are often cited as an underlying reason for the higher intake of vegetable oils, meat, dairy products and processed, energy-dense foods in urban compared to rural areas of SSA (Cockx et al., 2017; Du et al., 2004). Indeed, Stage and colleagues (2010:204) have posited that "the difference between urban and rural households' patterns of food consumption is not caused by urbanisation and cultural change but income differences".

This presupposes that though income and urbanisation are distinct constructs, they may be interrelated in an urbanising country in the effects on dietary behavior and health. However, it is conceivable that income may play out differently in different national and community contexts in terms of its implications for dietary behavior and health. In most of SSA, for example, supermarkets and fast-food outlets are concentrated in more urban versus less urban areas. This may mean that in less urban areas, access to certain food products may be extremely limited or nearly impossible, no matter the income of inhabitants. On the other hand, in more urban areas, income may play a significant role in whether lower income groups have adequate fiscal access to certain food products. It is also acknowledged that over time, price declines may make traditionally inaccessible diets more accessible to all income groups and community contexts (Du et al., 2004).

2.5.3 Consumer attitude and behavior

Although income, urban environment, trade policies and TFCs are important drivers of unhealthy eating in SSA and other developing regions, personal level factors are known to contribute substantially to consumer behavior (Swinburn et al., 2013). Existing literature covers such factors as beliefs, expectancies, the food needs and preferences based on an individual's psychological and physiological features, and the intangible resources such as knowledge, time and skills involved in acquiring food (Mogre et al., 2013).

Growth in consumer health consciousness has resulted from the increasing availability of health information coupled with increased risk for and prevalence of NR-NCDs. Thus, highly literate and well-informed consumers are not only adopting healthier dietary behaviours but also taking ethical and environmental impact factors into account in choosing what to eat, particularly in HICs. Notwithstanding this, a majority of daily consumption choices are still driven largely by price and value for money, convenience, individual responses to social and institutional norms, availability, and brand familiarity. The food choices an individual makes continue to take place increasingly in the setting where availability is largely influenced by food industry players and policies (Reardon et al., 2021).

In SSA, cultural beliefs and social norms continue to influence food consumption behaviour in a large section of the populace. Culturally, increasing body size has been perceived in the positive light as a marker of good health, greater economic well-being, and especially in women, as a sign of beauty and good marital life in most of the sub-region despite ethnic variations (Appiah et al., 2014; McHiza et al., 2011; Smedley, 2013). Ironically, thinness has been stigmatised and associated with poverty, disease and misfortune (Matoti-Mvalo & Puoane, 2011), although this may well be changing (Aryeetey, 2016; Murphy et al., 2017; Pedro et al., 2016). Where preferences for larger body size remains, it is conceivable that these may present major psychological impediments to awareness of obesity/overweight, adoption of healthier dietary behaviors and motivation for weight control, as found in South Africa and Morocco (Mchiza et al., 2016; Rguibi & Belahsen, 2006). There is also a deep-rooted social desirability to emulate 'Western' lifeways, influencing dietary behaviors in favor of obesogenic diets.

Current research from SSA appears to suggest that food consumption behavior is shifting towards healthier diets among the high socioeconomic class (highly educated or richer) who are better placed to access high quality health information and advice (Amare et al., 2012;

Msambichaka et al., 2018; Wrigley-Asante et al., 2017). There is however little-to-no public awareness of and interest in ethical consumerism and sustainability as drivers of food consumption decisions reported in the literature to date (Bonsu & Zwick, 2007; Rambe & Ndofirepi, 2016). Policy interventions in SSA intent on promoting healthy food consumption may need to capitalize on the role of consumers as drivers of food production as they have an important influence on the demand for various kinds of food products (Kearney, 2010).

2.5.4 The food retail environment, diets, and health

The food environment connects consumers to their food choices. It plays a significant role in influencing what individuals consume by determining what is available to them. The current urban food environment makes an increased amount of energy-dense foods and drinks available and at affordable prices, leading to excessive calorie intake and thus obesity (Monteiro et al., 2013). Research from high income countries, specifically, the UK, USA and Canada has often associated certain food environments with healthy or unhealthy diets and levels of body mass index (BMI).

In an extensive review of studies in high income countries, Larson et al. (2009) found increased access to supermarkets to be associated with improved dietary quality, fat intake, and FV intake in both adolescents and adults. Proximity to fast-food outlets has also been associated with increased fast-food consumption in the USA (Athens, et al., 2016), increased intake of unhealthy foods among adolescents (Fraser et al., 2011) and increased childhood obesity in the UK (Fraser & Edwards, 2010). Neighborhood density of small grocery stores has also been found to be significantly associated with obesity and increased BMI in a longitudinal study of urban Americans (Gibson, 2011). A multi-country study including 72,900 children from 17 countries and 199,135 adolescents from 36 countries also found significant association between fast-food consumption with higher BMI (Braithwaite et al., 2014). However, a systematic review by Gustafson et al. (2012) (n=56 studies) found no consistent association between food retail environment and dietary patterns or BMI. This is corroborated by a more recent systematic review (n=74 studies) (Snowdon, 2018). While only 20% of studies found a positive association, 60% of studies reported no positive association (of this, 15% showed that proximity of residence to fast food outlets reduced obesity risk). The remaining 20% reported mixed results.

Food environment research in SSA in nascent, although there is a strong consensus that context is key in understanding the influence of particular food environments on diets and health outcomes (Gustafson et al., 2012; Larson et al., 2009; Turner et al., 2020). In a cross-sectional study of adolescents (13 to 19 years) in Cotonou, home-prepared food consumption was associated with healthy eating, whiles the reverse was true for out-of-home food consumers (Nago et al., 2010). Consumption of sweets was highest (440g/day) among high out-of-home (OOH) food consumers with out-of-home foods accounting for 84% of all sweet foods and only 26% of FVs consumed daily. Home-prepared food accounted for 74% of FV consumption. However, FV intakes in both out-of-home consumers and at-home consumers were hardly a fourth of the recommended 400g minimum, but total energy intake obtained from fat (31%) exceeded the 15—30% WHO/FAO recommendation (Nishida et al., 2004). Becquey & Martin-Prével (2010) have also found ready-meals consumed outside the home to be associated with micronutrient adequacy among 182 women (19 to 60 years) in Burkina Faso. In addition, cross-sectional surveys in South Africa found that fruit, soft drinks, sweets, peanuts, crisps and biscuits were the most frequently purchased street foods by adults 16 years and older (Steyn et al., 2011 (n=3,287); Hill et al., 2016 (n=1,121).

However, an extensive scoping systematic review has recently concluded that research findings in the LMICs setting regarding associations between food environment exposure and nutrition status are inconclusive (Turner et al., 2020), although a recent review found association between availability characteristics of the neighbourhood food environment and diets and health outcomes (Westbury et al., 2021). Both reviews found sparse and mixed evidence on other neighbourhood food environment features (Turner et al., 2020; Westbury et al., 2021).

Specific to Ghana, in a study of urban poor adults (15 to 59 y; n=657) living in deprived communities in Ghana, Dake et al. (2016) reported an association between the presence of neighborhood convenience stores and increased BMI after adjusting for lifestyle behaviours, socio-demographic and other neighborhood characteristics. Availability of OOH cooked foods within the study site was associated with reduced BMI, as every additional OOH cooked food outlet resulted in a 01. Kg/m^2 reduction in BMI. The study also showed that for every additional convenience store, there was a 0.2 kgm^2 increase in BMI. While this appears to be the most relevant study available in the existing literature, it does not take into account other food outlets outside the neighborhood of study participants, such as open-air markets. Open-air markets are the main and most preferred retail food sources among the urban poor (Field et al., 2010; Meng et al., 2014; Reardon et al., 2004) who are able to patronize them using cheap public transport (Aryeetey et al., 2016). In addition, despite the contribution to tracking the rapidly changing food environment in the SSA setting, there is the absence of attention to how individuals interact with their food environment to identifying the pathways between the food environment, the multiple forms of malnutrition and other NR-NCDs (FAO et al., 2018). Apart from this study, there is a general lack of research tackling the personal food environment and the role that dimensions such as convenience, affordability and desirability play in food acquisition and consumption practices in the SSA setting (Herforth & Ahmed, 2015; Turner et al., 2018). Researchers have also suggested the need for food environment research in SSA to enhance appreciation of "the socio-ecological processes that shape food acquisition, diets, nutrition, and health" (Turner et al., 2020:393). The Food and Agriculture Organisation (FAO, 2016) and the Global Panel on Agriculture and Food Systems for Nutrition have also highlighted the absence of research attention to the role people's everyday life and activities play in food acquisition and dietary practices in the sub-region (Haddad et al., 2016).

Turner et al. (2020) identified low quality studies in a nascent body of food environment literature in LMICs with extremely limited research in SSA. They call for improved methodological designs and metrics that better capture and enhance understanding of the socio-ecological interactions that take place in the food environment than cross-sectional designs. Turner and colleagues recommend the use of qualitative and mixed methods studies adept at capturing perceptions, lived experiences and offer opportunities for more comprehensive and nuanced assessments of food environments (Turner et al., 2020).

2.6 Why emerging adults and the university food environment?

2.6.1 Emerging adulthood and dietary behaviour

Emerging adulthood, considered to be 18 to 25-year olds (Arnett, 2000; Tam et al., 2017) describes the period when individuals establish independence and take responsibility for life choices, including health behaviours (Lambert et al., 2019; Nelson et al., 2009). Research has shown that the diets of young people, including adolescents and emerging adults, are nutritionally poor, especially when compared with diets of other age cohorts. This has been found to be true for 28 European countries (European Commission, 2018), USA and Latin America (Rodrigues et al., 2019).

Previous evidence shows that emerging adults are less likely to meet standard dietary or nutrition recommendations than other age groups (Rodrigues et al., 2019). They engage in high intake of saturated fats, salt, sugar and UPFs, low FV intake, tend to display erratic eating behaviours and skip meals (Bull, 1992; Chin et al., 2018; Deliens et al., 2014; Kwok et al., 2016; Neumark-Sztainer et al., 1998; Rodrigues et al., 2019; Teleman et al., 2015), although some studies have reported socio-economic and cultural disparities in dietary practices in this age group (Desbouys et al., 2019). A recent systematic review has confirmed emerging adulthood is a high-risk period for low quality and unhealthy diets (Collins et al., 2020).

From a life course perspective, adolescents and young adults face a diversity of transition points that place them at increasing risk of unhealthy dietary habit formation and weight gain (Boasberg et al., 2018). During emerging adulthood, living circumstances often change and this affects food intake (Halfon et al., 2018). They transition from being dependent to independent roles including often living away from home for the first time. Their primary relationships change, they may get married, live with partners or with children (Halfon et al., 2018). For some emerging adults, transitions include increased autonomous living associated with university life, where individuals ground their dietary habits and other lifestyles. Longitudinal studies have found that healthy eating habits decline when emerging adults transition from living with family to living alone (Halfon et al., 2018; Laska et al., 2009) and from adolescence to young adulthood (Larson et al., 2008). The transition between adolescence and adulthood has therefore been highlighted as a crucial nutrition and obesity intervention period (Hales et al., 2018; Zheng et al., 2011).

Given that this is the period when dietary and lifestyle behaviours are established, their dietary behaviours may perpetuate into later life and influence dietary behaviours of their partners/spouses or inter-generational transfer of behaviours through their children. At the same time, emerging adulthood presents an opportune period to influence the adoption of healthy lifestyles, including dietary and physical activity behaviours for immediate and future health and environmental benefits. This age-group is particularly important for SSA, which harbours the youngest population that is projected to double by 2050 (UNDESA, 2015). This highlights the importance of this age group in shaping dietary behaviours of the general population and for research and efforts towards dietary behaviour change.

One of the important transitions that occur during emerging adulthood is the transition from living with parents/family at home into tertiary education. In many countries, a sizeable proportion of the population participate in tertiary education (UNESCO, 2021), with a global enrolment average rate of 39% based on 2019 UNESCO data (UNESCO, 2020). Most higher education students live away from home or family for the first time, take charge of their food decisions and this can be challenging for many young people (Deliens et al 2014; Kwok et al. 2016). At the tertiary education level, qualitative evidence suggests that students experience a higher level of independence associated with early adulthood and have greater autonomy regarding food choice than the period before commencing higher education (Deliens et al., 2014; Kwok et al., 2016; LaCaille et al., 2011; Tanton et al., 2015). However, the dietary practices of university students and graduates are sometimes viewed as desirable 'standards' for other non-student groups in the general population (Lawrence, 2017). Food environments in tertiary education institutions are critical spaces that may have shaped or is shaping dietary behaviours of many emerging adults. In addition, being an elite community, the university population represents the frontier in raising future healthy generations. This makes the university an ideal setting for future interventions.

2.6.2 What is known about campus food environments and diets in HICs.

2.6.2.1 Campus food environments in HICs

Research on campus food environments in HICs presents mixed findings although dominated by those depicting campus food environments as typically unhealthy. For example, Roy et al. (2016) conducted food environment audits of 252 outlets at seven Australian tertiary education institution campuses. They developed the Food environment quality index to assess all food outlets on seven campuses and ranked them into tertiles of healthiness. Using binomial logistic regressions, they compared the proportion of healthy and unhealthy foods across the various outlet types. They found that SSBs were the most common (20% of all food and drinks) food products, then chocolates (12%), and 10% each for energy-dense foods (>600 kj per serve), chips, and confectionery. They observed limited availability, and accessibility to healthy food and beverage options, which were relatively less promoted.

Adapting the Nutrition Environment Measures Survey (NEMS) instrument, Lee et al. (2019) assessed the healthiness of food outlets (n= 5) in the University of Waterloo (Canada) campus between two time points (2015 and late 2017–early 2018). The possible scores ranged from -5 to 23. Healthiness scores were low in both time points, with scores for the base year (2015) ranging from 7 to 14 (mean = 10.8, SD = 2.59) and 7 to 13 (mean = 9.6, SD = 2.19) in 2017–

2018. All outlets (except one cafeteria) had become less healthy since 2015. Although outlets offered FV and low-fat milk options, healthier foods were more expensive than unhealthy ones, located in low-traffic areas, and healthy options often limited to prepackaged options. Skelton & Evans (2020) have also used FGDs and key informant interviews with 33 undergraduates to collect their perceptions of their campus nutrition environment. The students reported a proliferation of vending machines and a lack of fresh and healthy food venues in the campus foodscape. They indicated that unhealthy and highly processed foods were more available, accessible, and cheaper than healthy options (Skelton & Evans, 2020).

In other qualitative studies, university students from the United Kingdom, USA and Hong Kong reported specific inhibiting factors within the university setting that discourage healthy eating. This includes inadequate time to prepare meals, lack of facilities and the availability of more unhealthy food options in university food outlets (Deliens et al., 2014; Kwok et al., 2016; LaCaille et al., 2011).

2.6.2.2 Emerging adult diets in HIC campus food environments

These campus food environment characteristics appear to reflect the dietary behaviors of emerging adults living in tertiary institution settings. Longitudinal studies have found that emerging adult diets become less healthy when they transition into the university. They display increased alcohol, meat, ready meals, and sugar-sweetened beverage consumption at the expense of FV. At least, this is true for German students (n=689) (Hilger et al., 2017); Belgian students (n=291) (Deforche et al., 2015); 13 European countries (n= ≈10,400) (Steptoe et al., 2002); Canadian students (n=301) (Beaudry et al., 2019); USA students (n=110) (Yan & Harrington, 2020); and Norweigian university students when they left their parents' homes (n=1100) (Winpenny et al., 2018).

Italian undergraduate students' diets were found to be high in packaged and ready meals, alcohol and salty snacks compared to high FV and protein diets when students lived at home (n=258) (Lupi et al., 2011) or students living with parents in four European countries (n=2402) (El Ansari et al., 2012). Similar health risk behaviours along with meal skipping have been found among German undergraduates from 40 universities since matriculation (Keller et al., 2008), including frequent consumption of sweet and salted snacks, soft/energy drinks, breakfast skipping, but low FV intake and low-quality diets among Polish and Dannish students (El Ansari et al., 2012). These findings are corroborated by results from recent systematic reviews of evidence from USA, Canada, Australia, Scotland, and other European countries (Rodrigues et al., 2019; Winpenny et al., 2020).

Cross-sectional studies also have found positive associations between the campus food environment and higher intakes of salty snacks, soft drink, meat products, and microwave meals among UK university students (n=137) (Park & Papadaki, 2016); high consumption of soft/energy drinks, breakfast skipping, inadequate FV intakes, and low-quality diets among Canadian university students and staff (n=3143) (Pérusse-Lachance et al., 2010) and students in USA (n=585) (Poulos & Pasch, 2015).

Another cross-sectional study found that buying food around the campuses of two institutions was associated with higher fat and sugar intakes and increased fast food consumption and meal skipping among USA students living off-campus than students bringing food from home (Pelletier & Laska, 2013), corroborated by findings from a more recent study among Australian students (n=371) (Whatnall et al., 2021). Tanton et al. (2015) (n=1707) found in their two-step cluster analysis that British university students living on campus were more likely to engage in unhealthy eating than those off campus. There is also evidence of unhealthier eating in Greek students living away from their family homes compared with those living at home (Papadaki et al., 2007). Indeed, in Kelly et al. (2013) systematic review, living together with other university students was found to adversely impact dietary habits due to the absence of peer support for healthy eating. This is reinforced by a survey among Northern Ireland students which reported that students who live alone were more likely to consume vegetable and salads than those who lived with other students (Devine et al., 2006). In their longitudinal study of German university students, Hilger et al. (2017) have also reported more frequent consumption of meat products and infrequent FV intake among male participants since matriculation. They speculated that body image concerns and better nutrition knowledge in females may explain lower meat consumption in female students, though they ate chocolates more frequently. However, in the Pelletier & Laska (2013) study, students living with family were more likely to procure food from campus outlets than those living independently. Using Project EAT (Eating Among Teen)-II data (n= 2,026) and linear regression analysis, Laska et al. (2009) also found that Minnesota university students living with parents or rented apartments were more likely to engage in unhealthy dietary practices compared to those resident on campus (Laska et al., 2009).

Other large cross-sectional studies have also reported contrary findings. Eating at university canteens have been associated with healthy dietary behaviours among university students including the daily consumption of five servings of fruit/vegetable and one serving of meat/fish among French (n=1,723) (Guagliardo et al., 2011) and North American students (n= 5,177) (Leischner et al., 2018). A multi-site cross-sectional study in 11 Spanish universities (n= 9,862) found that students living in rental accommodation with a partner are more likely to meet dietary recommendations for fresh and processed meat (Ortiz-Moncada et al., 2019). A qualitative study of USA students (n=14) found that campus cafeteria and vending machines influence positive food behaviours (Quintiliani et al., 2012). These contrary findings may reflect the variations in or a lack of homogeneity in the characteristics of the food environments in the various countries or individual campuses.

However, exposure to the university environment in HICs has consistently been associated with increased body weight in prospective cohort studies in Belgian (n=291) (Deforche et al., 2015); Canadian female (n=229) (Beaudry et al., 2019); and USA (n=131) (Mihalopoulos et al., 2008) students. Studies that include both male and female samples show that male students typically gain more weight than females (Beaudry et al., 2019; Cluskey & Grobe, 2009; Mihalopoulos et al., 2008; Vella-Zarb & Elgar, 2009). A meta-analysis with pooled a sample of 3,401 cases from 24 studies found that students gained approximately 3.86 (95% confidence intervals [CI] = 3.81–3.91) lbs additional weight at the end of their first year on campus (Vella-Zarb & Elgar, 2009). A more recent and updated meta-analysis of 22 longitudinal studies (5,549 students) calculated a pooled mean of 3lbs (1.36 kg) (95% CI:1.15 – 1.57) weight gain (Vadeboncoeur et al., 2015). Although weight changes in these studies are generally of small magnitude, they represent weight increases that are 5 times higher than the general population over a year on campus (Levitsky et al., 2004). In these studies, weight gain was linked with adverse dietary behaviours supported by the university food environment, time constraints, perceived lack of healthy food options, and increased sedentary behaviour (Deforche et al., 2015; Fedewa et al., 2014; Winpenny et al., 2020; Yan & Harrington, 2020).

2.6.2.3 Studies conducted in LMICs.

Campus food environment research in LMICs is nascent. Two recent systematic reviews for example, found only two studies (Curioni et al., 2020; Kivuyo & Sharma, 2020) conducted in a campus food environment in LMICs setting (Turner et al., 2020; Westbury et al 2021).

Kivuyo & Sharma (2020) studied how African emigrant students (n=120) adjusted to diets in India, but the Curioni et al. (2020) study focused on non-emerging adult (aged 45-54 years) civil servants (n= 2032) in a Brazilian university.

Among the few LMIC studies on campus food environments, Pulz et al. (2017) found that food and beverages made from processed ingredients were the most popular food and drink products in a Brazilian university campus. They were relatively more affordable and had lower nutritional quality. The researchers used an adapted Nutrition Environment Measures Survey–Restaurants (NEMS-R) tool and an original qualitative instrument to conduct a census of all campus food outlets, to evaluate and classify the nutritional quality and characteristics of food.

In SSA, Ranga & Venter (2017) used cross-sectional analysis to investigate the association of dietary fat knowledge with the consumption of fat-rich foods among first year undergraduates in a South African university located in Cape Town. The results of their analysis showed that black South African students in self-catering residences were more likely to eat high fat diets such as fried chicken, butter, eggs, and crisps five or more times a week.

In a more recent study also conducted in Brazil, Franco et al. (2020) used a cross-sectional design in a time trend study to characterize the food environment in a Brazilian public university and how it changed between 2011 and 2016. They identified an increased number of food outlets, improved convenience, and financial accessibility to food. However, the campus foodscape was dominated by highly processed foods, which had increased over the years along with a predominance of UPFs advertising material as against unprocessed and minimally processed options (Franco et al., 2020). Another recent Brazilian study (Barbosa et al., 2020) also used audits and checklists to assess a three-site public university food environment and classify available foods and meals by level of processing. They identified 21 food services (FS), a central university restaurant (UR), and 4 satellite UR, with UR offering FV daily and cheaper food prices compared to a large supply of UPFs in FS on all sites (Barbosa et al., 2020).

In the SSA context, Obayelu et al. (2019) used Quadratic Almost Ideal Demand System (QUAIDS) model, to analyse the demand elasticities for fruit using data they gathered from 300 university students in Nigeria. Richer university students were more likely than poorer students to consume fruit daily, most of which their expenditure elasticity analysis suggested were a “luxury” (pineapple, orange, banana, apple, and cucumber) rather than a “necessary” good. Only 40% of students receiving less than N10,000 per month in remittances bought fruit daily (Obayelu et al., 2019).

A cross-sectional study on South African undergraduates (n=161) found that 98% consumed less than 3 servings of vegetable; 93% consumed less than 2 servings of dairy group; 42% ate less than 2 servings of fruit; and 78% consumed more than 4 servings of sugar and sweets per day (Van Den Berg et al., 2012).

In another cross-sectional analyses of data among 552 university Medical and Health sciences students in northern Ghana, Mogre et al. (2015) have reported that students consumed animal products more frequently (> 3 times a week) than FV. General overweight/obesity prevalence (25.8 % vs. 5.9 %) and abdominal obesity (40.9 % vs. 0.8 %) was higher in female students than in male students. Students consuming FV (> 3 days per week) were at risk of general obesity (Adjusted Odds Ratio (AOR) = 2.6, 95 % CI = 1.2 – 5.4, p = 0.015). Male students were at lower risk of abdominal obesity (AOR = 0.0, 95 % CI = 0.0 – 0.5, p = 0.017), with roots and tubers consumers > 3 times per week (AOR = 8.0, 95 % CI = 2.2 – 10.1, p = 0.017), and soft drink consumers > 3 times per week (AOR = 8.2, 95 % CI = 2.2 – 31.1, p = 0.002) being at higher risk. Although, outside the scope of this study, the authors assumed that the observed dietary behaviours may be attributable to nutrition transition, urbanisation and the spread of fast-food restaurants in developing countries (Mogre et al., 2015).

A large cross-sectional study of 15,686 university students from 22 universities in 22 LMICs including 6 SSA countries (Ivory Coast, Madagascar, Mauritius, Namibia, Nigeria, South Africa) found 22% of students (24.7% men and 19.3% women) were either obese or overweight (Peltzer et al., 2014). Students who were now trying to increase fiber intake or to avoid fats and cholesterol were more at risk of being obese or overweight, with female students more likely to be obese than male students in SSA, Latin America and the Caribbean, except in Colombia.

These studies shed some light on dietary behaviours among emerging adults in university food environments in SSA. But they do not capture the characteristics of the food environments and how they shape the observed dietary practices, health and nutrition outcomes reported, demonstrating the need for further research in the SSA setting addressing these research gaps to inform public health interventions aimed at tackling the global syndemic through improved dietary practices.

2.7 Summary of limitations in current literature

The literature review highlighted some gaps in the evidence regarding the influence of the food environment on dietary behaviours, health, and the environmental sustainability of diets:

1. Limited research contributing to tracking the rapidly changing food environment in the SSA setting.
2. Absence of attention to how individuals in SSA interact with their food environment to identifying the pathways between the food environment, the multiple forms of malnutrition and other NRCDs.
3. What role does the personal food environment and dimensions such as convenience, affordability and desirability play in food acquisition and consumption practices in the SSA setting?
4. What are the socio-ecological processes that shape food acquisition, diets, nutrition, and health?
5. How do these socio-ecological processes shape food practices?
6. What role do people's everyday life and activities play in food acquisition and dietary practices in the sub-region?
7. The need for improved methodological designs and metrics that better capture and enhance understanding of the socio-ecological interactions that take place in the food environment than cross-sectional designs. E.g., using Geographic Information Systems (GIS) tools together with quantitative and qualitative methods in SSA setting for comprehensive and nuanced assessments of the food environment.

2.8 Summary

In this chapter, literature around the research topic is reviewed. It has also introduced some key concepts relevant to the study and outlined some research gaps in the literature which form the basis of the study's research questions. Together with chapter one, they set the scene for the study. The four study components are presented in turn in the subsequent chapters (Chapters 3 to 8).

CHAPTER THREE

MEAT, FRUIT AND VEGETABLE CONSUMPTION IN SUB-SAHARAN AFRICA: A SYSTEMATIC REVIEW AND META-REGRESSION ANALYSIS.

3.1 Chapter summary

Background: The dietary choices people make affect personal health and have consequences for the environment, both of which have serious implications for the United Nations 2030 Agenda for Sustainable Development. There is a strong consensus that cutting down on meat and dairy products in favour of FV and other plant-based diets would offer dual health and environmental benefits. In global reviews, the findings on MFV consumption in SSA is limited. It is therefore essential to quantify MFV consumption in SSA populations.

Scope and approach: This review systematically searched six databases to identify studies reporting meat, fruit and/or vegetable consumption in SSA populations. Using STATA SE version 15, random effects meta-regression analyses were used to test the effect of year of data collection and method of data collection on population MFV consumption. The analyses also tested any association between age, sex, urban/rural residence or a country's economic development, and population intake of meat, fruits and/or vegetable.

Key Findings: Richer SSA countries were likely to consume more meat (ß =36.76, $p=0.04$) and vegetable (ß =43.49, $p=0.00$) than poorer countries. Vegetable intake has increased dramatically over the last three decades from ≈10g to ≈110g (ß=4.43, $p=0.00$). Vegetable (ß=-25.48, $p<0.0001$) consumption was higher in rural than urban residents. Although the trend of meat consumption suggests it is increasing (≈25g to ≈75g), the trend is non-significant (ß=0.63, $p=0.76$). Daily average per capita meat consumption was however above recommended 70g, while FV intake remain below WHO's recommendation. No clear differences in consumption were noticed between sexes.

Conclusion: While dietary changes in SSA may offer large absolute benefits, consideration of the magnitude of dietary change, particularly increasing meat consumption, will need to occur to ensure policy and interventions support the reduction of under-nutrition and micronutrient deficiencies without worsening NCD prevalence and environmental impacts.

The study reported in this chapter has been published in Nutrition Reviews: (Mensah et al., 2020).

3.2 Introduction

Chapter two highlights a widespread acknowledgment of an ongoing nutrition transition in most of SSA and calls for policy makers to intervene in order to improve human and planetary health outcomes. However, research evidence on how consumption of food products, key amongst them being MFV, has changed over the years in SSA populations is limited and fragmented. Context-specific evidence that gives a more complete picture of changes in consumption of key food products are required to support development of appropriate interventions. The sub-region's policy makers need to see evidence that resonates with them to justify taking steps to intervene. This chapter systematically draws together research evidence to provide a more wholistic picture of the trends of MFV consumption and variations in consumption among subpopulation groups in SSA.

3.3 Objectives

This systematic review aimed to answer three questions:

1. How much meat, fruit and/or vegetable are being consumed daily by individuals in SSA?

2. Who is consuming the most (rural/urban; male/female, etc.)?

3. How has consumption changed over time?

3.4 Methods

3.4.1 Study protocol

A protocol for this systematic review was registered with PROSPERO on 15th March 2018 CRD42018090497 (available from: *http://www.crd.york.ac.uk/PROSPERO/display_record.php?ID=CRD42018090497*).

3.5 Search Strategy

The search strategy designed in consultation with a specialist librarian included the following steps:

1. An initial limited search of MEDLINE database was conducted with the following search terms; (Fruit or vegetable or meat) combined with (consumption or portion size)

AND (sub-Saharan Africa) to identify additional relevant keywords from the titles, abstracts, and subject descriptors.

2. Key words identified from the initial scoping search were then included as search terms for extensive searches of MEDLINE, EMBASE, ASSIA CINAHL, Web of Science, POPLINE and Google Scholar electronic databases. The search terms are summarized in Table 3.1. Searches were conducted between July and September 2018 with no time limits. Results were limited to French and English Languages.

3. Reference lists of papers that met the inclusion criteria after formal screening were also searched for additional relevant papers.

Table 3.1: Search strategy (after Pienaar et al. (2011)

Summary of search terms for MEDLINE, EMBASE (countries searched individually after Pienaar et al. (2011)**)**
1. sub-Saharan 1inimi.mp. or exp "Africa South of the Sahara"/ 2. Angola or Benin or Botswana or "Burkina Faso" or Burundi or Cameroon or "Cape Verde" or "Central African Republic" or Chad or Comoros or Congo or "Cote d'Ivoire" or Djibouti or "Equatorial Guinea" or Eritrea or Ethiopia or Gabon or Gambia or Ghana or Guinea or Guinea-Bissau or Kenya or Lesotho or Liberia or Madagascar or Malawi or Mali or Mauritania or Mauritius or Mozambique or Namibia or Niger or Nigeria or Rwanda or "Sao Tome and Principe" or Senegal or Seychelles or "Sierra Leone" or Somalia or "South Africa" or "South Sudan" or Sudan or Swaziland or Tanzania or Togo or Uganda or Zambia or Zimbabwe 3. 1 OR 2 4. meat/ or meat products/ processed meat or poultry/ or red meat/ or fish 5. exp FRUIT/ 6. exp VEGETABLES/ 7. 4 OR 5 OR 6 8. 3 AND 7 9. consumption/ or intake or EATING/ 10. diet/ or portion size/ or serving size/ or frequency 11. 9 OR 10 12. 8 AND 11 13. limit to humans
Search terms for Google Scholar & POPLINE (countries searched individually after Pienaar et al. (2011)**)**
(sub-Saharan Africa or Angola or Benin or Botswana or "Burkina Faso" or Burundi or Cameroon or "Cape Verde" or "Central African Republic" or Chad or Comoros or Congo or "Cote d'Ivoire" or Djibouti or "Equatorial Guinea" or Eritrea or Ethiopia or Gabon or Gambia or Ghana or Guinea or Guinea-Bissau or Kenya or Lesotho or Liberia or Madagascar or Malawi or Mali or Mauritania or Mauritius or Mozambique or Namibia or Niger or Nigeria or Rwanda or "Sao Tome and Principe" or Senegal or Seychelles or "Sierra Leone" or Somalia or "South Africa" or "South Sudan" or Sudan or Swaziland or Tanzania or Togo or Uganda or Zambia or Zimbabwe) AND (meat or "meat products" or "processed meat" or poultry or "red meat" or fish or fruit or vegetable) AND (consumption or intake or diet) AND ("portion size" or frequency or quantity).

3.6 Inclusion Criteria

3.6.1 Types of studies

The review considered quantitative studies that explored the consumption of meat, fruit and/or vegetable consumption in sub-Saharan Africa. Study types considered for inclusion were observational studies such as cross-sectional studies, and longitudinal studies like cohort studies and panel surveys with reports published in peer-reviewed academic journals. Studies that did not report the outcome of interest were excluded. Experimental studies that reported baseline consumption data were also considered for inclusion. This along with the other inclusion criteria explained below are summarized in Table 3.2 using an adapted PICOS model.

Table 3.2: Inclusion criteria

Mnemonic	**Adapted PICOS**	**Description**
P	**P**opulation or **P**articipants	Children (1- to 10-year-olds), Adolescents (11 to 19 year olds), Adults (19+). Excluded patient population samples.
I	Phenomena of **I**nterest	Meat, Fruit and Vegetable consumption (quantity, portions, servings)
C	**Co**ntext	sub-Saharan Africa (as defined by the World Bank, July 2018)
O		
S	**S**tudy design/type	**Quantitative observational studies** (Cross-sectional, Longitudinal, Panel studies). **Experimental studies** with baseline data.

Source: adapted from Methley et al. (2014); Pollock & Berge (2018)

3.6.2 Types of participants

Studies that included children, adolescents or adults were considered for inclusion. Studies that included patient population samples were excluded.

The research participants should have been in a sub-Saharan African country. The World Bank's definition of sub-Saharan Africa as of July 2018 was adopted (see here: *https://data.worldbank.org/region/sub-saharan-africa*). Multi-country studies that did not report country-specific data for included sub-Saharan African countries were excluded.

3.6.3 Phenomena of interest

Studies that estimated the portions/quantities/servings of meat, fruit and/or vegetable consumed were included.

Definition of Meat

Meat was essentially defined as animal tissue, including any accompanying skeletal muscle and fat consumed as food. This comprised both red and white meat and are usually listed to include beef and veal from cattle, mutton from sheep, chevon from goat, venison from deer, ham, bacon, and pork from pigs as well as poultry from chicken, ducks and turkeys, and fish. These were considered in this review, not excluding their processed forms such as sausages, corned beef, hot dogs, khebabs, canned meat, etc. (WHO, 2015). Studies that looked at bush meat and dog flesh consumption were also included. Studies that included eggs within their definition of meat were also eligible for inclusion.

Definition of Fruit and Vegetable

The significant between-country variations in the definition of what constitutes FV are well-known concerns among food and nutrition researchers (Roark & Niederhauser, 2013; Thompson et al., 2011). The main area of controversy has been the inclusion or exclusion of starchy tubers such as potatoes in classifying fruits and vegetable (IARC, 2003). For instance, the USA, Australia, and Canada classify potatoes as vegetable, whiles the UK does not (IARC, 2003). The review followed the definitions of study authors, but where possible, starchy crops such as potatoes, plantain, yam, taro, cassava, and breadfruits were excluded from the definition of vegetable. The global estimates of the burden of disease attributable to inadequate intake of FV (Lock et al., 2005; Pomerleau et al., 2004) and other studies that assess FV consumption, including WHO studies (WHO and FAO, 2003) and other research (Hall et al., 2009; Ruel et al., 2005) have exempted starchy crops. Although, starchy vegetable provide a variety of valuable nutrients that can make a healthy addition to diets, starchy vegetables contain 3 to 6 times more carbohydrates and calories than non-starchy vegetables (Condé Nast, 2018). A sensitivity analysis was also conducted excluding studies that included starchy vegetables in their estimation of vegetable consumption to assess the robustness of the results.

To ensure transparency, the search procedure and results, including the number of studies in/excluded at each stage have been summarized in a Preferred Reporting Items for Systematic

Review and Meta-Analysis (PRISMA) flow chart presented in the results section (Figure 3.1) (Dhillon & Gill, 2014; Liberati et al., 2009)

3.7 Study selection

There was an initial decision for possible inclusion based on titles and abstracts conducted by two independent researchers (DOM, and TB, a postgraduate student at University of Warwick). At this stage, studies were only eliminated if eligibility criteria were clearly not met. Where there was uncertainty about a study meeting the inclusion criteria, full texts were obtained for extensive assessment against the criteria. Full texts of potentially relevant papers selected based on titles and abstracts were retrieved and assessed against the eligibility criteria by two independent reviewers (DOM, OO). Any differences in opinions were resolved by consensus.

3.8 Data Extraction and Risk of Bias (ROB) Assessment

3.9 Data Extraction

Three independent investigators completed data extraction in duplicate (DOM, along with two supervisors: ARN and OO). Data was organized in excel spreadsheets using the following data types as headings:

Box 3.1: Data type extracted

1. Authors
2. Type of study
3. Year of publication
4. Year of data collection
5. Study population (e.g. size, age cohort, etc.)
6. Country of research
7. Geographical context (this included rural or urban). Peri-urban/semi-urban
8. Variable(s) measured (meat, fruit, or vegetables)
9. Measurement method used
10. Meat, fruit, or vegetables intake (g/day/portion/serving size). Data was extracted for age cohorts, male and female, and urban and rural settings. Where required, portion or serving size is converted into grams using the conversion 1 Portion/Serving=80g. Consumption data were reported differently in different studies. For example, some studies presented mean (standard deviation or standard error or confidence intervals) and others presented median (inter-quartile ranges IQR) in various measurement units. Measurement units reported in the selected papers include grams, number of servings, litres, ounce, and kg (per year, month and day). Consumption data were therefore standardized into gram/day (SD). Conversions used have been outlined in Appendix 3.2.
11. Standard deviation of mean meat, fruit or vegetables intake
12. Standard error of mean meat, fruit or vegetables intake

Any disagreements and discrepancies were resolved by referring to original papers and further discussion.

3.9.1 Risk of bias assessment

It was anticipated that the robustness of methods of the papers included in the review would differ, and that lower quality papers could bias essential findings. This was more importantly so, given that a number of confounding factors and design limitations often exist in observational studies (Harrison et al., 2017; Ross et al., 2011). The risk of bias (ROB) of included studies was therefore carefully and rigorously assessed by two reviewers (DOM, along with two supervisors, ARN and OO).

There was no universally accepted ROB assessment tool for observational studies (Harrison et al., 2017; Ross et al., 2011; Shamliyan et al., 2010) at the time of writing this report. The ROB of included studies was assessed using a tool adapted from Louw et al. (2007) and subsequently used in systematic reviews by Wong et al., 2008; Davids and Roman 2014; Davids et al., 2016; Roman and Frantz 2013, among others. The areas outlined in Table 2 were examined to assess methodological quality.

Table 3.3: Risk of bias Assessment tool

Domain/Question	Explanation	Scoring algorithm
Statement of study objective/aim 1. Was the research objective clearly stated (to measure meat/fruits/vegetables consumption)?	This examines whether a paper spelt out exactly what it set out to do. That is, to measure meat or fruits or vegetables consumption or both, for this review.	A score 0—2 will be assigned. Where, 0—Not stated, 1—Not clearly stated and 2—Explicitly stated.
Clarity of study population definition 2. Was the study population clearly defined?	This assesses whether the authors specified the characteristics of respondents they sought to include in their research.	0—Not stated 1—Not clearly defined 2—Explicitly defined
Sampling method Was the sampling method one that achieves a sample representative of the intended study population?	A. Non-probability sampling—such as quota, snowball, convenience and purposive sampling B. Probability sampling—such as simple random, cluster, systematic, stratified, two-stage, and multistage sampling	Not Reported—0 Category A—1 Category B—2
Response rate 4. Was a response rate mentioned in the study?	Response Rate is reported if authors reported a precise rate or drop-outs & cancellation of interviews were reported. Compute Response Rate where enough information is reported but precise rate not reported.	Not reported—0 Reported (below 60%)—1 Reported (60% plus)—2
Reliability and accuracy of measurement technique 5. Was the measuring technique accurate and reliable?	This is to examine how susceptible the measuring tool used in a FV consumption study is to errors. This brings clarity to how accurate measurements are, and the level of confidence readers should put in the results of the review. D1—Single Dietary recall (e.g. 24-hour recall) D2—Food Frequency Questionnaire D3—Repeated/Multiple dietary recalls (e.g. food records, multiple pass recall, etc.) D4—Biomarkers (e.g. vitamin C, carotenoids, etc.)	D1—1 D2—2 D3—3 D4—4
Reporting of data **6.a.** Missing Data-Were missing data and strategies for addressing missing data reported?	Researchers indicated the number of respondents with missing data/incomplete responses and appropriate steps/methods for addressing same.	Not reported—0 Reported only—1 Reported and addressed—2
6.b. Presentation of data—Were data clearly and accurately reported	Data presented were clear and accurate. Data presentation is accurate if average consumption data (MEAN/MEDIAN) and measures of statistical dispersion (SD, Variance, Range/IQR) are all reported correctly, Score 2. Score 1 where there are anomalies in reported data or only consumption data is reported without any measure of dispersion or where consumption data is reported in a graph/figure only.	Not reported—0 Reported with error—1 Reported accurately—2
Class Scoring: Total score divided by total number of items multiplied by 100		
Methodological Appraisal Class Score		
Bad/Low	**Satisfactory**	**Good**
0—33%	34—66 %	67—100 %

At the quality appraisal stage, studies with methodological weakness were not excluded. All studies were initially included in the analysis. Sensitivity analysis was conducted at a later stage to gauge or evaluate the impact of low-quality papers on the overall review outcome.

3.10 Statistical Analysis

A descriptive summary of findings from the included studies was organized and presented in Table 3.4, presenting on characteristics of study population, type of research, and measurement technique, among others enlisted above under data extraction section.

Extracted data was pooled into a meta-regression using a random effects model in Stata SE version 15 (StataCorp, 2017). This was intended to test heterogeneity among included studies as a result of gender, age cohort, rural/urban residence, year of data collection, method used to measure dietary intake, and the economic development of the setting/countries where included studies were conducted. The economic development of the study setting was based on the World Bank definition (low income, lower-middle income, upper-middle income) at the time of writing this report (The World Bank, 2019). In conducting these analyses, 'farm' men and women, peri-urban, semi-urban, and pastoralist populations were classified as rural, whiles unplanned settlements were considered urban. Country-specific data for each particular country in multi-country studies were treated as separate/standalone entries. The age cohort classifications used by authors of the included studies were followed.

Food intake measurement methods were grouped into Single 24-hour recalls, Food Frequency/Propensity Questionnaires, Multiple-pass 24-hour recalls, Food Balance Sheets and Others. The latter "Others" group captured all methods that did not fall under the first 4, including papers that did not report method of collection.

Where studies did not report period of data collection, 3 years prior to date of publication was estimated (Welsh et al., 2018). A median estimate was used in cases where reported collection period spanned 2 years or more (Oyebode et al., 2016). For longitudinal studies, each reported year was treated separately in the meta-analysis. The baseline year and baseline data were extracted in the case of experimental studies.

Median intakes were converted to means where both median and interquartile ranges (IQRs) were reported following the quantile rule (after Higgins et al., 2008 and Wan et al., 2014) (Higgins & Green, 2011; Wan et al., 2014) as indicated in Table 2 along with other conversion methods adopted. Studies reporting only median intakes without sufficient data (without IQRs, etc. which are required to estimate mean intakes and standard deviations) to approximate mean intakes were excluded from the meta-analysis. Where standard deviations were missing, they were calculated using Cochrane Handbook procedures (Wan et al., 2014) where ample data were reported or supplied by original authors when contacted.

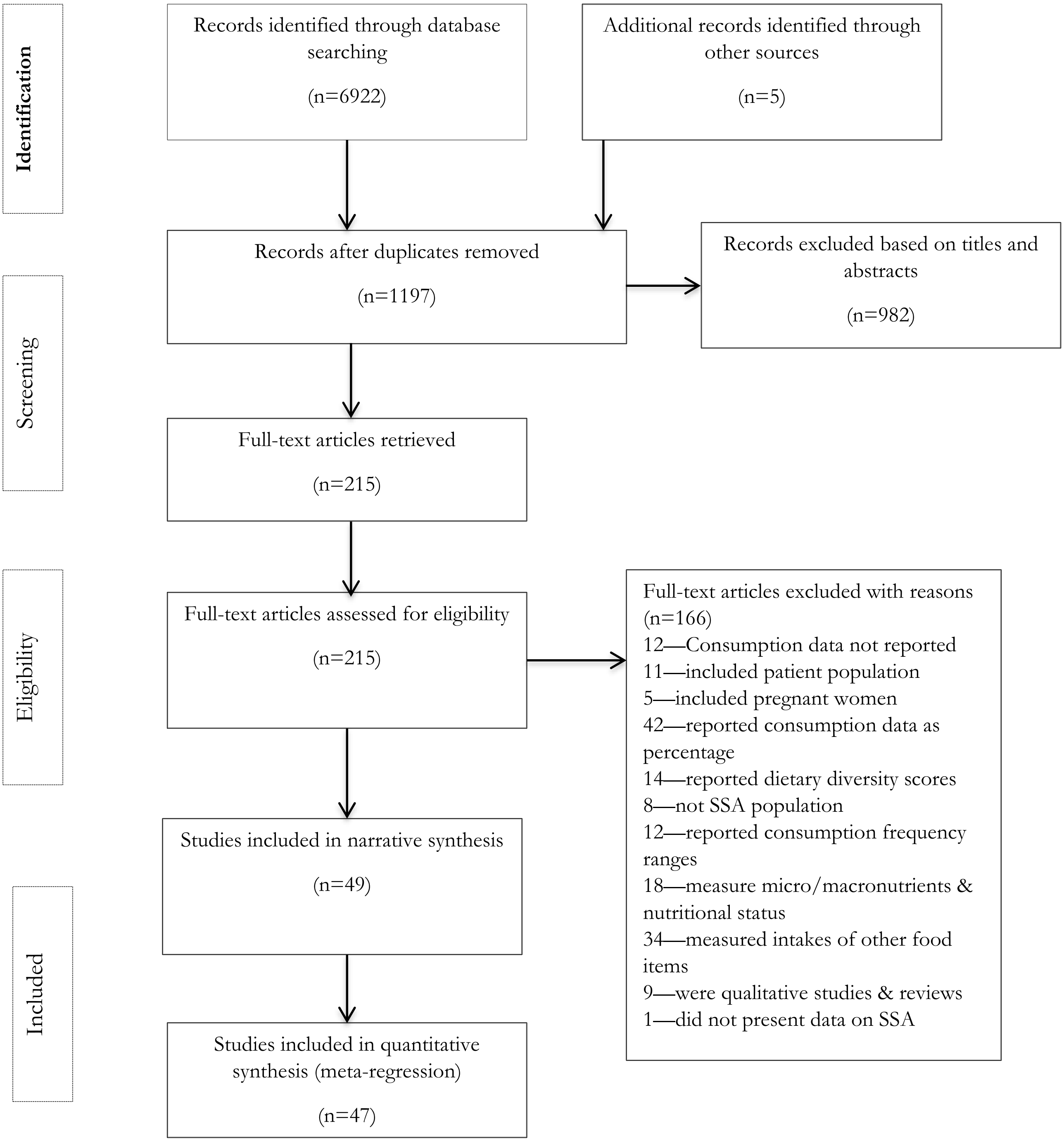
A sensitivity analysis was also conducted to assess the robustness of review conclusions. This involved the exclusion of studies with the lowest overall methodological appraisal scores that fell within the "Bad/Low" class score as described in Table 3.2. The quality appraisal scores for the various studies are presented in Appendix 3.2. All consumption estimates for children and adolescents were excluded in the third model of the sensitivity analyses. In a fourth model, studies that included starchy vegetables in their estimation/definition of vegetable consumption were excluded.

3.11 Results

Searches of MEDLINE, EMBASE, CINHAL, POPLINE, and Web of Science retrieved 5922 records. The search of Google scholar found 28508. The first 1000 papers, after sorting by relevance, were included for review, making a total of 6922 records. These records were screened, and the abstracts of 1197 papers retrieved after omitting irrelevant papers. After title and abstract screening, the full texts of 215 papers were retrieved after 982 papers were excluded. Of the remaining, 44 papers were found relevant after reviewing full texts against eligibility criteria. Five more papers were identified through reference searches, giving a total of 49 papers. Two studies were subsequently excluded due to insufficient reported data and authors not responding with additional information when contacted. The remaining 47 papers were included in the meta-regression analysis (see Table 3.4 for characteristics of included studies). Figure 1 is a PRISMA flow chart detailing the search results.

The included studies covered 24 SSA countries with the highest number of studies coming from South Africa (17) followed by Kenya (4) (Ferguson et al., 2016; Gewa et al., 2014; Keding et al., 2017; Mwaniki & Makokha, 2013) and Ghana (4) (Amo-Adjei & Kumi-Kyereme, 2014; Amoateng et al., 2017; Galbete et al., 2017; Osei-Asare & Eghan, 2014).

Figure 3.1: PRISMA flow chart of search results



Adapted from Liberati et al. (2009)

Fifty percent of these were conducted in low-income countries (LICs), 29% within lower-middle income and 21% within the Upper-middle income category (based on World Bank, 2018 classification). These studies were published between 1985 and 2018. Dates of data collection span from 1977 to 2015, though a few papers did not report this. Of the 47 included studies, 31 reported on MFV[12], 8 reported on FV only(Amo-Adjei & Kumi-Kyereme, 2014; Amoateng et al., 2017; Faber et al., 2011; Gelibo et al., 2017; Jemmott et al., 2015; Keding et al., 2017; Matsinkou et al., 2016; Peltzer & Phaswana-mafuya, 2012), 3 reported on meat and vegetable only (Caswell et al., 2015; O'Keefe et al., 1988; O'Keefe et al., 1985), 1 reported on vegetable only (Faber et al., 2007), and 4 reported on meat only (Albrechtsen et al., 2006; Foerster et al., 2015; Nel et al., 2013; Osei-Asare & Eghan, 2014). In terms of age-cohort, 28 of the included studies looked at adults only, 13 included children only and 6 studied both children and adults. Consumption of MFV in the various populations reported in the 47 studies are summarized in Table 3.4. Quality of these studies were assessed by two reviewers working independently (summarized in Appendix 3.3).

3.11.1 Meat Consumption

After extracting data separately for five domains, children, and adults, for male and female, for rural and urban populations, for method, and period of data collection, as reported in included studies, gave 91 (adults=75, children=16) population estimates for meat consumption. The oldest and most recent data collection dates were 1977 and 2013, respectively. Forty-nine percent (representing 45 population estimates) of all 91 meat consumption estimates were above 70g per day, putting average per capita intake at 98g. Fifty-one percent of adult estimates were above 70g per day, compared to 44% of child population estimates. The 3 lowest meat intakes (1 to 2g) were reported in rural Mali populations in the mid-1990s. Of the remaining intakes under 12g, one was recorded in rural Namibians in the 1980s, four from rural Malian adults and one found in rural children in Kenya all of which were studied in the late 1990s. The rest included 2 urban adult populations and one rural adult population, respectively found in Ethiopia and Burkina Faso and all were studied in the early 2000's.

[12] (Albrechtsen et al., 2006; Amare et al., 2012; Anderson et al., 2010; Asayehu et al., 2017; Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Bourne, Langenhoven, Steyn, Jooste, Nesamvuni, et al., 1994; Caswell et al., 2018; Faber, 1999; Ferguson et al., 2016; Galbete et al., 2017; Gewa et al., 2014; Huybregts et al., 2008; Jackson et al., 2012; Langenhoven et al., 1988; Macintyre et al., 2000; MacIntyre et al., 2002; Maruapula & Chapman-Novakofski, 2008; Mwaniki & Makokha, 2013; Nago et al., 2010b; Nkondjock & Bizome, 2010; Oguntona & Kanye, 1995; Parr et al., 2002; Premji et al., 2008; Ronquest-Ross et al., 2015; Sanusi & Olurin, 2012; Sodjinou et al., 2009; Steyn et al., 2003; Steyn et al., 2001; Steyn et al., 2016; Steyn et al., 2000; Torheim et al., 2001; Vähätalo et al., 2005).

Table 3.4: Characteristics of included studies.

Country of study	**Date of data collection**	**Study population/sample**	**Variable(s) of Interest Measured (Meat/ Fruit/ Vegetable)**	**Author's definition of variable(s)**	**Measurement method (FFQ/24H Recall/FBS/Portion Size)**	**Reference**
Benin	January to May 2007	656 Secondary School adolescents 13 to 19 years randomly recruited from 12 randomly selected Secondary schools based on the Beninese Ministry of Secondary Education list of all private (n 109) and public (n 18) secondary schools in Cotonou.	Fruit, Vegetables and Vegetable products Meat & Meat Products	Adapted from FAO food composition table for use in Africa (Wu Leung et al., 1968). **FRUIT**: examples cited to include pineapples, mangoes, apples and oranges were present as fruit. **VEGETABLES**: green leafy vegetables consumed in sauces	24-hour dietary recall repeated on two non-consecutive school days. Standardised recipes and portion sizes (grams) were used for street foods.	Nago et al. (2010)
Benin	Not Stated	200 men and women randomly selected in 10 neighbourhoods in Cotonou	Meat, Fruit, Vegetables	**MEAT**: Reported separately for White meat, red meat, and fish. **FRUIT** (not explicit): reports separately for Fruit, fruit juices. **VEGETABLES** (not explicit): Green leafy vegetables, other vegetables.	Three non-consecutive 24-hour recalls using food frequency questionnaire (FFQ). Local cups, bowls, spoons, plates and glasses commonly used in the study area served as visual aids to increase the accuracy of portion size estimations.	Sodjinou, Agueh, Fayomi, & Delisle (2009)
Botswana	September 2006 to August 2007	79 adults (63 women, 16 men) aged 18 to 75 recruited--one from every second household in a larger epidemiological study in Kanye, a large village in southern Botswana	Meat, Fruit, Vegetables	**MEAT**: red meat, poultry and fish; **FRUITS**: (not defined), **VEGETABLES**: dark green leafy and yellow vegetables, other vegetables	4 repeated 24-hour recalls at 3 months intervals using FFQ, Cross sectional	Jackson et al. (2012)

Botswana	June to August 2003	99 elderly persons aged 60-69 recruited and interviewed at local post offices or the Kgotla (traditional meeting place) by convenience sampling in Urban stratum (represented by Gaborone the capital city and Francistown); Urban village stratum (Kanye, Molepolole, and Mahalapye); and Rural villages (Makaleng, Molapowabojang, and Sebina)	Fruits, Vegetables, Meat (includes animal-sourced foods)	Followed the USDA Food Guide Pyramid. **MEAT:** meat, poultry, fish, dry beans, eggs, and nuts Definitions for Fruits and Vegetables were not explicitly stated but the USDA Food Guide defines. **FRUITS:** Orange, 100% fruit juices, apple, banana, etc. **VEGETABLES**: Sweet potatoes, corn, peas, tomatoes, onions, green beans, carrots, lettuce, green beans, spinach, romaine, broccoli	Multiple pass 24-hour recalls. Followed USDA Food Guide Pyramid (1996) to estimate mean servings per day	Maruapula & Chapman-Novakofski (2007)
Burkina Faso	December 2004	176 non-pregnant women conveniently selected and 218 randomly sampled pregnant women from two villages, Koho and Karaba, in the health district of Houndé, province of Tuy, Burkina Faso. (Data extracted for non-pregnant women)	Meat, Fruit, Vegetables	**MEAT (Meat/poultry/fish products)**: Dried fish, chicken, Sheep and goat, pork. **VITAMIN A-RICH FRUIT & VEGETABLES**: Baobab leaves, Cowpea leaves, Bush okra leaves, Kapok tree flowers, Sorrel leaves; **OTHER VEGETABLES**: okra, tomato, onion, and cabbage; **OTHER FRUIT**: Lemon, Orange. Data collected for "Other Fruits" but not presented because Medians and 25th and 75th percentiles are only presented if the at least 75% of sample consumed the food group	An interactive 24-hour recall survey	Huybregts, Roberfroid, Kolsteren, & Camp (2009)
Burkina Faso, Burundi, Cameroon, Congo, Dem Republic of, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Mali,	2001 to 2003	Multi-country analysis based on FAO data for SSA countries	Meat, Fruit, Vegetables	Not defined	Data from FAO balance sheets.	Premji et al. (2008)

Mozambique, Nigeria, Sudan, Uganda, Tanzania, Zimbabwe						
Cameroon	November 2008	Randomly recruited 541 members of the defence force (including national gendarmerie, army, air force, navy and fire brigade) for 8 military institutions aged 21 to 59 years in Yaoundé, Cameroon.	Meat, Fruit, Vegetables,	**MEAT**: Beef, lamb, pork, smoked meat; Bush meat; Organ meats: Liver, kidney and other organ meats; Poultry. FISH and SEAFOOD: Fish, dry fish, shrimp, crab. **FRUITS and VEGETABLES**: Fresh fruits, yellow/dark-green vegetables (not explicitly); Fruit juices: Orange/pineapple/lemon/mango juices; Vegetable juices Red beet/folere juices	Self-administered validated FFQ. Frequency of intake and amounts consumed in grams per day.	Nkondjock & Bizome (2010)
Equatorial Guinea	December 2003–March 2004	198 households randomly selected from 7 neighbourhoods within the city of Malabo, Bioko Island, Equatorial Guinea	Meat	Bush meat, Small livestock meats, Beef, and Fresh fish	24-hour recall. Consumption figures converted to per capita using Adult Male Equivalent (AME)	Albrechtsen, Fa, Barry, & MacDonald (2006)
Ethiopia	July to August 2013	Random sample of 164 Non-pregnant women (159 Pregnant women) recruited from a subsistence farming community of Butajira district southern Ethiopia	Meat, Fruit, Vegetables	Based on Ethiopian & Ugandan Food Composition Tables definition: **MEAT (excludes FISH & seafoods):** Red meat, white meat, poultry, game, rodents, processed meats, organ meats (kidney, liver, mixed offals, intestines), blood, animal skin/ears/feet/head, insects **Fish (includes SEAFOODS)**: Whole fish, fish meat, eel, reptiles, shell fish. **FRUITS (includes FRUIT JUICES)**: Fresh fruits, dried fruits, undiluted pure fruit juices, starchy fruits (banana/plantain). **VEGETABLES**: Fresh vegetables, dried vegetables (excludes potatoes).	Multiple pass 24-hour recalls. Spoons and calibrated utensils used to estimate amount consumed in grams.	Asayehu, Lachat, Henauw, & Gebreyesus (2017)

Ethiopia	April to June 2015	Random sample 9800 of 10,260 study participants aged 15 to 69 from 513 EA's in the 9 regions and the 2 Administrative cities (Addis-ababa and Dire Dawa) in Ethiopia based on 2007 Population and Housing Census. 60% participants were female	Fruit, vegetables	**VEGETABLE**: Not defined. **FRUIT**: not explicit but lists include apple, banana, orange, fruit juice, cooked and canned fruit.	Weekly food recalls, "Asked for the number of days they ate FV in a typical week and on one of those days how many servings they ate". Serving size measured using pictorial show cards. The conversion 1 Serving= 80 grams. For raw green leafy vegetables, 1 serving = one cup; for cooked or chopped vegetables, 1 serving = ½ cup; for fruit (apple, banana, orange etc.), 1 serving = 1 medium size piece; for chopped, cooked and canned fruit, 1 serving = ½ cup; and for juice from fruit, 1 serving = ½ cup.	Gelibo et al. (2017)
Ethiopia	July 2005	356 participants (71.3% female and 28.7% male) randomly selected from Gondar city, Northwest Ethiopia. Household level data collection. Only one adult individual was selected from a household.	Meat, Fruit, Vegetables	Not defined	Food frequency questionnaire and 24-hour dietary recall. Quantities of food consumed were estimated in household measures and a digital household dietary scale.	Amare et al. (2012)

Gabon	Longitudinal Feb to May 2006, Sept to Dec 2006	1219 households in 121 Rural villages in the vicinity of three newly established national parks in rural Gabon: Biringou, Ivindo, and Monts de Cristal in Gabon. Data reported based on 751 adult respondents.	Bushmeat	Blue duiker (Philantomba monticola), Red duikers, Unidentified duikers (Cephalophus spp.), Sitatunga (Tragelaphus spekii), Brush-tailed porcupine (Atherurus africanus), Red river hog (Potamochoerus porcus), Monkeys (Cercopithecus spp.). Water chevrotain (Hyemoschus aquaticus), Bay duiker (Cephalophus dorsalis), Mandrill (Mandrillus sphinx), Gambian rat (Cricetomys gambianus), African palm civet (Nandinia binotata), Cane rat (Thryonomys swinderianus), Golden cat (Profelis aurata), Long-tailed pangolin (Manis tetradactyla), Leopard (Panthera pardus), Gabon viper (Bitis gabonica), Western lowland gorilla (Gorilla g. gorilla), Bushbuck (Tragelaphus scriptus), Sun-tailed guenon (Cercopithecus solatus)	Household heads recalled all produce, natural resources and manufactured foods consumed during the 48 hours prior to the survey. Estimated weights based on Wikie et al., 2005.	Foerster et al. (2012)
Ghana	September to November 2008	Data from the 2008 Ghana Demographic and Health Survey. 4916 Women aged 15–49 years and 4568 Males aged 15–59 years selected in a two-stage sampling technique based on year 2000 Ghana Population and Housing Census	Fruit, Vegetables	No definition stated. But the GDHS from which data was used cites examples to include- **FRUIT**: mangoes, pawpaw, banana, orange, avocados, tomatoes, passion fruit, apples. **VEGETABLES**: kontomire, aleefu, ayoyo, kale, cassava leaves.	Household Questionnaire, Men/Women's Questionnaire to estimate Mean intake of fruits and vegetables: Captured as "in a typical week, on how many days do you eat fruit?" and "on a day when you eat fruit, how many servings do you eat on average" and similar for vegetables	Amo-Adjei & Kumi-Kyereme (2014)

Ghana	September to November 2008	Data from the 2008 Ghana Demographic & Health Survey on 6193 young people aged 15 to 34 (45% Males, 55% Females Mean age: Females: 23.43, Males: 23.21 (S.D: 5.6) selected using a two-stage sampling design based on year 2000 Ghana Population and Housing Census	Fruit, Vegetables	Not defined but the GDHS from which data was used cites examples to include- **FRUIT**: mangoes, pawpaw, banana, orange, avocados, tomatoes, passion fruit, apples. **VEGETABLES**: kontomire, aleefu, ayoyo, kale, cassava leaves.	Household Questionnaire, Men/Women's Questionnaire to estimate Mean intake of fruits and vegetables: Captured as "in a typical week, on how many days do you eat fruit?" and "on a day when you eat fruit, how many servings do you eat on average" and similar for vegetables	(Amoateng et al., 2017)
Ghana	Not Stated (as of January 2014 had interviewed 3868 participants in all 4 centers out of which 1920 from Ghana site)	1619 Urban GH Adults (Kumasi, Obuasi) and 946 Rural GH Adults (Ashanti Region) selected in a random sampling design based on 2010 Ghana Population and Housing Census (part of RODAM multi-centre study Ghana, Berlin, London, Amsterdam).	Meat, Fruit, Vegetables	**MEAT**: Beef, goat, pork, bush meat, liver, and giblets. Data presented separately for poultry, processed meat products, fish, and mixed meaty dishes. **FRUITS (excludes FRUIT JUICES):** Orange, mandarin, kiwi, watermelon, mango, cantaloupe, pawpaw, pineapple, banana, plum, peach, apricot, nectarine, flat peach, apple, pear, strawberries, cherries, berries, grapes, and stewed fruit. Presents data on consumption of **fruit juices** together with SODAs. **VEGETABLES:** Green leaves, spinach, chard, lettuce, endive, chicory, Chinese and white cabbage, tomatoes, peppers, carrots, cucumber, eggplant, beans (green beans), onions and garlic. Excludes potatoes. Presents data on consumption of Vegetable soups, stews and sauces separately. **Vegetable soups, stews and sauces**: Palmnut soup, nkontomire stew, okro stew, tomato sauce and stew, vegetable soup.	Food Propensity Questionnaire (12-month food and 24-hour recalls). Ghanaian household utensils were used to estimate consumption in grams.	Galbete et al. (2017)

Ghana	September 2005 to September 2006	Data on 5313 Ghanaian Households from the Ghana Living Standards Survey Round 5 (included a total of 8,687 households) recruited randomly	Meat	Pork, Beef, Chevron, Mutton, Game, and Chicken	Estimates mean intakes of meat using Ghana Living Standards Survey (GLSS) data. Survey questionnaire	Osei-Asare & Eghan (2014)
Kenya	August to November 2012. Conducted in four districts of Vihiga County during a season of relatively high food diversity (August 2012) and in four districts of Kitui County at the end of the food shortage season (October/November 2012)	Random sample of children 6 to 23 months old recruited from 4 purposively selected districts in Vihiga County (Luanda, Emuhaya, East Tiriki and West Tiriki; n = 201) and Kitui County (Kitui Central, Lower Yatta, Mutomo and Kitui West; n = 200) Kenya. Data extracted for 12 to 23 months cohort: 8.2 % of 179 children from Kitui County and 6.4% of 156 children from Vihiiga County.	Meat, Fruit, Vegetables	WHO et al., (2008) definition of FV	Four-pass 24-hour recalls, cross sectional, Portion sizes from weighing of foods. Dietary data collected through caregivers.	Ferguson et al. (2015)
Kenya	Longitudinal Panel Survey: collected in 2000, 2005, and 2010	200 Households randomly selected from register of households in Siambu and Mbaringon Pastoralist communities. 100 from each community, Kenya. However, there was attrition: 2000: 199 households 2005: 186 households 2010: 159 households. Household heads interviewed.	Vegetable and Meat	**MEAT**: not explicitly defined but mentions cattle, chicken, or livestock ownership **VEGETABLES**: cabbage, kale.	Three waves of data using 24-hour recalls were collected in 2000, 2005, and 2010	Iannotti & Lesorogol (2014)

Kenya	SI: July/Aug 2013 S2: Feb/Mar 2014	272 Rural Kenyan Women (Mean age: 40 years) randomly selected from household lists supplied by village elders of villages covering 5 different agro-ecological zones (AEZ) in the counties of Kakamega and Siaya in western Kenya	Fruit, Vegetables	Not explicitly defined but listed as follows: **FRUIT**: Mango, Cape gooseberry, Papaya, Passion fruit, Loquat, Guava, water melon, Orange, Jack fruit, Sweet banana, Avocado, Pineapple, Lemon, Tamarind, Custard apple, mulberry, Soursop	24-hour food recalls to capture fruit consumption in Rural Women	Keding et al. (2017)
Kenya	November 2009 and February 2010	208 School-aged children aged 4 to 11 years randomly selected from four public primary schools in Dagoretti Division (including several unplanned settlements namely; Dagoretti Corner, Congo, Wanyee, Githembe, Ngando, Lenana, Waithaka and Gachui Village) in Nairobi, Kenya	Meat, Fruit, Vegetables	**MEAT:** chicken, fish, beef. **FRUITS** (not defined). **VEGETABLES:** listed in table to include Cabbage, kales, spinach. Excluded carrots and potatoes	24-hour recalls using FFQ used to obtain the foods consumed for breakfast, lunch and supper. Portions/grams. Amounts of foods/ meals served were approximated using standard cups, plates and measuring jug	Mwaniki & Makokha (2013)
Kenya	Baseline study from July to August 1998	529 Grade 1 schoolchildren aged 6 to 14 from twelve primary schools selected based on size and accessibility for food delivery criteria that participated in the Child Nutrition Project study	Meat, Fruit, Vegetables	**MEAT**: Meat, fish, poultry and eggs reported together. **FRUIT**: Avocado, Ripe mangoes, Oranges, lemons, papaya. FV intake reported together. **VEGETABLES**: Kales, cowpea leaves, green beans, onions.	Three non-consecutive 24-hour recalls in a randomized controlled feeding intervention study	Gewa et al. (2014)

Mali	October to December 1998, March to May in 1999	34 women and 36 men aged 15–45 years, from 29 random selection of households (during a village meeting) in the village of Ouassala in the Kayes region, Western Mali	Meat, Fruit, Vegetables	**MEAT** not defined but meat estimates includes Eggs. **FRUIT**: Apple, banana, mandarin, lemon, date, guava, mango, orange, papaya, watermelon, sweetsop (Annona squamosa), sweet dattock (Detarium microcarpum), akee fruit (Blighia sapida), cashew fruit, jujube (Zizyphus spina-Christi), tamarind, shea-butterseed (Butyrospermum parkii), red sorrel (Hibiscus sabdariffa), baobab pulp (Adansonia digitata). **VEGETABLES**: Cassava, potato, sweet potato, yam, African fan palm (fruit and germinating radicle), cabbage, carrot, cucumber, eggplant, garlic, okra, onion, tomato, tomato paste, bitter tomato (Solanum incanum) and ginger; Green leaves: Lettuce, amaranth leaves, baobab leaves, onion leaves, mint leaves, horseradish-tree leaves (Moringa oleifera), cassava leaves and cow-pea leaves.	Quantitative Food Frequency Questionnaire (QFFQ) and Weighed Record (WR). Household measures typical of the area (plastic cup and aluminium serving), measuring tape and measuring jugs were used to estimate amounts of foods consumed.	Parr et al. (2002)
Mali	October to December 1996	75 persons. 27 men and 48 women aged 15 to 59 years representing 18 households recruited from a small village, Kersignane, in the Cercle of Bafoulabe. Bafoulabe is in the Kayes Region of Western Mali.	Meat, Fruit, Vegetables	**MEAT AND FISH** reported together (meat not defined). **FRUIT AND VEGETABLES** (reported together): Pumpkin, lady fingers, bitter tomato (Solanum incanum), onion, tomato, pepper, sweet potato, cassava, yam, lemon, watermelon and monkey bread (Adansonia digitata); Green leaves (reported separately): Pumpkin leaves, baobab leaves (fresh and dried), onion leaves, bean leaves, amaranth leaves and sweet potato leaves.	QFFQ and Combined Weighed/Recalled Dietary Records. In QFFQs, volume measures of different sizes were used for estimating amounts eaten of non-solid foods, groundnuts and beverages. Digital scales were used to determine the weight equivalents of volumes. In the Combined weighed/recalled dietary records, ingredients of the dishes were weighed separately, using the same digital scales	Torheim et al. (2001)

Namibia	September to October 2002, dry season	53 school children (Town: 43, Rural: 10) aged 8 to 15/Grades 1 to 4 randomly selected from a Primary school and 4 mobile school units in a small town and in two rural villages in the Kaokoland area, situated in north-west Namibia.	Meat, Fruit, vegetables	**Listed to include:** **MEAT**: in Town: beef, goat and chicken; in the Rural area: goat. **VEGETABLES**: including potatoes.	24-hour recall interviews. Local dishware, food photographs, and food models were used as aids for estimating food quantities.	Vähätalo et al. (2005)
Namibia	Not stated	18 years or older adults sampled from Rural villages accessible by four-wheel drive vehicle based on ordinance survey maps of Hereroland and Kavangoland. Villages from Hereroland were Okakarara, Otumborom-bonga, Otjinene and Otijituo. Villages from Kavangoland: Rundu, Andara and Bagani	Meat, Vegetables	None was defined but examples include- **MEAT**: fresh or tinned; **FISH**: tilapia, tiger fish.	Food frequency questionnaire	O'Keefe, Rund, Marot, Symmonds, & Berger (1988)
Nigeria	January to July 2003	50 fishing households and 50 Non-fishing households randomly selected from traditional fishing communities in the coastal state of Lagos and the inland state of Niger. Average 7 members per household.	Meat	39 species of fish (including Tilapia spp, Synodontis spp, Mormyrops spp, Citharinus spp, Clarias spp, Bagrus spp, Heteroitis niloticus, Gnathonemus spp, Hydrocynus spp, Clarotes spp, Titus ice fish, Petrocephalus spp, Snail, etc. and 16 types of meat including beef, goat, chicken, lamb, grasscutter and other bush meat	24-hour recalls. Portions obtained by weighing with weighing balance/scales.	Gomna & Rana (2007)
Nigeria	June to September 2011	413 adult males and females aged 20 or older randomly selected from two Local Government Areas--Ibadan South-West and Ibadan North-West of Oyo state in Nigeria	Meat, Fruit and Vegetables	**MEAT**: Lean Beef. **VEGETABLES** (excludes/reports starchy tubers, legumes, etc. separately): Vegetable soup (Efo riro, Egusi and Efo). Fruit: Banana and Orange.	Interviewer-administered questionnaire with a 24-hour dietary recall. Amount of foods consumed at a sitting/portion size were determined using measuring guides (household measures).	Sanusi & Olurin (2012)

Nigeria	October 1993 to April 1994	142 (out of 187) children recruited from 12 randomly selected schools (that included two private and ten public schools) in two Local Government Areas of Abeokuta Government Areas of Abeokuta, the capital of Ogun State, Nigeria. Male: 79, Female: 63	Meat, Fruit, Vegetables	Not explicitly defined but MEAT, FISH and EGG intake reported together. Vegetables and fruit intake also reported together	Repeated (3 times) 24-hour recalls. Estimates of serving sizes and quantities of foods eaten were based on common household measuring utensils	Oguntona & Kanye (1995)
Senegal	Not Stated	Convenience sample of 50 Adult Men recruited at the Hôpital Général de Grand Yoff (but were not hospitalized) in Dakar, Senegal (n=40) and from neighbouring Sendou village (n= 10).	Meat, Fruit, Vegetables	Not explicitly stated but listed the following under various food groups. **MEAT:** Fish, Beef, Sausage, Chicken, Ox, Goat, Sheep, Pork, Eggs/Omelet, Chockpeas, Peanuts. **FRUITS** (excludes fruit juices listed separately): Mango, Coconot, Cola nut, Banana, Rasins, Papaya, Pear, Watermelon, Apple, Grapes, Sapoti, and Maad bi. **VEGETABLES** (excludes Vegetable juices. listed separately): Potato, Tomatoes, Lettuce, Carrot, Cabbage, Corn, Eggplant, Okra, Garlic, Onion, Potato, Turin, Cucumber, Green bean, Green pepper, Green pea, Petit pois, Broccoli, Green olive, Cowpeas.	Single 24-hour dietary recall. Estimated amount per day consumed	Anderson et al. (2010)
Senegal	Not Stated	20 adolescent girls (13–15 years) attending a high school in the city of Dakar. Sampling method not reported	FV	Not defined	24-hour recalls administered over a 3-day period before and after the implementation of the activities. Food quantities were estimated using local measures or weighted	Matsinkou et al. (2016)

South Africa	January to March 1990	163 children (Boys: 93, Girls: 70) aged 3 to 6 years selected in a Stratified proportional sampling from all black residential areas of Cape Town, including squatter and formal housing areas	Meat, Fruit, Vegetables	No explicit definitions were stated. But Sweet potatoes and potatoes were included as vegetables. Portion sizes for food groups were estimated using Diabetic Exchange Lists Reference as set out in Langenhoven et al., 1989. One Meat portion was calculated as total protein from the meat group divided by 6 and 7 (6g of protein equals 1 egg and 7g of protein = 30g meat 125ml cooked legumes). For vegetables, total available carbohydrate minus sugar was divided by 5 to estimate the number of vegetable portions, and for fruit by 15 for number of portions (5 g carbohydrate represents one 125 ml vegetable portion and 15 g carbohydrate one fruit portion).	24-hour recalls combined with questions on habitual intake	Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al. (1994)
South Africa	February to October 2007	Caregivers of 400 children (2 to 5-year-old/ Grade 6 and 7 learners) selected randomly from 4 Primary Schools in the Mariannhill area, Pinetown in the KwaZulu-Natal Province, South Africa	Fruit, Vegetables	WHO 1990 definition of FV. Reports intake (grams) for FRUIT: Apple and Banana; VEGETABLES: Cabbage and Mixed vegetables.	24-hour recall repeated at one-week intervals	Faber et al. (2011)
South Africa	A repeated cross-sectional study done during February, May, August, and November of 2005	2 to 5-year olds registered on the Community-based growth monitoring project in 2 neighbouring rural villages in KwaZulu Natal willing to be interviewed 5 consecutive times: February (n=79), May (n=74), August (n=75) and November (n=78). Caregivers interviewed.	Vegetables (Dark green leafy vegetables).	**Includes Spinach and Imifino. Imifino** is a collective term for various dark-green leaves that are eaten as a vegetable; the leaves either grow wild or come from vegetables such as pumpkin, beetroot and sweet potato	Five repeated 24-hour dietary recalls per study period. Food intake reported in household measures was converted into weight using the MRC Food Quantities Manual (Langenhoven et al., 1991a)	Faber et al. (2007)
South Africa	October 2004 to December 2006	1057 grade 6 learners from 18 schools at baseline, 9 schools during 3 months, 6 months and	Fruit, Vegetables	**FRUIT and VEGETABLES**: 100% orange or grapefruit juice, other 100%	7 item FFQ in a Cluster randomised controlled trial	Jemmott-III et al. (2011)

		12 months follow-up. Random sampling of 9 pairs of schools from 17 matched pairs. Convenience sample of grade 6 learners based on parent consent and child assent then a random sample of those to reduce numbers		juices, fruit, green salad, fried potatoes, other potatoes, and other vegetables		
South Africa	May 2010 and August 2011	150 children aged 24 to 59 months recruited based on eligibility criteria Calvinia West, the disadvantaged section of the town Calvinia in the Hantam district of the Northern Cape Province. Mothers responded to questions	Liver (Meat)	Sheep's liver	24 hour recalls and a quantified liver frequency questionnaire. Frequency of consumption and Portion sizes.	Nel et al. (2013)
South Africa	2008	3840 persons aged 50 years and older recruited randomly in a national population-based cross-sectional study in South Africa	Fruit, Vegetables	**FRUIT**: such as an apple, banana, or orange, cooked, chopped, or canned fruit; and fruit juice, not artificially flavored. Insufficient FV consumption was defined as less than five servings of fruits and/or vegetables a day. Not defined but lists examples to include the following: **VEGETABLES**: tomatoes, carrots, pumpkin, corn, Chinese cabbage, beans, or onions, vegetable juice.	Used questionnaire to estimate number of servings per day in a 24-hour recall. FV consumption were assessed using two questions 'How many servings of fruit do you eat on a typical day?' and 'How many servings of vegetables do you eat on a typical day?'	Peltzer & Phaswana-mafuya (2012)
South Africa	Consumption data since 1994. Intervals of 5 years were compared, from 1994 to 2009 for FAOSTAT FBS data and from 1999 to 2012 for Euromonitor	South Africa	Meat, Fruit, vegetables	FAOSTAT: **MEAT**: Bovine data, Mutton and goat meat, Pig meat, Poultry meat, Meat (other). Reports data for Offal but not as part of meat. EUROMONITOR PASSPORT: not explicit on Offal as part of meat and does not report Offal separately. **FRUIT**: Oranges, mandarins, Lemons, limes, Grapefruit, Citrus (other), Bananas, Apples, Pineapples, Fruits (other). **VEGETABLE** (excludes Starchy roots (Potatoes, Sweet potatoes), Pulses	Used FAO food balance sheets (FBS) and Euromonitor International Passport data. Both sets of exported data (Euromonitor International Passport and FAOSTAT FBS) were converted to per capita consumption figures as this considers increases in population growth over time. Per capita intake is a crude	Ronquest-Ross et al. (2015)

	PFBC data, with specific time overlaps in 1999, 2004 and 2009			and Nuts): Tomatoes, Onion, and Vegetables (other).	estimate of consumption as it is the total amount consumed divided by the total population and does not take into account wastage, losses in storage, urban/rural distribution differences or distribution within households	
South Africa	1998 to 1999 period	Food balance sheets published by the South African National Department of Agriculture's Directorate of Statistical Information	Meat, Fruit, Vegetables	**MEAT**: Beef and veal; Mutton and goat; Pork and Chicken. **VEGETABLES and FRUIT**: Potatoes, sweet potatoes, other vegetables, citrus, other fruit, and dry fruit and nut.	Used food balance sheets published by the National Department of Agriculture's Directorate of Statistical Information on the food supply in South Africa for the 1998/99 period. Consumption data were derived by taking total production of a specific food item in the country and by subtracting the total amount used for animal feed as well as the total amount of imports and exports of the specific food item. This amount was then divided by the total population in the country, thus obtaining the per capita availability of each food item	Steyn, Abercrombie, & Labadarios (2001)
South Africa	Primary data from the National Food Consumption Survey (NFCS) in 1999 provided primary data on children. Data on adults: from 8 different studies	Secondary data from various sources, including the National Food Consumption Survey (NFCS) in 1999 provided primary data on children. Data on adults: from 8 different studies conducted in different provinces and ethnic groups. Total sample not reported.	Meat, Fruit, Vegetables	**MEAT**: Beef & offal; Vension; Mutton/goat & offal; Pork & offal; and Chicken & offal. **FRUIT**: Pome, Tropical, Citrus, Stone, Berry, and Other. **VEGETABLES**: Stem, Brassica, Leaf, Fruiting, Cucrubits, Bulb, Green legumes, and Mixed vegetables.	Used National Survey data and secondary data from 8 cross-sectional studies conducted previously in addition to National Food Balance sheet. Only datasets collected by 24-hour recalls were used here, results of the frequency	Steyn, Nel, & Casey (2003)

	(secondary sources) conducted from 1983 to 2000				databases were excluded and reported elsewhere.	
South Africa	Not stated	50 children and 42 mothers/caretakers who were part of a school-based clinical trial in a low socioeconomic rural area, 60 km northwest of Durban, KwaZulu-Natal, South Africa.	Meat, Fruit, Vegetables	**MEAT**: beef, chicken, chicken pie, sausage. **FRUITS**: Apple, Pear, Avocado. **VEGETABLES**: Tomato, Cabbage, Onion, Mealie, Imifino, Pumpkin, Carrots, Onion, Potato.	24-hour recall and an unquantified food frequency questionnaire. Fresh food, food models, household utensils and sponge models were used for quantifying and recording food intake. In addition, dry samp (commercially available coarsely broken maize) was used to quantify portion sizes of dishes made with either samp or maize. Actual food intake reported in household measures was converted into weight using the MRC Food Quantities Manual (Langenhoven et al., 1992a)	Faber (1999)
South Africa	Not stated	7-day Weighed Food Record: 74 (out of 85) volunteers (15 to 65-year-olds) recruited from participants in the THUSA study (n= 890). To test the relative validity of a culture sensitive Quantitative Food Frequency Questionnaire (QFFQ).	Meat, Fruit, Vegetables	Not defined	7-day Weighed Food Record: 74 participants Scales, measuring jug and set of measuring spoons were used to determine weight of foods consumed	Macintyre et al. (2000)

South Africa	1996 (15 to 65-year-old participants) and in 1998 participants older than 65 years were recruited	Randomly recruited 1751 respondents (743 males and 1008 females), aged between 15 and 80 years and apparently healthy from 37 randomly selected sites representing the health districts in the North West Province	Meat, Fruit, Vegetables	**Listed examples of VEGETABLES**: Onion, Tomato, Cabbage; Fruit: Apple, Banana,	Quantitative Food Frequency Questionnaire (QFFQ) made of 145 food items. Photographs of commonly eaten foods in a validated food portion photograph book (FPPB), common utensils and containers were used to estimate portion sizes.	MacIntyre et al. (2002)
South Africa	February 1994	115 black female students aged 17 to 34 years mean age: 21.4 years) attending a first-year pre-registration program at the University of the North.	Meat, Fruit, Vegetables	Not defined but list examples to include **MEAT**: poultry, red meat. **FRUIT**: Bananas. **VEGETABLES**: Spinach, pumpkin.	QFFQ gather data on each student's diet over 6 months prior to entering the University. Food models based on local foods were developed and used during the study along with other dietary aids, such as empty food containers and volume measures.	Steyn, Senekal, Brtis, & Dsc (2000)
South Africa	2009	544 randomly selected 19 to 64 years old urban Africans participants living in the townships of Langa, Gugulethu, Khayelitsha, Crossroads and Nyangain in Cape Town	Meat, Fruit, Vegetables	Reports the following classifications but reports each sub-item separately: **MEAT** group: red meat, white meat, eggs, legumes. **VEGETABLES and FRUIT**: Vitamin C rich, Carotene rich, Potato/sweet potato, Other veg/fruit.	24-hour recall using the multiple pass method. Visual life-size photographs and sketches of foods and measures (such as cups, glasses) were used to identify portion sizes	Steyn et al. (2016)
South Africa	1990	983 respondents (Female: 542. Male: 441) in Black residential areas of Cape Town aged 15 to 64 years randomly selected from sampling frame based on 1988 Human Sciences Research Council Census.	Meat, Fruit, Vegetables	**MEAT**: Red meat (beef, mutton, pork, and cold cuts made of these commercial pies). White meat (chicken and fish) and Organ meats. **VEGETABLE and FRUIT**: Vitamin C rich, Carotene rich, Potato and sweet potato, other vegetables and fruit.	24-hour recall method used in combination with questions on habitual intake. Household crockery and utensils used in serving meals, and the checking of food labels were adopted to estimate portion sizes.	Bourne, Langenhoven, Steyn, Jooste, Nesamvuni, et al. (1994)
South Africa	1977	1977: 96 randomly selected lactating Xhosas (black race) women aged 16 to 44 years	Meat, Fruit, Vegetables	Not defined but vegetable and fruit consumption reported together. Meat and fish intake also reported together	24-hour recall and diet history methods	Langenhoven et al. (1988)

		(mean age: 26) from rural and urban areas in Ciskei				
	1979	Random sample of 1113 male and female (out of 7188 respondents) from three Rural Afrikaans speaking white communities aged 15 to 64 years	Meat, Fruit, Vegetables		24-hour recalls to collect dietary data and Food models and portions of real food used as visual aids to quantify food intake	
	1982	976 randomly selected healthy urban male and female coloured population in Cape Peninsula aged 15 to 64 years	Meat, Fruit, Vegetables		24 hour recalls and frequency questionnaire. Number of portions estimated based on the principle of food exchanges: milk and meat portions were based on protein content, vegetable, fruit and cereal portions based on carbohydrate content, and fat portions on fat content. Total protein from meat and fish was divided by 21g for number of portions estimate, total carbohydrate from vegetables divided by 5g, for fruit by 20g for number of portions.	
South Africa		42 men and 60 women (aged over 18 years) of the Isandhlwana area of rural district in Zululand. the sample was selected by travelling from one group of huts to another in a four-wheel drive vehicle to interview adults met at home or at work in the fields	Meat, vegetables	Not defined	Simple frequency questionnaire	O'Keefe, Ndaba, & Woodward (1985)

Zambia	September 2012 to March 2013	938 Children aged 4 to 8 years (not attending school) recruited for an efficacy trial through a Door-to-door census of all households in towns or villages (accessible by vehicle all year round) in Mkushi, a rural district in central Zambia (baseline results used)	Vegetable, Meat (Chicken)	Based on Ugandan & Zambian Food Composition Tables. Most food items in the Zambian Food Composition Tables are presented in local languages. **MEAT** (excludes FISH & seafoods): Red meat, white meat, poultry, game, rodents, processed meats, organ meats (kidney, liver, mixed offals, intestines), blood, animal skin/ears/feet/head, insects. **Fish** (includes SEAFOODS): Whole fish, fish meat, eel, reptiles, shell fish. **FRUITS** (includes FRUIT JUICES): Fresh fruits, dried fruits, undiluted pure fruit juices, starchy fruits (banana/plantain). **VEGETABLES:** Fresh vegetables, dried vegetables (excludes potatoes).	24-hour recall tool on Android tablets	(Caswell et al., 2015)
Zambia	August 2012 to April 2013	200 Children (4 to 8 years not yet enrolled in school) in non-intervened group of an efficacy trial. Selected in a door-to-door census of all households in towns or villages (accessible by vehicle all year round) in northern Mkushi, a rural district in Zambia	Meat, Fruit, Vegetables	**MEAT**: small fish, tilapia or bream fish, chicken. **Other ASFs**: milk, eggs, insects. **FRUIT**: mango, other fruit. **VEGETABLES**: tomato, onion, rape leaves, pumpkin leaves, beans, other dark green leafy vegetables, eggplant, cabbage, cassava.	Multipass 24-hour recall tool using Android tablets to estimate number of servings per day and quantity consumed per serving of 25 most frequently consumed foods. Photo aids used to estimate Portion size/Quantity in grams from Number of Servings per day. Caregivers of children answered. Randomised efficacy trial. But could use data for the non-intervened group.	Caswell et al. (2018)

The highest meat intakes of over 380g and 340 g per day were respectively recorded in urban adult populations in Equatorial Guinea and Ghana in 2003 and 2005. These, including a 320g per day intake in two other South African adult populations, were outliers and are likely to be unreliable.

These estimates were mostly extracted from studies that derived consumption data (portions) from household expenditure on meat (Osei-Asare & Eghan, 2014), total protein intake from meat, fish, poultry, eggs, legumes and nuts reported together as ‘meat group’ (Langenhoven et al., 1988), and 24-hour recalls of amount of meat purchased (Albrechtsen et al., 2006).

In all 8 studies that reported meat intakes for both males and females separately, male intake estimates were always higher, except for Amare et al., 2012. In 5 studies that reported estimates for both urban and rural populations, urban intakes were always higher than intakes in rural populations.

For the meta-regression, two studies (Asayehu et al., 2017; Iannotti & Lesorogol, 2016), were excluded from the 49 due to non-reporting of IQRs of median meat intakes to allow mean intake conversions and attempts to contact authors were unsuccessful. Six outliers (Langenhoven et al., 1988; Osei-Asare & Eghan, 2014) were also excluded. Regressing mean meat intake on 6 potential sources of heterogeneity separately, suggested that there was a correlation between method of data collection and meat intake; between economic development of included countries and meat intake; and between residence (rural or urban) and meat intake. Meat consumption has been on an upward trend over the last 3 decades, with higher intakes in more recent studies, however this trend was not statistically significant (Table 3.5 and Figures 3.2 to 3.5).

Table 3.5: Meta-regression for meat consumption entering single covariates[13]

Covariate	Coefficient	CI	Standard error	p
Year of data collection	1.27	-2.33 to 4.87	1.81	0.49
Gender	-3.28	-44.54 to 37.99	20.75	0.88
Age (children/adults)	8.14	-71.86 to 88.13	40.22	0.84
Method of data collection	-45.45	-85.46 to -5.44	20.12	0.03
Economic development*	44.32	16.82 to 71.82	13.83	0.00
Location (rural-urban)	35.80	7.81 to 63.78	14.07	0.01

Multivariate meta-regression showed statistically significant association between country economic development and meat intake, with populations from richer countries consuming more meat than those from lower income countries. This association remained robust in sensitivity analysis (Table 3.6).

Table 3.6: Meta-regression for meat consumption entering all covariates[14]

Covariate	Model 1 (including all studies)			Model 2 (excluding quality<34%)			Model 3 (including adults only)		
	Coefficient (95% CI)	**SE**	**p**	**Coefficient (95% CI) (M2)**	**SE**	**p**	**Coefficient (95% CI) (M3)**	**SE**	**p**
Year of data collection	0.63 (-3.51 to 4.77)	2.1	0.76	0.63 (-3.55 to 5.80)	2.08	0.76	-2.92 (-8.74 to 2.90)	2.91	0.32
Gender	3.03 (-34.64 to 40.70)	18.9	0.87	3.03 (-34.92 to 40.98)	18.92	0.87	4.86 (-34.04 to 43.76)	19.45	0.80
Age (children/Adults)	-14.64 (-100.82 to 61.02)	43.3	0.74	-14.64 (-101.46 to 72.19)	43.29	0.74	N/A	N/A	N/A
Method of data collection	-28.80 (-67.66 to 71.55)	20.8	0.17	-28.80 (-70.51 to 12.92)	20.80	0.17	-29.33 (-80.38 to 21.73)	25.53	0.26
Economic Development	36.76 (2.61 to 70.91)	17.2	0.04	36.77 (2.36 to 71.17)	17.15	0.04	54.26 (13.68 to 94.83)	20.29	0.01
Location (Rural-Urban)	15.29 (-20.72 to 51.31)	18.1	0.40	15.29 (-20.99 to 51.58)	18.09	0.40	19.68 (-22.36 to 61.72)	21.02	0.35

[13] Entering single covariates: The covariates used in our analyses included: year of data collection, gender, age, method of data collection, economic development of included countries, and rural/urban residence. Only one covariate was entered at a time to test its effect on or association with meat consumption estimates of the population in the included studies.

[14] Entering all covariates: All six covariates were entered together at the same time to explore the role of year of data collection, gender, age, method of data collection, country's economic development, and rural/urban residence as sources of heterogeneity for the estimated meat intakes of the population in the included studies.

Figure 3.2: Mean Meat intake by year of data collection

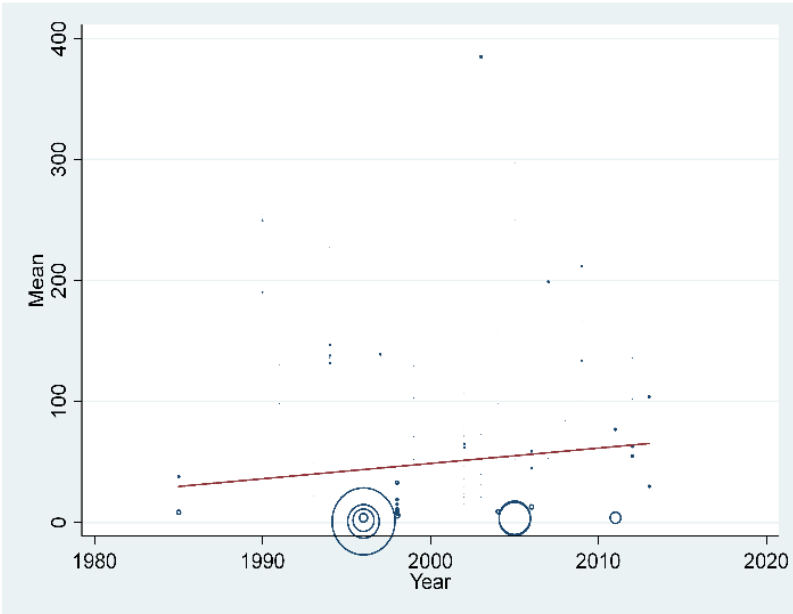


Figure 3.3: Meat intake & Country Economic classification

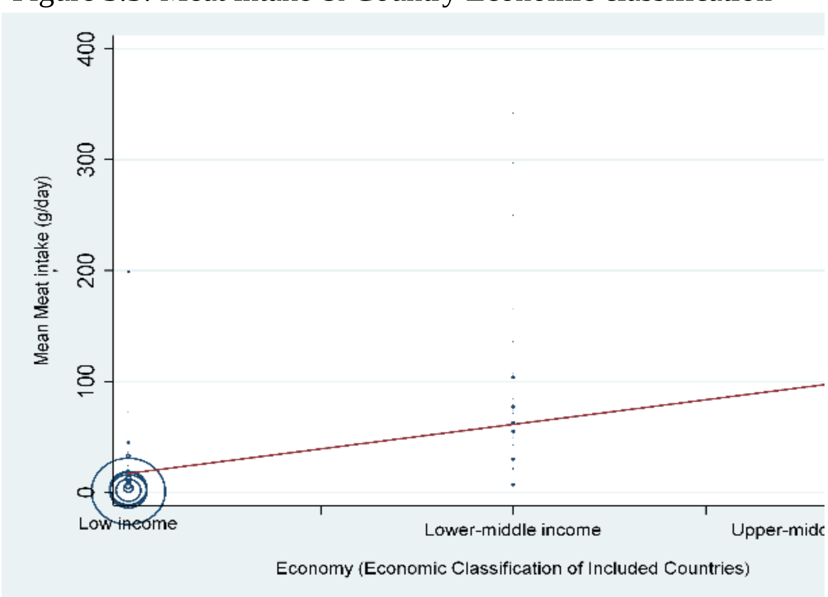


Figure 3.4: Meat intake & Method of data collection

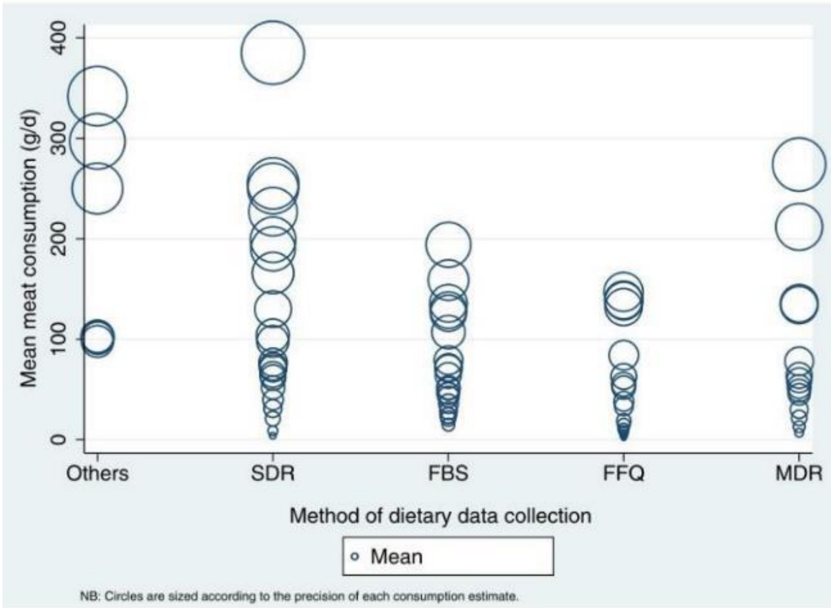


Figure 3.5: Meat intake & Country Economic classification

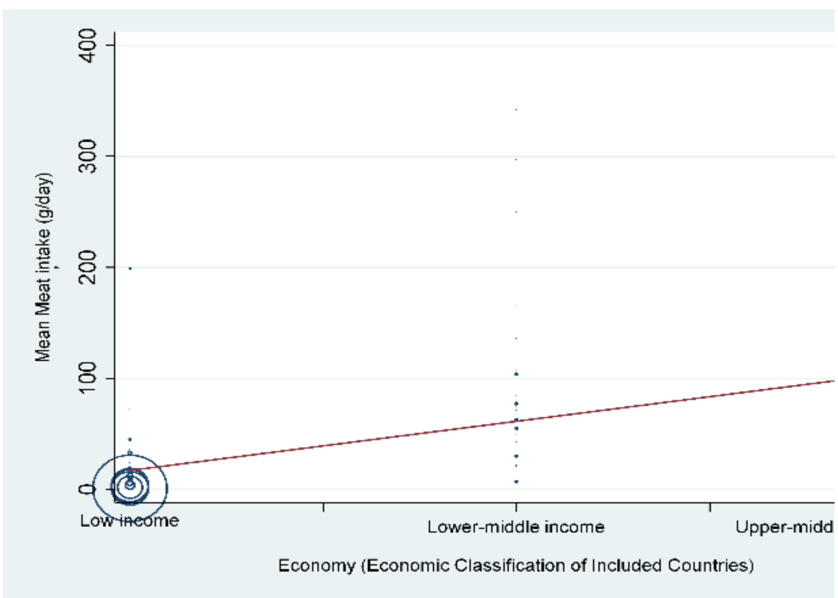
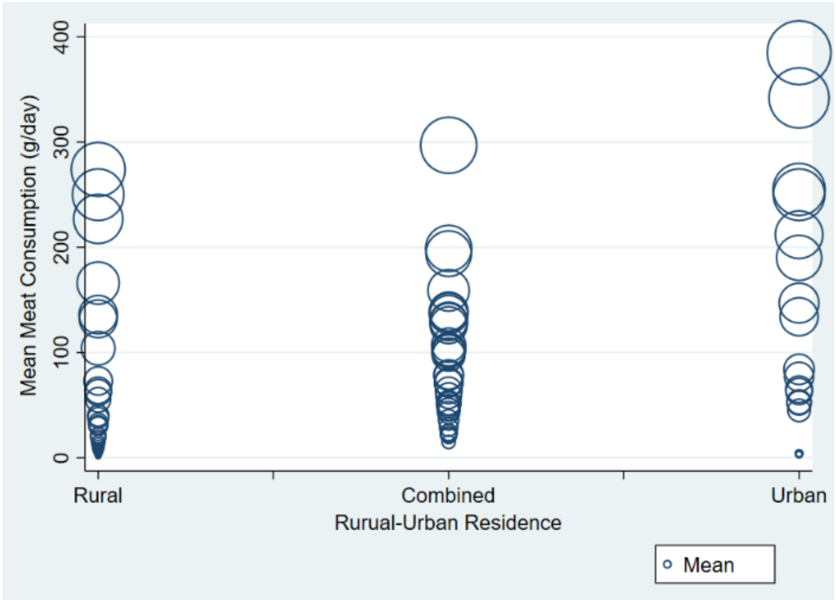


Figure 3.6: Meat intake by Rural/Urban Residence



3.11.2 Vegetable Consumption

By extracting data separately for the five domains, there were 87 population estimates recorded between 1985 and 2015 for vegetable intake. Out of this, 39.1% (34) reported daily per capita vegetable intakes below 80g (1 portion) while 72.4% (63) reported intakes of less than 160g (2 portions). An overall average consumption of 132.26g compared to a 100.66g average in adults and 245.33g average daily intake in children.

The 3 lowest intakes (2 to 8g) were reported in rural Namibian and urban Ethiopian adults in 1985 and 2005 respectively. Five others under 30g were recorded in rural adults studied in Mali in the 1990's. Of the rest, one each was found in Kenya, Mozambique and Congo (D.R) among adults in the early 2000's.

The highest vegetables intake was found in rural Kenyan children at 502g per day in 2012. Other high vegetables intakes at more than 400g per day were recorded in 2 South African populations in 2011 and 1999. Intakes between 240 and 323g (3 and 4 portions) per day were also found in 13 populations in Zambia, Kenya, Ghana, South Africa, Nigeria, and Benin. Of the remaining, 7 study populations were reported to be consuming between 160 and 232g (2 to 2.5 portions) per day. In terms of rural-urban differences in vegetables intake, 60% of studies reporting estimates separately for both populations, pointed to higher intakes in urban than rural residents.

All 87 population estimates were included in the meta-regression. Examining the 6 potential sources of heterogeneity separately, suggested that there was an association between year of data collection and vegetable intake; between economic development of included countries and vegetable intake; and between age and vegetable intake. Vegetable consumption has increased dramatically over the 30-year period, with higher intakes in more recent studies, higher intakes in children than adults; and higher intakes in higher income than poorer SSA economies/countries; and slightly higher intakes in rural than urban populations (Table 3.7 and Figures 3.7 to 3.9).

Table 3.7: Meta-regression for vegetable consumption entering single covariates[15]

Covariate	Coefficient	CI	Standard error	p
Year of data collection	2.97	0.47 to 5.48	1.35	0.00
Gender	-5.40	-36.08 to 25.27	15.32	0.73
Age (children/adults)	171.20	-91.76 to 250.63	39.95	0.00
Method of data collection	0.77	-20.06 to 21.60	10.48	0.94
Economic development*	24.58	7.40 to 41.77	8.64	0.01
Location (rural-urban)	-3.83	-27.02 to -19.36	11.66	0.74

[15] Entering single covariates: Only one covariate was entered at a time to test its effect on or association with vegetable consumption estimates of the population in the included studies.

Figure 3.7: Mean Veg. intake by year of data collection

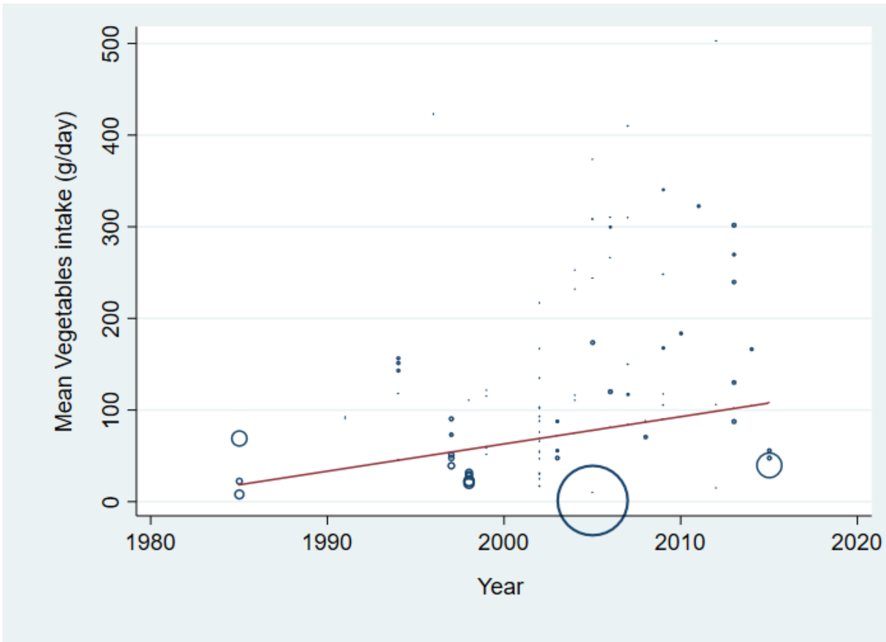


Figure 3.8: Vegetable intake by Age Cohort

Figure 3.9: Vegetable intake & Economic Classification

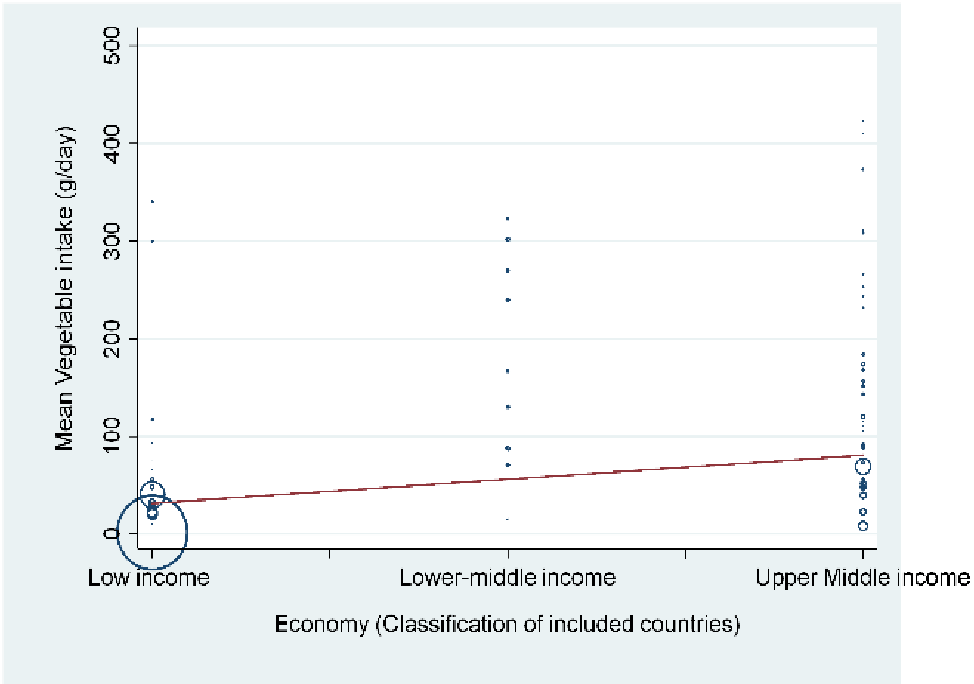
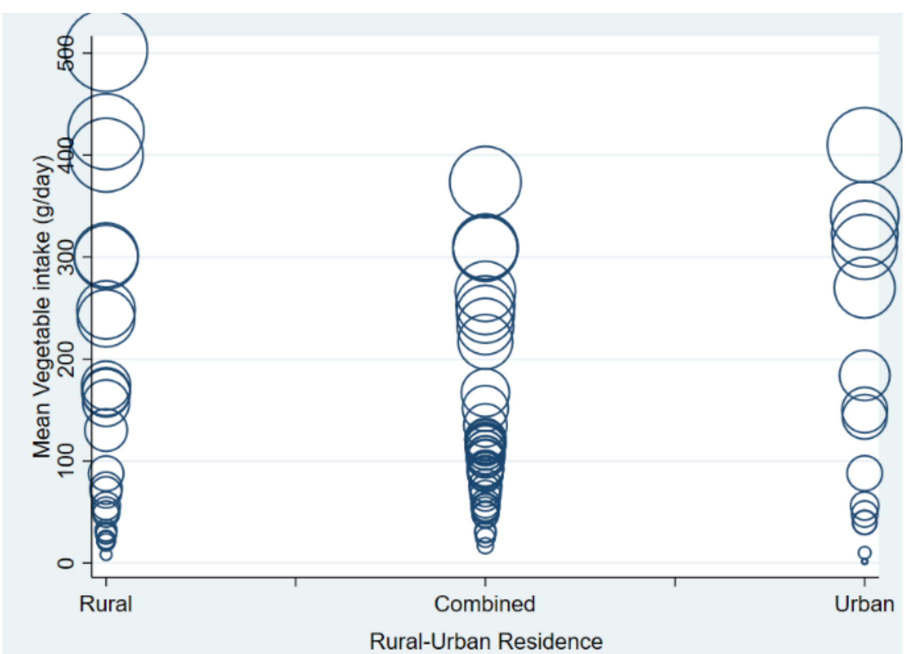


Figure 3.10: Vegetable intake by Rural/Urban Residence



A meta-regression, including all covariates, confirmed a statistically significant association between year of data collection and vegetable intake; between rural-urban residence and vegetable intake; between economic development and vegetable intake; and between age and vegetable intake (at 10% level). These associations remained robust in sensitivity analyses (Model 1, Table 3.8). These associations remained robust in sensitivity analysis excluding low quality studies (Model 2, Table 3.8). In sensitivity analyses including only non-starchy vegetables, the associations remained robust between vegetable intake and year of data collection; vegetable intake and rural-urban residence; and economic development and vegetable intake (Model 4, Table 3.9). However, the rural-urban gradient became more visible after excluding starchy vegetables (Figure 3.11).

Figure 3.11: Vegetable (non-starchy) intake by Rural/Urban Residence

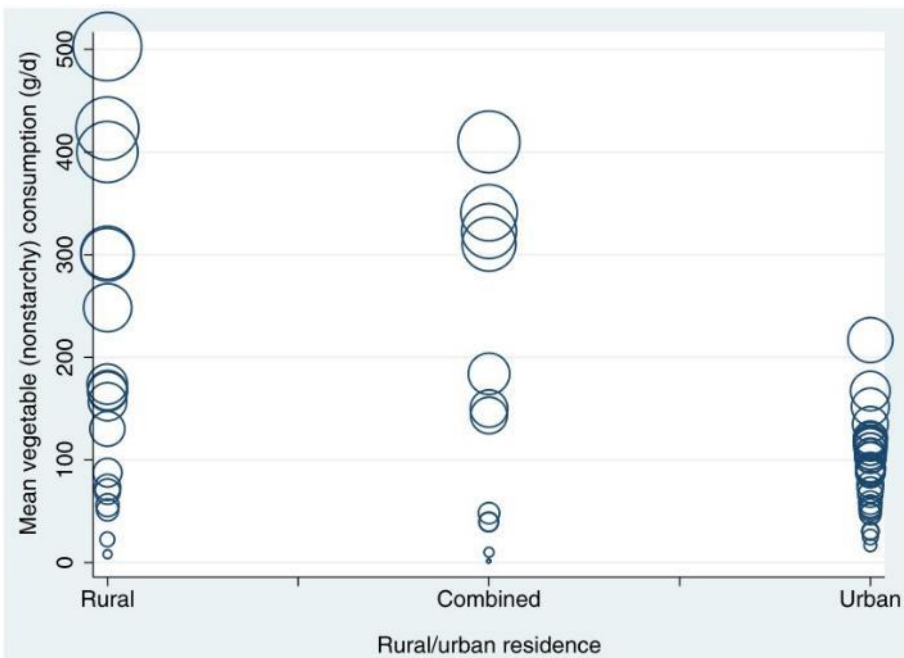


Table 3.8: Meta-regression for vegetable consumption entering all covariates[16]

Covariate	Model 1 (including all studies)			Model 2 (excluding quality<34%)			Model 3 (including adults only)		
	Coefficient (95% CI)	**SE**	**p**	**Coefficient (95% CI) (M2)**	**SE**	**p**	**Coefficient (95% CI)**	**SE**	**p**
Year of data collection	4.43 (1.74 to 7.12)	1.35	0.00	4.43 (1.72 to 7.14)	1.35	0.00	4.79 (2.05 to 7.53)	1.37	0.00
Gender	-0.18(-4.04 to 3.67)	1.94	0.93	3.029 (-4.07 to 3.70)	1.94	0.93	-.44(-6.71 to 5.84)	3.14	0.89
Age (children/adults)	80.32 (-10.62 to 171.27)	45.70	0.08	80.32(-11.26 to 171.90)	45.70	0.08	N/A	N/A	N/A
Method of data collection	1.75 (-8.73 to 12.22)	5.26	0.74	1.75 (-8.80 to 12.29)	5.26	0.74	3.44 (-7.59 to 14.47)	5.52	0.54
Economic development*	43.49 (25.96 to 61.03)	8.81	0.00	43.49 (25.84 to 61.15)	6.74	0.00	44.94(27.15 to 62.73)	8.90	0.00
Location (rural-urban)	-25.48 (-38.88 to -12.07)	6.74	0.00	-25.48 (-38.98 to -11.97)	6.74	0.00	-26.63(-40.51 to -12.75)	6.94	0.00

Table 3.9: Model 4 (excluding starchy vegetables)

Covariate	**Entering Individual Covariates (Univariate Analysis)**			**Entering all Covariates (Multivariate Analysis)**		
	Coefficient (95% CI)	**SE**	**p**	**Coefficient (95% CI) (M4)**	**SE**	**p**
Year of data collection	2.15 (-0.74 to 5.04)	1.45	0.14	3.38 (-0.06 to 6.70)	1.66	0.05
Gender	-16.45(-60.96 to 28.06)	22.04	0.46	-5.45 (-31.57 to 20.67)	13.06	0.68
Age (children/adults)	156.45 (-66.88 to 246.02)	44.86	0.00	76.64 (-28.68 to 181.95)	52.67	0.15
Method of data collection	-44.91 (-67.67 to -22.14)	11.27	0.00	-22.96 (-46.79 to 0.87)	11.92	0.06
Economic development*	16.05 (-14.61 to 46.71)	15.36	0.30	43.85 (10.64 to 77.06)	16.61	0.01
Location (rural-urban)	-9.53 (-50.67 to 31.61)	20.61	0.64	1.50 (-37.68 to 40.68)	19.59	0.94

[16] Entering all covariates: All six covariates were entered together at the same time, adjusting for covariates, to explore the role of year of data collection, gender, age, method of data collection, country's economic development, and rural/urban residence as sources of heterogeneity for the estimated vegetable intakes of the population in the included studies. In Model 1 of the multivariable analysis, data extracted from all included studies were included. In Model 2, data from studies that scored less than 34% in quality appraisal were excluded. Model 3 included data extracted for adults only.

3.11.3 Fruit Consumption

There were 83 population estimates for fruit intake. These data were collected between 1991 and 2015. Of all 83 estimates, the proportion consuming less than 80g (1 portion) and 160g (2 portions) of fruits a day reached 36.1% (30) and 66.0% (55) respectively. Average daily fruit intake in adults was lower at 147.45g than the overall mean of 155.64g. These compared to an average of 187.45g in children.

The lowest intakes found in 6 study populations in Botswana, Ethiopia, and Mali between 2002 and 2005 were less than 10g per day. All these but one study in Botswana were urban adult populations. Of the remaining, 14 of the populations studied reported daily per person intakes of between 10 and 49g, studied mostly between 2000 and 2009. The rest included 9 populations in Ghana, South Africa and Kenya consuming between 60 and 80g. Whiles the lowest fruit intake (0.80g) was recorded in urban adults in Ethiopia, the lowest intake in children was at 10g, reported in rural Kenya in 2012.

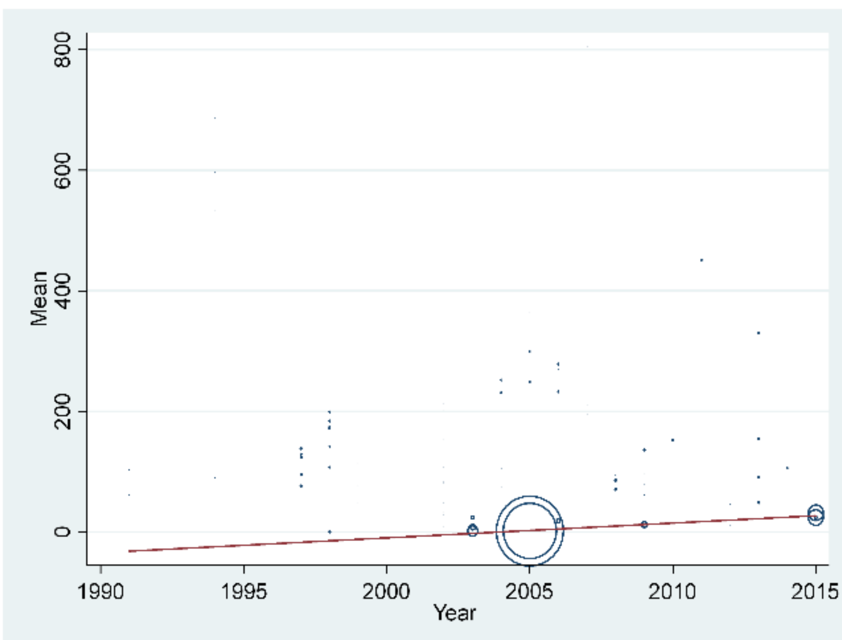
Fruit intake was highest at over 805g per day in Senegalese adults studied in 2007. Other high daily fruit intakes between 450 and 687g (4.5 and 6.6 portions) were also recorded in 5 other adult populations in Nigeria, Uganda, and South Africa. The rest included 11 estimates, representing 13%, consuming between 240 and 365g (3 to 4.5 portions) per day. The highest fruit intake in children was reported at 365g per day found in South Africa compared to over 805g in Senegalese adults.

All the 83 population estimates were included in the meta-regression. Exploring the 6 potential sources of heterogeneity separately, suggested that there was an association between year of data collection and fruit intake, with higher intakes in more recent studies; between age and vegetables intake, with children consuming higher; and between residence (rural or urban) and vegetables intake, where intakes were higher in rural than urban populations (Table 3.10 and Figures 3.12 to 3.14).

Table 3.10: Meta-regression for fruit consumption entering individual covariates[17]

Covariate	Coefficient	CI	Standard error	p
Year of data collection	2.46	1.33 to 3.58	0.57	0.00
Gender	-1.43	-21.80 to 18.94	10.24	0.89
Age (children/adults)	224.55	28.85 to 420.26	98.36	0.03
Method of data collection	-8.32	-12.07 to -4.57	1.87	0.00
Economic development*	5.30	-10.21 to 20.82	7.80	0.50
Location (rural-urban)	-16.60	-23.39 to -9.82	3.41	0.00

Figure 3.12: Mean Fruit intake by year of data collection



[17] Entering single covariates: Only one covariate was entered at a time to test its effect on or association with fruit consumption estimates of the population in the included studies.

Figure 3.13: Fruit intake & Method of data collection

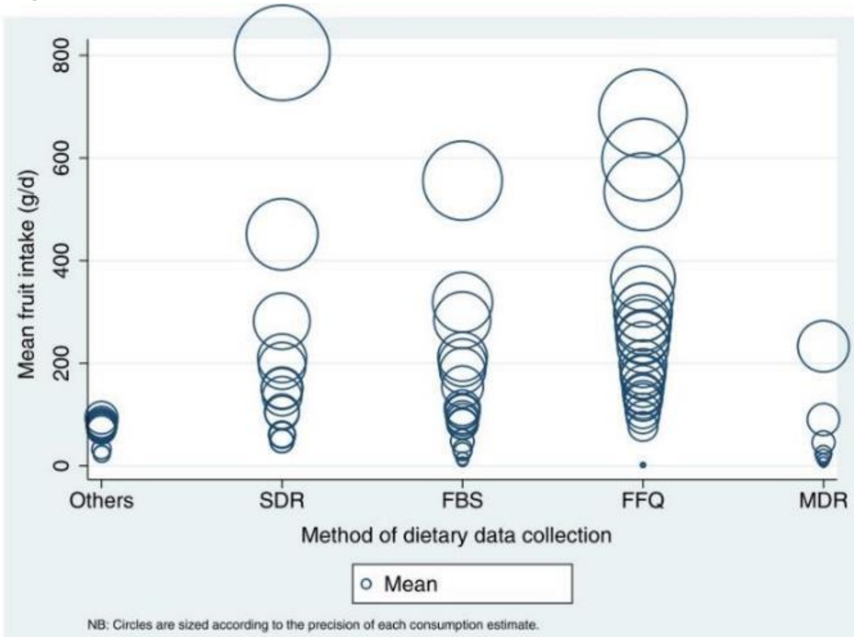


Figure 3.14: Fruit intake by Age Cohort

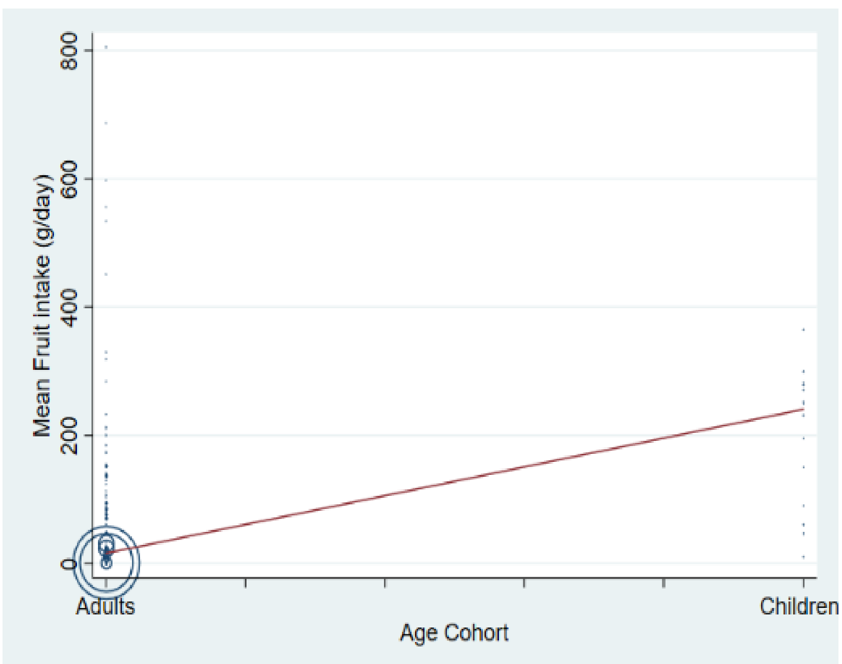
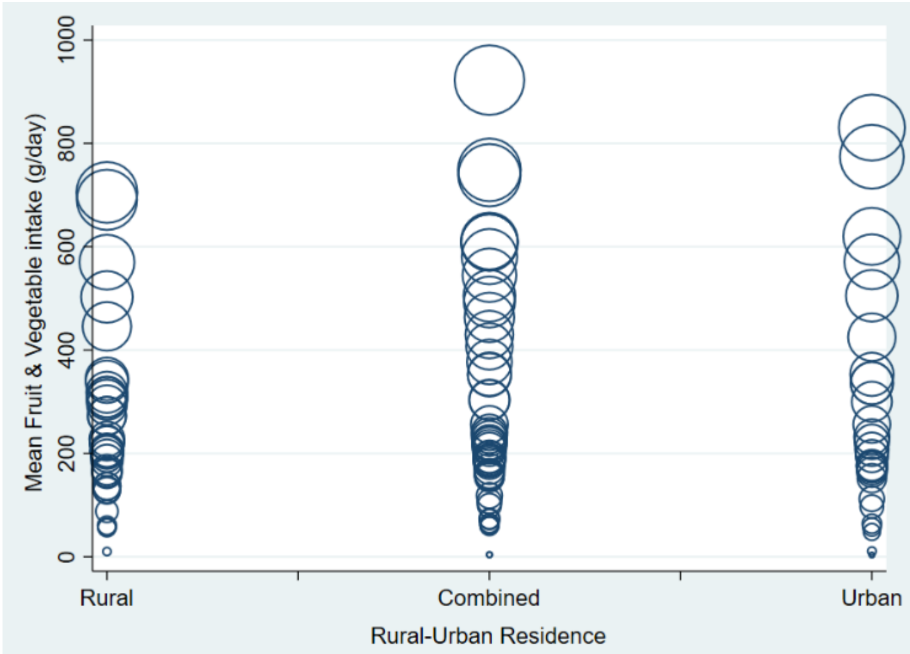


Figure 3.15: Fruit intake by Rural/Urban Residence



A meta-regression including all covariates pointed to statistically significant association between age and fruit intake. This relationship remained robust in sensitivity analysis (Table 3.11).

Table 3.11: Meta-regression for fruit consumption entering all covariates[18]

Covariate	Model 1			Model 2 (Excluding quality<34%)			Model 3 (adults only)		
	Coefficient (95% CI)	SE	p	Coefficient (95% CI) (M2)	SE	p	Coefficient (95% CI)	SE	p
Year of data collection	-1.55 (-6.30 to 3.21)	2.39	0.52	-1.55 (-6.36 to 3.27)	2.39	0.52	-1.41(-6.20 to 3.40)	2.40	0.56
Gender	-0.16 (-2.98 to 2.66)	1.42	0.91	-0.16 (-3.01 to 2.69)	1.42	0.91	-.162(-2.99 to 2.67)	1.42	0.91
Age (children/adults)	219.87 (23.42 to 416.33)	98.62	0.03	219.87 (21.25 to 418.50)	98.62	0.03	N/A	N/A	N/A
Method of data collection	-9.56 (-25.15 to 6.04)	7.83	0.23	-9.56 (-25.32 to 6.21)	7.83	0.23	-9.02(-24.77 to 6.73)	7.87	0.26
Economic development*	6.38 (-5.48 to 18.24)	5.95	0.29	6.38 (-5.61 to 18.37)	5.95	0.29	6.20(-5.72 to 18.12)	5.96	0.30
Location (rural-urban)	-9.24 (-23.35 to 4.88)	7.09	0.20	-9.24 (-23.51 to 5.04)	7.09	0.20	-9.36(-23.54 to 4.82)	7.09	0.19

3.11.4 Fruit and Vegetable intake

Data were extracted data for 115 population estimates based on the five domains (children and adults, male and female, rural and urban populations, method dietary data collection, and period of data collection) for FV intake, reported between 1977 and 2015. These covered 22 SSA countries and included 90 estimates for adults and 25 estimates for children. Of all 115 estimates, 79.13% (91) reported intakes below WHO's recommended daily intake of 400g. Up to 15.65% (18) found per capita intakes below 80g per day and 28.70% (33) consuming less than 160g (2 portions). Over 32% (37) reported daily intakes of 161 to 240.70g (2 to 3 portions). Those reporting intakes of 400g or more reached 20.87% (24), with 15.65% (18) consuming between 502 and 923g per day.

The 4 lowest intakes (3 to 4g) were adult populations (1 male, 3 females) in 1977 and 2005 in South Africa and Ethiopia. Other low FV intakes (between 10 and 74g) were found in 12 adult and 2 populations of children in Namibia, Kenya, Ethiopia, Botswana, Burkina Faso, Mali, Mozambique, and Zimbabwe mostly recorded between 2002 and 2005. The

[18] Entering all covariates: All six covariates were entered together at the same time, adjusting for covariates, to explore the role of each covariate as a source of heterogeneity for the fruit consumption estimates of the population in the included studies. In Model 1 of the multivariable analysis, data extracted from all included studies were included. In Model 2, data from studies that scored less than 34% in quality appraisal were excluded. Model 3 included data extracted for adults only.

lowest intake in children was 10g per day reported in rural Namibia in 2002 compared to 3.22g in urban adults reported in 2005 in Ethiopia.

The highest FV intakes at 922.52g and 830.50g were respectively recorded in Senegalese and South African adults in 2007 and 1994. Other high intakes between 705 and 774g (8.8 and 9.7 portions) per day were found in 4 populations (2 adult, 2 children) in Nigeria and South Africa. The rest included 12 populations (5 adult, 7 children) in Cameroon, Kenya, Ghana, South Africa, and Uganda consuming between 500 and 690g. In children, the highest intake reported was 738g per day in South Africa in the 2005.

In 6 of 8 papers that reported separately for both males and females reported higher intakes for females than males. Out of 9 papers reporting intakes separately for both urban and rural residents, 6 always reported higher intakes in urban. The highest intake in females (830.50g) and males (344g) were both reported in South Africa in 1994 and 1979, respectively.

All 115 population estimates were pooled in the meta-regression. Exploring the 6 potential sources of heterogeneity separately suggested that there was an association between method of data collection and fruit and veg. intake; and rural-urban residence and fruit and veg. intake. Although not statistically significant, fruit and veg. consumption has increased over the last 38 years, with higher estimates in more reliable methods; higher intake in rural than urban areas; and higher intake in males and females (Table 3.12 and Figures 3.16 to 3.18). No clear difference was observed between LICs and HICs. However, in a sensitivity analysis removing starchy vegetables, higher consumption was observed in HICs than LICs (Figure 3.20) and this was statistically significant (Table 3.14).

Table 3.12: Meta-regression for FV consumption entering single covariates[19]

Covariate	Coefficient	CI	Standard error	p
Year of data collection	1.31	-2.59 to 5.21	1.97	0.51
Gender	21.51	-39.73 to 82.75	30.91	0.49
Age (children/adults)	-68.37	-201.33 to 64.59	67.07	0.31
Method of data collection	35.17	.255 to 70.09	17.62	0.05
Economic development*	-12.83	-57.77 to 32.12	22.69	0.57
Location (rural-urban)	-31.79	-78.28 to 14.70	23.46	0.18

Table 3.13: Meta-regression for FV consumption entering all covariates[20]

Covariate	Model 1 (including all studies)			Model 2 (excluding quality<34%)			Model 3 (including adults only)		
	Coefficient (95% CI)	**SE**	**p**	**Coefficient (95% CI)**	**SE**	**p**	**Coefficient (95% CI)**	**SE**	**p**
Year of data collection	1.82 (-2.477 to 6.12)	2.16	0.40	1.78 (-2.52 to 6.08)	2.16	0.41	2.49 (-1.66 to 6.65)	2.09	0.24
Gender	8.31 (-53.977 to 70.59)	31.32	0.79	8.41 (-53.91 to 70.72)	31.34	0.79	8.06 (-52.02 to 68.14)	30.22	0.79
Age	-72.96 (-218.36 to 72.46)	73.12	0.32	-72.52 (-217.98 to 72.93)	73.14	0.32	N/A	N/A	N/A
Method of data collection	32.58 (-2.34 to 67.50)	17.56	0.07	32.63 (-2.32 to 67.57)	17.57	0.07	27.47 (-6.52 to 61.47)	17.10	0.11
Economic development*	11.25 (-43.41 to 65.90)	27.49	0.68	10.92 (-43.70 to 65.54)	27.47	0.69	16.19(-35.09 to 67.46)	25.79	0.53
Location (rural-urban)	-34.57 (-82.10 to 12.97)	23.90	0.15	-34.39 (-81.92 to 13.14)	23.90	0.15	-37.20(-85.80 to 11.40)	24.45	0.13

[19] Entering single covariates: Only one covariate was entered at a time to test its effect on or association with FV consumption estimates of the population in the included studies.

[20] Entering all covariates: All six covariates were entered together at the same time, adjusting for covariates, to explore the role of each covariate as a source of heterogeneity for the FV consumption estimates of the population in the included studies. In Model 1 of the multivariable analysis, data extracted from all included studies were included. In Model 2, data from studies that scored less than 34% in quality appraisal were excluded. Model 3 included data extracted for adults only.

Table 3.14: Model 4 (excluding starchy vegetables)

Covariate	Entering Individual Covariates (Univariate Analysis)			Entering all Covariates (Multivariate Analysis)		
	Coefficient (95% CI)	**SE**	**p**	**Coefficient (95% CI) (M4)**	**SE**	**p**
Year of data collection	0.93 (-3.09 to 4.96)	2.03	0.65	0.70 (-3.92 to 5.32)	2.33	0.76
Gender	16.00 (-47.29 to 79.30)	31.86	0.50	9.24 (-54.07 to 72.56)	31.85	0.77
Age (children/adults)	-77.78 (-217.07 to 61.51)	70.13	0.27	-135.06 (-294.19 to 24.06)	80.06	0.09
Method of data collection	-4.14 (-33.49 to -25.21)	14.76	0.78	-7.30 (-41.61 to 27.01)	17.26	0.67
Economic development*	-13.33 (-62.22 to 35.57)	24.62	0.59	17.28 (-49.17 to 83.72)	33.43	0.60
Location (rural-urban)	-54.05 (-108.42 to 0.33)	27.38	0.05	-60.75 (-126.98 to 5.47)	33.32	0.07

Figure 3.16: Fruit & Veg intake by year of data collection

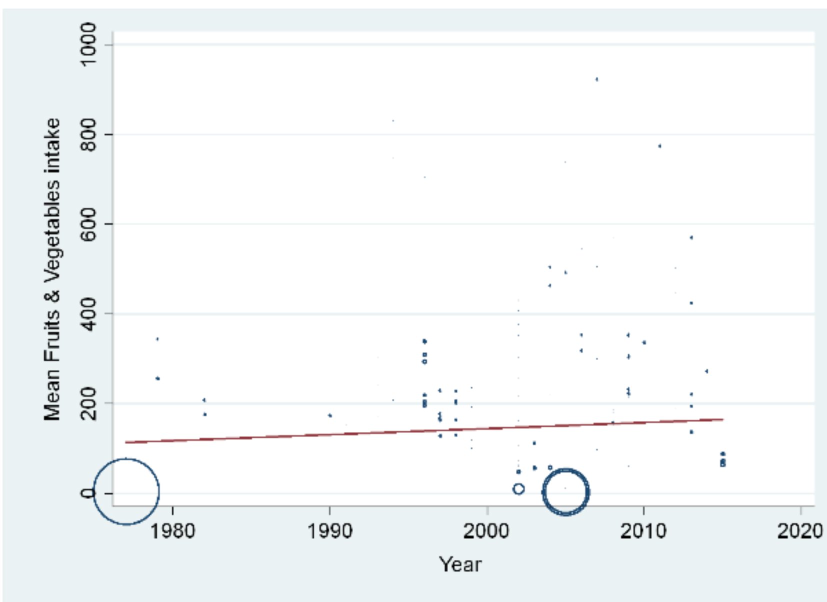


Figure 3.17: Fruit & Veg. intake & Method of data collection

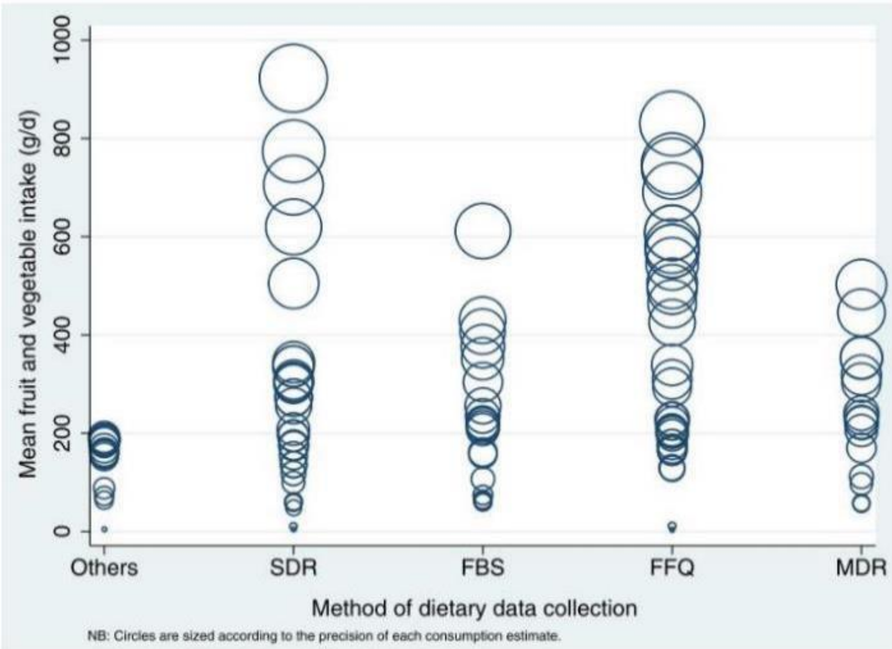


Figure 3.18: Fruit & Veg. intake by Age Cohort

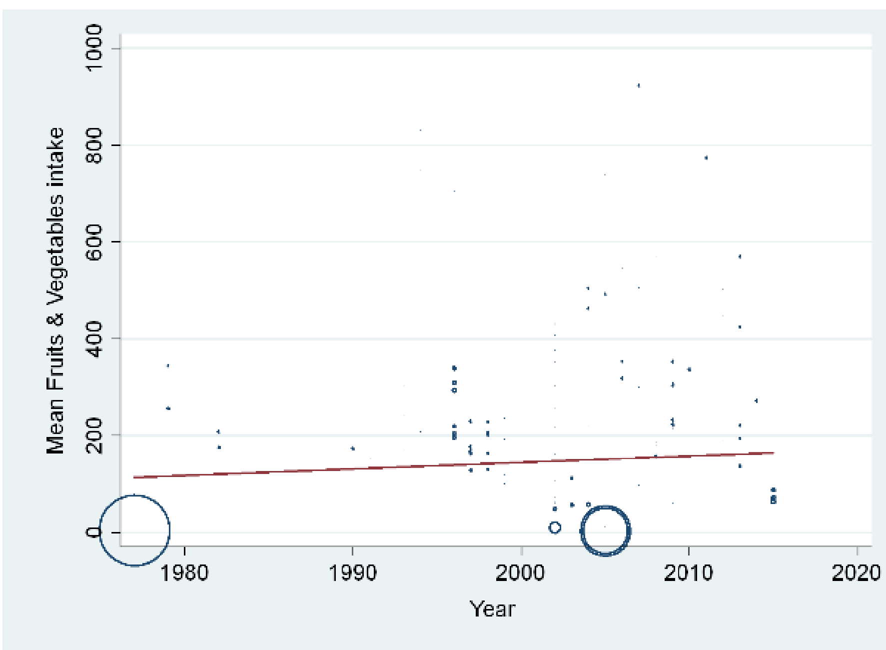


Figure 3.19: Fruit & Veg. intake by Rural/Urban Residence

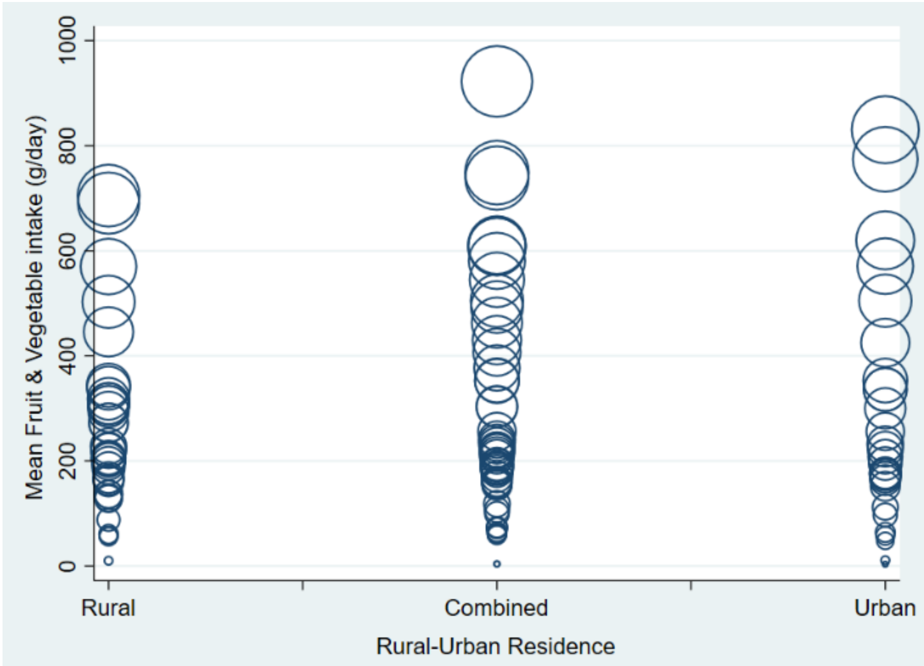
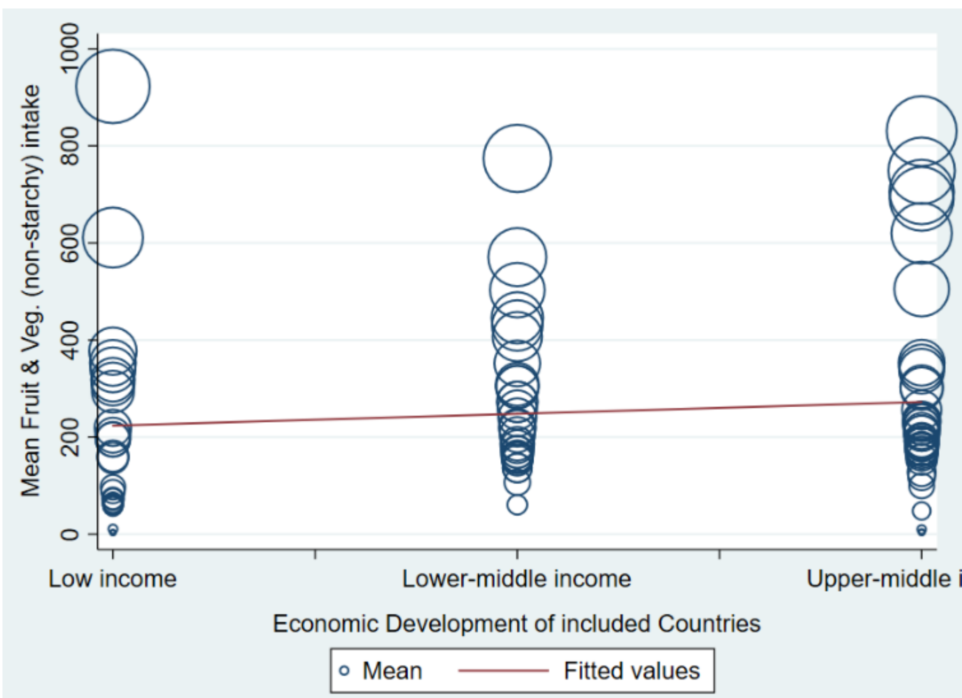


Figure 3.20: Fruit & Veg. (non-starchy) intake by Economic classification



3.12 Discussion

This review systematically identified and synthesised 49 papers reporting meat, fruit and/or vegetable consumption focused on sub-Saharan Africa and with no date restrictions.

3.12.1 Summary of Key Findings

The average per capita daily consumption over the previous 30 years was found to be 98g for meat and 268g for FV. While nearly a half of mean population meat intake estimates were above 70g, about a third of mean population daily vegetable (32%) or fruit (36%) consumption estimates were less than one portion. Through random effects meta-regression, it was found that richer SSA countries consumed more meat ($p=0.010$) and more vegetables ($p<0.001$) per capita than poorer SSA countries, and these findings remained robust in both multivariate and sensitivity analyses. Vegetable consumption in rural areas was also more likely to reach WHO recommended levels than in urban areas, after controlling for age, gender, year of data collection, method of data collection, and country economic development ($p<0.001$). This rural-urban gradient became more evident after removing estimates that included starchy vegetable consumption; suggesting that a greater proportion of the vegetables that urban SSA populations consume is starchy vegetables. Rural residents were more likely than their urban counterparts to meet WHO recommended daily intakes for fruits ($p<0.001$) in univariable regression analyses, but meat consumption ($p=0.013$) was higher in urban populations. The rural-urban differences in meat or fruit consumption were, however, not robust in multivariable analyses. No clear gender differences in meat, fruit or/and vegetable consumption were observed.

3.12.2 Comparison & Interpretation

3.12.2.1 MFV consumption by Countries' Economic Development

The results of the meta-regression showed that higher income SSA countries consumed more meat ($p=0.002$) than poorer countries (Figure 3.4, Table 3.6), which appear to support the hypothesis that meat consumption increases as societies get richer. This income gradient was also observed for vegetable intake in the meta-regression (Figure 3.8). Poorer countries consumed fewer vegetables than higher income SSA countries ($p=0.006$) (Table

3.8 and 3.9). These results are in line with existing literature (Delgado, 2003; Marques et al., 2018; Vranken et al., 2014) which could be a confirmation of the robustness of the results in this review. As disposable incomes increase, usually resulting from economic development and urbanisation, people tend to consume more protein and high-calorie products, especially meat and other livestock products, potentially influenced by a desire to emulate “Western” lifestyle. Economic growth and urbanisation are widely believed to alter lifestyle and dietary patterns partly as a result of changes they bring to the food environment, increased disposable incomes, more time-consuming (and sedentary) occupations (HaganJnr et al., 2018; Kuuire et al., 2018). According to Marques et al. (2018) economic growth has greater impact on poorer countries’ change in the consumption of such products. This impact reduces along the way towards the richer HIC state on the economic development scale. At this point the consumption of meat plateaus and possibly even declines among individuals in high-income economies as is being witnessed in some HICs, according to the FAO (Godfray et al., 2018; OECD/FAO, 2016). Given that meat consumption in HICs (at already high levels) will potentially level off, in the future, the greater adverse health and environmental impacts will likely result from low-income and emerging economies increasing their meat intake. It has been previously found that persons in lower income economies are less likely than those in high income economies to meet recommendations for vegetable consumption (Miller et al., 2016). Miller and colleagues (2016) also found that for persons in LICs, the cost of both FV in relation to household incomes (i.e.: their affordability) were markedly higher compared to individuals in richer countries. In the same study, increase in the prices of FV was associated with reduced intakes. A systematic review and other studies have also found recommended healthy diets to be more expensive and less desirable in deprived and lower income societies (Ball et al., 2015; Giskes et al., 2010). Households on low incomes are more concerned about hunger and are more likely to choose food that is filling or with high satiety value (such as starchy staples, including starchy vegetables) over food such as fruit or vegetable with high nutrient value (Kennedy, 2014). The current results provide added support for studies that have reported monetary cost as a key determinant and known barrier to vegetable and fruit consumption, especially for those in lower socioeconomic societies (Chapman et al., 2017; Pollard et al., 2002, 2007). Culture as an influence on dietary behaviours is well-documented (Boatemaa et al., 2018; Hagan Jnr et al., 2018; Kruger et al., 2005). In most African cultures and other LICs, some food items are associated with social status and seen as desirable status symbols (Agyei-Mensah & Aikins, 2010)—often referred to as 'luxury' foods, and usually include meat, other animal products, chocolates and other confectionery, biscuits, ice-cream, soft drinks, fried foods and ready meals (Agyei-Mensah & Aikins, 2010; Renzaho, 2004). Eating such foods on a regular basis is seen to confer a superior social status compared to fruit, vegetable and legumes which are less desirable and seen as survival food for the poor (Collins Afriyie Appiah et al., 2016; Renzaho, 2004).

3.12.2.2 MFV Consumption trends between 1977 and 2015

The results of the meta-regression also showed that consumption of two of the variables of interest (meat and vegetables) have been on an upward trend over the last three decades (Figures 2, 6, 9 & 13). Meat consumption (p= 0.76) and especially, vegetable intake (p=0.002) are likely to have increased dramatically over the 30-year period, with meat intake in many adult populations (49% of population estimates) exceeding the upper limit of 70g recommended by the WCRF, and above this level in some populations of children. It is however possible a section of the population may be consuming much smaller amounts of meat given that the results presented here are averages. This is because averages may conceal the differences in consumption among different sections of the population. This finding is consistent with global meat consumption trends which has seen a 20kg per capita increase per annum between 1961 and 2014 and in LICs, but in contrast, a slow decline in many HICs (Ritchie & Roser, 2018). The results also support the EAT Lancet Commission's report regarding low intake of FV compared to higher meat intakes (Willett et al., 2019). Though the increase in meat consumption in this study (Figure 3.2) was statistically non-significant, other studies have also found an upward trend in many LDCs. In most SSA cultures and especially countries going through economic transition, eating meat is seen as a symbol of wealth and thus aspirational and desirable. Such between-country disparities in meat consumption have been attributed partly to cultural differences.

On the contrary, fruit or/and vegetable intake remain substantially below WHO recommended levels (Figures 3.6, 3.10 and 3.14). Similar findings of less than 1 portion of fruit or vegetables have been reported in Ghana, Uganda, Tanzania and other LICs like Bangladesh, India, Jamaica, and Philippines. The prevalence of low fruit intakes (less than 1 portion daily) was in a similar range as those reported by other studies conducted in some HICs. In 2015, for example, 37% of U.S adults in the Behavioral Risk Factor Surveillance System (BRFSS) survey consumed less than 1 serving of fruit. A similar finding has been reported in 29% of Austrian adults. In Barbados 26.9% of adults are reported to consume less than 1 serving of FV.

Compared to meat and other ASFs consumption which in most African cultures is seen to confer a superior social status, fruit, vegetables, legumes, and grains are less desirable and seen as survival food for the poor. It is therefore likely that as suggested in the EAT-Lancet commission's report, the consumption of other plant-based foods like legumes, nuts or seeds is also low in SSA populations apart from FV, though the review did not cover legumes, nuts, or seeds. Based on inference from the EAT-Lancet report on plant-based foods as sources of high-quality protein and micronutrients, it may also follow that the SSA population may likely be deficient in micronutrients and high-quality protein.

3.12.2.3 Rural/urban variations in MFV consumption

Through a between-study comparison in univariable meta-regression, it was observed that urban populations in SSA may be consuming significantly more meat than rural populations ($p=0.013$) (Figure 3.5) but taking fewer fruits ($p<0.001$) and vegetables ($p<0.000$) than rural residents (Figures 3.9 and 3.13). Though these findings did not remain statistically significant (robust) in multivariable analyses, higher meat intakes in urban areas may be due to higher disposable incomes associated with urban living (Lara; Cockx et al., 2017; Galbete et al., 2017b; OECD, 2019a; Popkin, 1999) and/or shifts towards high animal protein diets that characterize populations in transition to the "degenerative disease" period of Popkin's (1999) nutrition transition (Mogre et al., 2015). Yıldırım & Ceylan (2008) have previously reported similar finding of high meat intakes in urban populations in Turkey, and there are similar findings report in urban Ghanaian adults (Galbete et al., 2017) and in Italian adolescents (Grosso et al., 2013). Conversely, studies conducted in

Australia and Romania have reported higher meat intakes in rural than urban adults (Lutfiyya et al., 2012; Martin et al., 2017).

Regarding FV consumption, the rural-urban difference observed in this review is supported by findings on FV consumption prevalence in other African countries (Congo, Côte d'Ivoire, Kenya, Zambia and Tunisia) and in Bangladesh, Ecuador, Paraguay, Philippines, and Ukraine in a multi-country study based on WHO survey data (Hall et al., 2009). Padrão et al. (2012) have also reported lower intakes of both FV in urban than rural Mozambique's. In rural areas in SSA and other LICs, farming is largely for subsistence and provides increased access to FV in rural areas. It is therefore conceivable that rural populations would consume more fruits and vegetables. The influences of food environments on food choice may also explain low FV intake in urban areas of SSA where the food environment offers a wider variety of food products, especially ultra-processed foods. However, based on household expenditure data on 10 SSA countries, Ruel et al. (2005) reported higher FV intake in urban than rural populations. While this may have changed after nearly two decades of their research, similar findings have been reported in 3 Baltic countries (Estonia, Lithuania and Latvia) and in Norway (Johansson et al., 1999; Prattala et al., 2006; Ritva et al., 2014). Similarly, rural residence has been associated with low FV intake also in countries of the former Soviet Union (Abe et al., 2013), in the USA (Lutfiyya et al., 2012), Morocco (El-Rhazi et al., 2012), India (Bowen et al., 2011; Oyebode et al., 2015), and other countries from 8 geographical regions (V. Miller et al., 2017; Oyebode et al., 2015).

3.12.2.4 MFV consumption by other variables

Whiles there was no clear difference between adults and children for meat consumption, it was found that consumption decreased with age for fruits (Figure 3.12, Table 3.10 & 3.11) and for vegetables (Figure 3.7, Table 3.11). This finding is in line with findings from studies by Ndagire et al. (2019) in Uganda, for fruits in Tanzania (Msambichaka et al., 2018) and in the UK based on National Diet and Nutrition Survey (NDNS) (Albani et al., 2017). Conversely, studies from Tanzania Msambichaka et al. (2018) have reported higher vegetable intakes in the old than in younger populations. Surprisingly, adults consumed more in terms of fruit plus vegetables, though this was not statistically significant ($p=0.310$)

(Table 11), given that higher intakes in children for fruits only and vegetable only were both statistically significant (Tables 3.8 and 3.9). There were no clear and statistically significant differences in consumption of MFV between sexes.

In terms of method of data collection, studies that adopted more reliable dietary assessment methods (MDR, FFQ) reported lower consumption estimates than methods considered less accurate, such as a single dietary recall method (Figures 3.3 and 3.11, and Tables 3.9, 3.10 & 3.11), except for combined FV intakes, though not statistically significant. A systematic review that assessed the validity of dietary assessment methods against doubly labelled water as a gold standard, found similar results (Burrows et al., 2010). Over-reporting was most often associated with 24-hour recalls than food frequency questionnaires. As most of the reviewed studies adopted single 24-hour dietary recalls, it is recommended that future research adopts more reliable assessment methods that give more accurate dietary intake estimates.

3.12.2.5 Strengths and Weaknesses of the study

This systematic review has a number of strengths and weaknesses. Most of the shortcomings of this review largely reflect the limitations of the included studies.

This review is the first of its kind that focuses on SSA and in terms of strengths, it involved an extensive and thorough search of literature. Despite adopting narrow inclusion criteria, this review identified a large set of 47 relevant studies that focused on SSA and provides diversity. Previous systematic reviews like (Mayen et al., 2014) included 7 studies from SSA. To minimize bias, ensure transparency and achieve objectivity, this review included articles published in peer-reviewed journals selected based on predetermined criteria. Papers written in languages other than English, and French were excluded, which is a potential limitation, as other relevant data may have been identified in such papers. However, the diversity of included studies offers an interpretive context in which the generalizability of findings is enhanced, which is otherwise not available in any one study or a smaller number of studies. This is because the large set of reviewed studies captured a diversity of SSA participants, wide variety of MFVs, and different methods of measurement.

Congruently, some of the reviewed reports were restricted regarding sampling and generalizability as they included small non-random samples of specific groups. In relation to the above, non-reporting of response rate in some of the included studies could increase non-responder bias in the results. This issue was dealt with by doing a sensitivity analysis in which studies with low quality were excluded. It is recommended that future SSA research reporting should highlight response rates and other relevant statistics including missing data which was also not reported in some of the reviewed reports.

The included studies defined "meat", "fruits" and "vegetables" differently. The significant between-country and between-study variations in the definition of what constitutes fruits or vegetables are well-known concerns among food and nutrition researchers (Roark & Niederhauser, 2013; Thompson et al., 2011). The main area of concern is the classification of vegetables (IARC, 2003). Eleven[21] of 43 studies reporting on vegetable intake captured starchy tubers in their vegetable consumption estimates, while others (Asayehu et al., 2017; Ronquest-Ross et al., 2015; Sanusi & Olurin, 2012) did not. In 5 (Caswell et al., 2015; Galbete et al., 2017; Gelibo et al., 2017; Peltzer & Phaswana-mafuya, 2012) of studies reporting fruit consumption, fruit juices were captured in fruit consumption estimates. Of the 38 studies that reported meat consumption estimates, 15 studies included fish but 23 excluded it from meat consumption estimates. These differences in definitions may affect the accuracy of consumption estimates.

Another potential limitation relates to the use of different dietary intake measurement methods that agree less with each other. Some methods also relied on respondents' memory and skills of the interviewer. This may have resulted in under-and/or over-reporting of consumption estimates. By entering this into the multivariable models, the review has taken some account of the nature of the measurements in the analyses.

It is also widely known that FV consumption display seasonal variability, including in SSA (Amo-Adjei & Kumi-Kyereme, 2014; Amoateng et al., 2017; Caswell et al., 2018;), which

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[21] (Anderson et al., 2010; Bourne, Langenhoven, Steyn, Jooste, Nesamvuni, et al., 1994; Caswell et al., 2018; Faber, 1999; Jemmott et al., 2015; Lachat et al., 2013; Maruapula & Chapman-Novakofski, 2008; Ronquest-Ross et al., 2015; Steyn et al., 2001; Steyn et al., 2016; Torheim et al., 2001; Vähätalo et al., 2005).

may limit the comparison of the current findings within and across countries. This is because the different time periods for data collection for the various countries included in this review may have influenced meat, fruit, or vegetable intakes at the time of data collection. For example, if majority of the dietary data used here were gathered during off peak season, resulting consumption estimates would not be representative of consumption in a full year. Although some papers included in this review collected data during the dry season (Caswell et al., 2015; Keding et al., 2017; Nel et al., 2013; Parr et al., 2002), others captured data during the peak season or throughout the year (Amo-Adjei & Kumi-Kyereme, 2014; Amoateng et al., 2017; Ferguson et al., 2016; Steyn et al., 2003). This makes consumption estimates in this review reflective of consumption estimates throughout the year.

3.12.2.6 Policy Implications

The findings of this review have important implications for food and nutrition security, health, and environmental sustainability policies in sub-Saharan Africa. This is because the subregion has the world's highest prevalence of hunger and undernourishment. Coexisting with this is a rapidly increasing prevalence of NR-NCDs. These trends are likely to worsen in the business-as-usual scenario where meat consumption continues to increase as incomes rise in SSA countries as have been observed in this review. Meat production and supply would need to increase to meet increasing demand. This will mean the emission of more GHGs to increase climate change and catastrophic weather events which impairs agricultural production and contributes to food insecurity and undernutrition in LICs. GHG emissions from livestock production in SSA and other LICs has increased by 117% between 1961 and 2010 compared to a 9% global average increase and a 23% decrease in HICs (Caro et al., 2014). In addition to the adverse environmental footprints of meat production including biodiversity loss, land and water degradation, and deforestation, about 36% of global crop calories (especially from grains) is fed to livestock and only 12% return as food for people (Cassidy et al., 2013). The latter increases demand for grain and drives up grain prices making it difficult for the poor in especially SSA to feed. This traverses the 2030 Sustainable Development agenda and makes the achievement of the SDGs and targets to eradicate hunger and ensure access to safe, nutritious, and adequate food for all to end malnutrition of all forms problematic. It also makes the achievement of sustainable food production systems bleak, in addition to knock-on effects on goals to ensure healthy lives for all, reduce premature mortality and to end poverty of all forms.

Apart from the need for the adoption of more efficient livestock production methods in SSA, climate change, health and well-being need to be properly integrated in livestock production systems along with other agricultural practices in the sub-region. There is the need for the promotion of both the adequate supply and demand (including the production, access to and consumption) of plant-based protein and micronutrients including nuts, seeds, and legumes in SSA countries. While dietary changes in SSA may offer large absolute health and environmental benefits, consideration of the magnitude of dietary change, particularly reducing or increasing the consumption of meat or other animal protein, will need to occur to ensure reduction of under-nutrition and micronutrient deficiencies without worsening NCD prevalence and environmental impacts. There is also the need for public health promotion as part of multi-component interventions to educate SSA populations about standard nutrition guidelines (including recommended portion sizes) and the health risks and environmental impacts of food consumption behaviours. This is to ensure that as disposable incomes increase and countries' economic development rise, SSA populations do not continue to increase their meat intake as seen in most countries undergoing economic transformation. The EAT-Lancet Commission's planetary health diet may be a good starting point. The Commission recommends a flexitarian diet that does not completely eliminate meat and dairy but recommends a larger proportion of plant-based protein portions (Willett et al., 2019). In Africa, however, the guideline calls for reduction in the consumption of starchy vegetables like cassava and taro, which the sensitivity analyses (model 4) indicate make up a larger proportion of vegetable consumption in richer SSA countries and in urban populations. Given that starchy vegetables are important staple foods in most SSA countries, it might be recommendable retaining them as part of healthy diet of developing and urbanizing countries. While low starchy vegetable diets would fit the EAT-Lancet Commission's flexitarian dietary regime retaining a place in a healthy diet of developing and urbanizing countries may deserve more attention. The flexitarian diet promises to save 11 million lives each year and ensure availability of safe, nutritious, and affordable food for all 10 billion global population expected by 2050, without causing damage to the environment.

Across the sub-region, the most popular policy interventions have been catchall health promotion interventions that have sought to educate on the health benefits of FV or good nutrition with little or no attention to environmental sustainability and climate change mitigation (Amoateng et al., 2017; Darfour-Oduro et al., 2018; Carl Lachat et al., 2013).

Though there has been some improvement over the years through health promotion interventions (Amoateng et al., 2017; Darfour-Oduro et al., 2018), consumption of FV is still unpopular in the sub-region. Of the 28 LMICs that have policies to promote FV consumption, only 5 include strategies to meet WHO's recommended daily intake for FV. This underscores the need for innovative and evidence-based policy interventions that are tailored to various socioeconomic and demographic sub-groups.

Further research to better understand and update knowledge on the attitudes and perceptions of SSA populations towards meat consumption is therefore recommended in order to inform policy. Research to understand how personal health, body image/weight, animal welfare and environmental sustainability concerns influence these attitudes will also shed more light on the direction of future policy and interventions. Research on individuals' willingness to reduce starchy staples or increase/reduce meat consumption as well as increasing FV is also recommended. Finally, research towards standardized definitions for meat, fruit or vegetable is highly recommended to facilitate uniformity and consistency in research reporting and allow more realistic cross-regional comparison.

3.13 Conclusion

Given the low intake of plant-based foods it is likely that SSA populations may be deficient in high quality protein and micronutrient as suggested by the EAT-lancet commission. There is the need for promoting both the adequate supply and demand of plant-based protein and micronutrients including fruit, vegetables, nuts, seeds, and legumes in SSA countries. While dietary changes in SSA may offer large absolute benefits, consideration of the magnitude of dietary change, particularly increasing or reducing meat consumption, will need to occur in a way that ensures that policy and interventions support the reduction of under-nutrition and micronutrient deficiencies without worsening NCD prevalence and environmental impacts. There is also the need for preventive action that ensures that SSA populations do not increase their meat consumption as disposable incomes increase and countries' economic development rise as seen in most countries undergoing economic transformation.

CHAPTER FOUR

CONSUMPTION OF ULTRA-PROCESSED FOODS IN SUB-SAHARAN AFRICA: A SYSTEMATIC NARRATIVE REVIEW.

4.1 Chapter summary

Background: The food environment in SSA is said to have seen changes in recent decades resulting in increased availability and consumption of UPFs, partly blamed for the on-going nutrition and epidemiologic transitions in the sub-region. Secular trends in consumption over the years, population subgroup variations in consumption, and its relationship with health and nutritional outcomes in SSA populations are unclear.

Scope and approach: Six databases were systematically searched to synthesise evidence from studies reporting UPFs consumption over the years, the contribution to nutrition outcomes, and the association between UPFs consumption and health outcomes in SSA populations. A narrative approach was adopted to data synthesis using Microsoft Excel.

Key findings: There is limited research focusing on the assessment of UPFs consumption only, either in terms of amount consumed or frequency of consumption in SSA populations. Studies included in this review were based on data collected between 1975 and 2018, with SSBs being the most researched ultra-processed food category. Nearly a quarter of research focused on South Africa. UPFs consumption is positively associated with obesity/overweight in SSA populations based on findings from the eight studies that assessed this association. While these studies shed some light on the relationship between UPFs consumption and health or nutritional outcomes in SSA populations, it also reveals that there is limited research assessing this association, the data appears patchy, and the association may thus be inconclusive.

Conclusion: More research assessing ultra-processed food consumption as well as research assessing the association between UPF (only) consumption and health outcomes are required to isolate the effect of UPF consumption on obesity/overweight, hypertension, and other health outcomes in SSA populations.

4.2 Introduction

In this chapter, the thesis synthesises existing research evidence aimed at a more wholistic view of the trends in the consumption of UPFs, another important food group reported to be contributing to the on-going nutrition and epidemiologic transitions in the sub-region, to build on findings in Chapter 3. Evidence of the environmental impacts of UPF consumption (including GHG emissions, water overconsumption and pollution, solid waste generation/plastic pollution, and environmental impacts of disposal, etc.) are dire as have been presented in Chapter 2.

Despite the dire implications of UPFs consumption for SSA, research evidence around UPFs consumption in SSA is limited and fragmented, lacking an integrated overview that could guide future research and policy actions. For example, only one (Costa et al., 2018) of four recent systematic reviews (Chen et al., 2020; Costa et al., 2018; Lane et al., 2021; Pagliai et al., 2021) of evidence on UPFs consumption and its association with health and/or nutrition outcomes have included a study (Feeley et al., 2013) from SSA, specifically South Africa. Given the importance of the theme in understating the trends of food consumption in SSA, the work in this chapter addresses this gap by identifying and synthesising research evidence on UPFs consumption in the sub-region and/or its association with health and nutrition outcomes in SSA populations.

4.3 Review Questions

This review set out to answer the following questions:

1. How has UPFs consumption in SSA changed over time?
2. How much UPFs is being consumed in SSA?
3. Which SSA populations are consuming UPFs the most?
4. What is the link between UPFs consumption and health/nutritional outcomes in SSA populations?

4.4 Searches and eligibility criteria

MEDLINE, Embase, Google/Google Scholar, ASSIA, CINAHL, and Web of Science databases were searched for papers published in the English language or other languages if at least, the title and abstract are published in the English language. Research should have been conducted in SSA to be considered for inclusion. No publication date and study-participant-age restrictions were applied.

The following terms were used for an initial scoping search: ultra-processed food; processed food; consumption/intake; portion size/ serving size; sub-Saharan Africa/SSA; and individual African country names. Additional search terms identified through the scoping search were included in the formal searches of the various databases as shown in Table 4.1.

Table 4.1: Search strategy

Summary of search terms for MEDLINE and EMBASE (countries were searched individually after Pienaar et al. (2011) (Pienaar et al., 2011)**)**
1. sub-Saharan Africa.mp. or exp "Africa South of the Sahara"/ 2. Angola or Benin or Botswana or "Burkina Faso" or Burundi or Cameroon or "Cape Verde" or "Central African Republic" or Chad or Comoros or Congo or "Cote d'Ivoire" or Djibouti or "Equatorial Guinea" or Eritrea or Ethiopia or Gabon or Gambia or Ghana or Guinea or Guinea-Bissau or Kenya or Lesotho or Liberia or Madagascar or Malawi or Mali or Mauritania or Mauritius or Mozambique or Namibia or Niger or Nigeria or Rwanda or "Sao Tome and Principe" or Senegal or Seychelles or "Sierra Leone" or Somalia or "South Africa" or "South Sudan" or Sudan or Eswatini or Swaziland or Tanzania or Togo or Uganda or Zambia or Zimbabwe 3. 1 OR 2 4. ultraprocessed/ or "ultra processed"/ or "ultra-processed"/ or "ready-to-heat"/ or "ready-to-eat"/ or "ready-to-consume"/ 5. fastfood/ or "fast food"/ or fast-food/ or packaged/ or "pre-prepared"/ 6. exp confectionery/ or sweets/ or candy/ or "sweet snack"/ or "sugared snack"/ or "salted snack"/ or biscuit/ or crisps/ or "sweetened beverage"/ or "carbonated drink"/ or "soft drink"/ or exp "ice cream"/ 7. exp burger/ or sausage/ or salami/ or "hot dogs"/ or "frozen pasta"/ or "frozen pizza"/ or noodle/ or "canned fish in oil"/ or 8. 4 OR 5 OR 6 OR 7 9. 3 AND 8 10. consumption/ or intake or EATING/ 11. exp diet/ or portion size/ or serving size/ or frequency/ 12. 10 OR 11 13. 9 AND 12 14. limit to humans

4.4.1 Eligibility criteria

Eligibility criteria for including or excluding a study are summarized in Table 4.3 using an adapted PICOS framework and explained in detail in the following sections.

Types of studies

The review considered all quantitative studies that assessed ultra- processed/processed food consumption in SSA. Study types considered for inclusion are observational studies including cross-sectional studies, case-controls, and longitudinal studies such as cohort studies and panel surveys. Experimental studies that report baseline data were also considered for inclusion. Studies that did not report the outcomes of interest were not included. Papers published from the inception of the selected databases were considered for inclusion. At least, the title and abstract of the research must have been published in the English language and peer-reviewed articles published in academic journals.

Table 4.2: Eligibility criteria

Domain	**Inclusion criteria**	**Exclusion criteria**
Population	Must include generally healthy children, adolescents, or adults	Studies based on patient populations were excluded.
Phenomena of Interest	Must have assessed the consumption of an ultra-processed food (as defined by Monteiro et al. (2013) in the NOVA classification). If a study reported consumption data on a number of food items, one of which was a UPF (as defined by the NOVA food classification), the study was included. Studies reporting fast food consumption were also included.	Papers reporting only consumption of unprocessed, or minimally processed foods were excluded (see Table 1.1).
Context	Study must be conducted in a country or group of countries within the SSA region as defined by the World Bank.	Studies from other geographical regions outside SSA, including Latin America, Europe, Asia, North America, etc.
Outcome	Health and nutrition outcomes	Did not investigate a health or nutritional outcome or

		the Phenomena of interest (UPF consumption above).
Study type	Quantitative peer-reviewed journals or mixed methods studies reporting quantitative data in observational studies (including cross-sectional, longitudinal/cohort, case-control) or experimental studies.	Qualitative studies, Reviews including systematic/scoping reviews, Protocols, theses, case series and case reports were excluded.

4.4.2 Context

The research should have been conducted in a SSA country or group of countries and included participants from the sub-region. The study followed the World Bank definition of sub-Saharan Africa (see: *https://data.worldbank.org/region/sub-saharan-africa*) as outlined in Table 4.1 under Search strategy.

4.4.3 Condition or domain being studied

This review looks at the consumption or intake of ultra-processed food products as defined by the NOVA classification system (Monteiro et al., 2010, 2019).

The review includes the intake of ultra-processed foods and sugared or sweetened drinks which are "industrial formulations manufactured from substances derived from foods or synthesized from other organic sources" (PAHO/WHO, 2015:5). Often these food products have no or very limited amounts of whole foods and are made from five or more ingredients (Monteiro et al., 2010, 2019). A greater proportion of the ingredients are usually additives—bulkers, flavors, sensory enhancers, stabilizers, non-sugar sweeteners, preservatives, hydrogenated oils, gluten, emulsifiers, and anti-caking agents, among others. Ultra-processed foods are usually ready-to-eat or drink or ready-to-heat, highly palatable, and require little or no cooking time or skills. As outlined in Table 4.1, typical examples of such foods include carbonated drinks, sweet or savoury/salty packaged snacks (e.g., crisps); confectionaries such as ice-cream, chocolate and candies; cookies, biscuits, cake mixes; SSBs and energy drinks; French fries; poultry and fish nuggets; sausages, burgers, hot dogs, pre-prepared pies, pasta and pizza dishes; infant formulas and other baby foods; powdered and packaged instant soups, noodles and desserts.

The NOVA system classifies food into four groups based on the kind, degree, and purpose of its processing:

1. Unprocessed or minimally processed foods

2. Processed culinary ingredients

3. Processed foods

4. Ultra-processed foods and drinks (Table 4.1 shows a comprehensive list of examples of UPFs and drinks).

4.4.4 Participants/population

The review included studies that involve children, adolescents, and adults in any setting (rural, peri-urban, and urban). The child, adolescent or adult was as defined by the UNICEF (1989) and the WHO (2016) to respectively include all persons aged between 1 to 10 years, 10 and 19 years inclusive, and 19+ years. Studies in which the participants were patient populations were excluded. Papers with any two or all three age-cohorts as part of their participants were also considered for inclusion. Such studies must have, however, reported disaggregated data for each age cohort. The research participants should have been in a sub-Saharan African country. Multi-country studies must have also reported country-specific information to be considered for inclusion.

4.5 Quality appraisal, Data extraction and synthesis

4.5.1 Risk of bias (quality) assessment

The methodological quality of included studies was assessed using a tool adapted from (Q. A. Louw et al., 2007) and subsequently used in systematic reviews by (Davids & Roman, 2014; Mensah et al., 2020; Roman & Frantz, 2013; Wong et al., 2008). The quality of these studies was assessed by two reviewers working independently.

4.5.2 Study selection, data extraction and synthesis

Studies identified were screened for inclusion using the eligibility criteria. An initial decision for possible inclusion based on titles and abstracts was conducted. Two independent reviewers completed this to exclude personal biases and minimize possible errors. At this stage, studies were only eliminated if eligibility criteria were clearly not met. Where there was uncertainty about a study meeting the inclusion criteria, full texts were obtained for extensive assessment against the criteria. Full texts of all potentially relevant literature selected based on titles and abstracts were retrieved. Two independent reviewers then assessed full texts against the eligibility criteria. Any differences in opinion were resolved by consensus or by a third reviewer. Search results were recorded in Rayyan QCRI. To ensure transparency in the selection process, a flowchart detailing the number of studies at each selection stage is displayed in Figure 4.1.

Following methodological quality appraisal, all studies selected for inclusion (with poor, good or satisfactory ratings) were reviewed. Two independent reviewers extracted data on the various domains (outlined in Box 4.1) from shortlisted studies. Extracted data were organised and presented in descriptive tables (Table 4.4). Due to the heterogeneity and patchy nature of the extracted data, findings were not pooled into a meta-analysis. Data were therefore pooled into a narrative synthesis after Rodgers and colleagues (2006; 2009) to ensure methodological rigor and transparency.

Box 4.1: Domains for data extraction

1. Authors 2. Type of study 3. Date of publication 4. Date or period of data collection 5. Information on study population (e.g. sample size, age cohort, socio-economic indicators) 6. Geographical scope (this will include country and setting (i.e. rural or urban) 7. Variable(s) measured (processed food/ultra-processed food type) 8. Measurement method used 9. Mean (quantity/servings) of ultra-processed food(s) consumed 10. Standard deviation of ultra-processed food(s) intake 11. Standard error of ultra-processed food(s) consumed 12. Frequency of ultra-processed food consumption 13. Proportion of study population/sample consuming ultra-processed food. 14. effect on/association with health and nutritional outcomes.

4.6 Results

MEDLINE, EMBASE, Google Scholar, ASSIA, CINAHL, and Web of Science were searched to retrieve 2988 records reporting UPF consumption in portion size or frequency. After title and abstract screening, 449 were identified as relevant for full-text review. The majority of studies were excluded because they reported nutritional composition or dietary diversity but did not present data on consumption of the amount or frequency of any UPF food. During full text screening 46 studies were identified with an additional 2 papers identified through reference screening. Due to the way that data had been collected and reported in the studies, it was easiest to synthesise papers collecting and reporting data on the portion size (amount) of UPF consumed by study participants separately from those that had collected and reported data on the frequency of UPF consumed by study participants. Splitting up the studies in this way gave 24 studies in each category.

4.6.1 Characteristics of included studies

Of the 24 studies reporting portion sizes, 10 studies evaluated association between consumption of groups of UPFs and health/nutritional outcomes[22]; nine looked at specific UPF item(s) and health/nutritional outcomes[23]; and five focused on dietary patterns including UPF items and nutritional/health outcomes (Frank et al., 2014; Galbete et al., 2017; Holmes et al., 2018; Maruapula & Chapman-Novakofski, 2008; Nkondjock et al., 2010; Sodjinou et al., 2009a; Zeba et al., 2014). The characteristics of included studies reporting portion sizes have been summarized in Table 4.4.

In frequency of consumption studies, only two studies (Adamu et al., 2012; Allain et al., 1997; Venter & Winterbach, 2010) included specific UPF items, one study (Becquey et al., 2010) included food groups and identified dietary patterns, with the remaining studies[24] reporting consumption of food groupings that captured some UPF items among other food types that fit under the various food typologies in the NOVA food classifications system. Table 4.3 shows the characteristics of studies reporting frequency of consumption.

[22] (Amare et al., 2012; Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Charlton et al., 2005, 2008; Maruapula et al., 2011; Mwaniki & Makokha, 2013; Nago et al., 2010; Nkondjock et al., 2010; Oldewage-Theron & Kruger, 2011; Steyn et al., 2006; Vähätalo et al., 2005).

[23] (Asayehu et al., 2017; Kyamuhangire et al., 2013; Maruapula & Chapman-Novakofski, 2008; Ronquest-Ross et al., 2015; Smith et al., 1981; Steyn et al., 2006; Steyn et al., 2003; Theron et al., 2007; Wolmarans et al., 1989).

[24] (Anteneh et al., 2015; Åstrøm & Masalu, 2001; Becquey et al., 2010; Cardoso et al., 2013; Caswell et al., 2015; Fadupin et al., 2014; Feeley et al., 2012, 2016; Feeley & Norris, 2014; Feeley et al., 2013; Feeley et al., 2013; Ferguson et al., 2015; Frank et al., 2014; Kiwanuka et al., 2006; Lateef et al., 2016; Leyvraz et al., 2018; Ogunkunle & Oludele, 2013; Olatona et al., 2018; Pries et al., 2017; Van Zyl et al., 2010).

Figure 4.1: Prisma flow chart

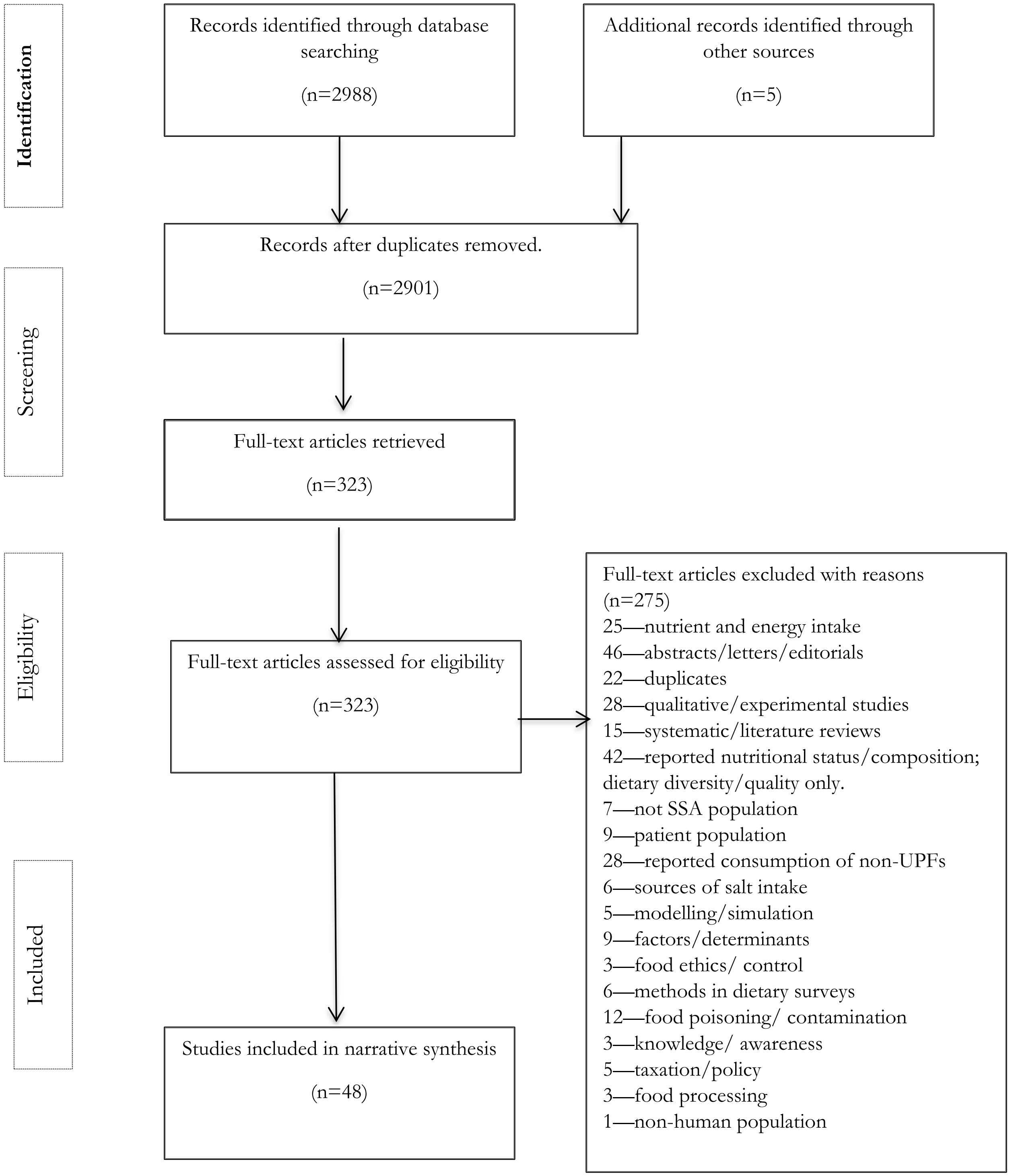


Table 4.3: Characteristics of included studies (reporting portion sizes)

Reference	Country of Study	Date of Data Collection	Design	Study Population/Sample	Age Cohort	Variable(s) of Interest Measured	Author's Definition of Variable(s)	Dietary Assessment Method	Measurement Unit	Setting (Urban, Rural, Combined)	Test of Association/ Health Implication Reported
(Amare et al., 2012)	Ethiopia	2005 in July	Cross-sectional study	356 randomly sampled from Gondar city, Northwest Ethiopia	Adults	Sweets, Yoghurt	No definition reported	24-hour recall and FFQ modified from the Helen Keller International FFQ	Gram per day	Urban	Nutritional status, Energy intake, Waist-to-hip ratio: **Nutritional status**: A significantly higher proportion of women were deficient in calcium, thiamin and niacin compared to men while the proportion of inadequate retinol, riboflavin and ascorbic acid intakes were similar between the two sexes. **Energy intake**: Mean energy intakes was significantly higher in men participants (3001 vs 2510 kcal/day, P = 0.007). However, the mean energy intake for both men and women was not significantly different from the estimated mean energy requirement (2234 vs 2167, P = 0.3). The mean fat, protein and carbohydrate intake (g/day) was 80, 79 and 320 and their percentage contribution for total energy was 33.0%, 14.1% and 52.9%,

											respectively. **Waist-to-hip ratio**: The correlation coefficients between BMI and the food consumption frequency were significantly positive for meat ($r = 0.36$; $p < 0.01$), egg ($r = 0.177$; $p < 0.01$), vegetables ($r = 0.252$; $p < 0.01$), fruits ($r = 0.263$; $p < 0.01$), sweets ($r = 0.124$; $p < 0.05$) and Milk ($r = 0.217$; $p < 0.01$).
(Anderson et al., 2010)	Senegal	Not Stated	Cross-sectional study	50 healthy Senegalese men, aged 20-62 years recruited at the Hôpital Général de Grand Yoff in Dakar, Senegal and from Sendou village, a rural village outside Dakar	Adults	Cheese, Milk biscuits, Ketchup, Candy.	No definition reported	Single 24H dietary recall. Estimated amount per day consumed	Ounze	Combined	None
Asayehu, Lachat, Henauw, & Gebreyesus (2017)	Ethiopia	02 July to 30 August 2013	Cross-sectional study	164 randomly selected non-pregnant women recruited from a rural subsistence farming community in the Butajira district of southern Ethiopia	Adults	Vegetable oil	No definition reported	Interactive multiple pass 24-h recall survey. Spoons, calibrated utensils, weighing scales were used to estimate portions sizes.	Grams	Rural	**Nutrients and energy intake**: Except for iron, vitamin A and C, intakes of macro and micronutrient were below the recommendations. Almost all study participants were deficient in energy, protein, calcium, folate and niacin intakes.

(Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994)	South Africa	First quarter of 1990	Cross-sectional study	163 stratefied proportional sample of children (93 boys, 70 girls) aged 3 to 6 years in Cape town metropolitan area (Cape Peninsula) drawn from black residential areas in Cape town	Children	Milk group, Fat group	Milk group (Milk, cheese); Fat group (Dripping, saturated animal fat, Brick margarine, Oil, Tub margarine)	24h dietary recall. Simple dietary kit was used to quantify food items.	Number of portions	Combine	**Nutrient and Energy intake**: The macronutrient energy distribution was within prudent dietary guidelines, with 28.1% of energy being obtained from total fat, 63.7% from carbohydrate and 13.2% from protein.
(Charlton et al., 2005)	South Africa	Not reported	Cross-sectional study	110 Blacks, 112 Mixed ancestry and 103 White ethnic group out of 325 men and women aged 20 to 65 years recruited from their place of work, the Cape Town City Council offices in central Cape Town, South Africa	Adults	Beef sausage—boerewors; Chicken, Steak and kidney pie (commercial); Soup powder (reconstituted); Savoury snacks; Margarine; Polony; Salami; Sausage/ Sausage rolls; French fries; Crisps; Popcorn; Sausage; Canned Soups; Aromat; Baked beans; Crackers;	No definition reported	24-h dietary recalls	Grams per day	Urban (Blacks, mixed ancestry and whites)	**Sodium intake**: Between 33% and 46% of total Na intake was discretionary, and, of the non-discretionary sources, bread was the single greatest contributor to Na intake in all groups.

						Pizza; Breakfast cereals.					
(Charlton et al., 2008)	South Africa	Not reported	Cross-sectional study	324 conveniently sampled men and women aged 20–65 years recruited from their workplace at the Cape Town City Council offices using stratified convenience sampling.	Adults	Breakfast cereal, crackers, cookies, biscuits, cake, pizza, crisps, sausage, salami, burger, milk/ malted drinks, french fries, ice cream, salad dressing/ mayonnaise, cheese, yoghurt, margarine, Biltong, Gravy stock/ powder	1. **Breakfast cereal (processed)**: cornflakes/rice crispies/all bran/hi-bulk fibre bran/Pro Nutro/frosties/puffed corn/Special K. 2. **Crackers**: ProVita/crackers/rye bread and crispbread/matzos. 3. **Potato crisps**: Potato crisps/Niknaks/Chipkins **4. Commercial pie**: Meat or chicken pies, sausage rolls Steak and kidney pie **5. Kentucky fried chicken**: Chicken burger/chicken patties/fried battered chicken (KFC, etc.). **6. Brown gravy powder, reconstituted**: Gravy, made with stock or gravy powder. **7. Cheddar cheese:** Cheese, including	Repeated 24-hour dietary recalls	Grams per day	Urban	**Sodium intake**: all foods included in questionnaire contained at least 50mg Na per serving.

							processed cheese, feta, cottage. 8. **Yoghurt**: Low-fat sweetened 9. **Margarines**, all types, butter, Butro, Brick margarine				
(Galbete et al., 2017)	Ghana	Not reported	Cross-sectional study	946 Rural adults aged 18+ randomly recruited from Ashanti Region of Ghana. 1619 Adults aged 18+ years living in urban Ghana (Kumasi and Obuasi in the Ashanti region of Ghana).	Adults	Margarine, Condiments, Sweets and Cake	**Margarine**: Regular margarine and fat-reduced margarine. **Condiments**: Ketchup, mayonnaise, crème fraiche, salad cream, sour cream, remoulade, and sauces **Sweets and Cake**: Tart, pie, yeast cake, pastry, sponge cake, cream pie, cheesecake, cookies, chocolate, sweets, candy, and toffee	Food Propensity Questionnaire	Grams per day	Rural	**Socio-demographic factors**: The 'rice, pasta, meat, and fish' pattern was associated with male sex, younger age, higher education, and urban Ghanaian environment.
(Holmes et al., 2018)	Uganda, Tanzania, South Africa	2011	Cross-sectional study	Total of 738 including Teachers recruited in Tanzania and South Africa, and nurses in Nigeria. The two Ugandan sites were defined	Adults	Yoghurt, Cheese and other, Soda, Diet soda, Cold cuts, Dressing, Sweets,	No definition stated	Questionnaire including FFQ	Number of servings per day	Rural, Peri-urban, Urban	**Obesity**: Women in the highest tertile of the Processed Diet pattern (characterized by high intakes of salad dressing, cold cuts and sweets) score were 3·00 times more likely to be overweight (95% CI

				geographically; we recruited residents from one rural site and one peri-urban site.		Chips, Spread, Margarine					1·66, 5·45; prevalence=74 %) and 4·24 times more likely to be obese (95% CI 2·23, 8·05; prevalence=44 %) than women in this pattern's lowest tertile (both P<0·0001; prevalence=47 and 14 %, respectively). Men in the highest tertile of intake of the Processed Diet pattern had 2·08 times the odds of being overweight (95% CI 1·07, 4·02; prevalence= 45 %) and 3·59 times the odds of being obese (95% CI 1·20, 10·71; prevalence=20 %) than men in the lowest tertile (linear trend P<0·001 for both associations; prevalence=29 and 5% respectively).
(Kyamuhangire et al., 2013)	Uganda	2008	Cross-sectional study	510 children 24 to 59 months of age and 957 women of reproductive age	Adults	Vegetable oil	No definition reported	Multiple-pass 24-hour recall	Grams per day	Kampala	Nutrient adequacy

(Maruapula & Chapman-Novakofski, 2008)	Bostwama	2003	Cross-sectional study	99 elderly (67%female, 33% males), aged 60-95 years, recruited through purposive sampling	Adults	Soda	No definition reported	24-hour recall	Number of servings	Urban	Healthy Eating Index (HEI)
(Maruapula et al., 2011)	Botswana	Not reported	Nationwide cross-sectional survey	704 students with mean age of 14.9 (SD 1.36) years, with 272 boys (38.6%) and 432 girls (61.4%).	adolescents	Savoury snacks, Sweet snacks, Fizzy drinks	No definition reported	self-recorded recall of food intake for the previous day using a survey form	Servings per day	Urban, Rural	**Overweight/Obesity**: Overweight /Obesity is associated with greater SES, city residence and a snack-food diet pattern. The odds of OW/OB were increased 1.16-fold with a snack-food diet, a result that was diminished when controlled for SES.
(Mwaniki & Makokha, 2013)	Kenya	November 2009 and February 2010	Cross-sectional study	208 students aged 4-11years of both gender randomly selected from four public primary schools in Dagoretti Division in Kenya.	Children	Spread	Spread was defined to include margarine, butter and fruit jam.	24-hour recall. Amounts of foods/meals served were approximated using standard cups, plates and measuring jug	Grams per day	Urban	The proportion of stunted and underweight children was inversely and significantly ($p<0.05$) correlated with children's energy intake, variety of foods, vaccination rate for both girls and boys and washing hands with soap.

(Nago et al., 2010)	Benin	Jan to May 2007	Cross-sectional study	656 adolescents aged 13 to 19 years recruited from 12 secondary schools in Cotonou.	Adolescents	Sweet foods, Other beverages, and Condiments.	Sweet foods are energy-dense foods such as sweet beverages, candies and chocolate. Condiments were captured as Miscellaneous considered as foods used in small quantities.	24 h dietary recall repeated on two non-consecutive schooldays.	Gram per day	Urban	**Energy and micronutrient intake**: Out-of-home prepared foods contributed more than 40% of the daily energy, fat, protein, carbohydrate and fibre intakes and of the daily weight of food in the adolescents.
(Nkondjock et al., 2010)	Cameroon	2008	Cross-sectional study	571 members of defence forces aged 21–59 years receuited from eight military institutions in Yaounde, Cameroon.	Adults	Sweets, candies, oils and fats, Cakes and cookies; and soft drinks	Sweets: Candies, chocolate. Oils and fats: Oils used in cooking, butter, margarine, mayonnaise, salad dressing. Cakes and cookies: Cakes, cookies. Soft drinks: Soft drinks	Self-administered validated food frequency questionnaire (FFQ). The FFQ focused on the 1-year period before interview.	Gram per day	Urban	**Hypertension**: After adjustment for age, body mass index, rank, vigorous physical activity and total energy intake, no significant relationship was apparent between the meat pattern (reflecting elevated bush meat, poultry and red meat consumption, with reduced intake of sweets, cakes and sugar) and hypertension.
(Oldewage-Theron & Kruger 2011)	South Africa	Not reported	Cross-sectional study	357 randomly selected households (28% of the total households) in an informal settlement.	Adults	Cold drinks/squash	Cold drinks/squash	1-wk quantified food frequency questionnaire (QFFQ) and 24 hour recalls	Gram per day	Peri-urban informal settlement	None
(C. Ronquest-Ross et al., 2015)	South Africa	1999	Secondary data analysis	Euromonitor International Passport databases	Combined	Milk drinks/products (Flavoured milk drinks, Flavoured powdered	Flavoured milk drinks, Flavoured powdered milk, Soy beverage	Euromonitor International Passport packaged food data are a consensus of	Kilogram/capita per annum	Combined	None

						milk, Powdered milk, Soy beverage), Yoghurt and sour Milk, Cheese, Margarine, Vegetable oil		opinions based on data gathered from trade sources, national statistics and secondary sources.			
(V. E. Smith et al., 1981)	Sierra Leone	1974 to 1975	Cross-sectional study	500 households randomly selected	Adults	Beverage	No definition reported	No reported	Kilogram per annum	Rural	None
(Sodjinou et al., 2009a)	Benin	2003	Cross-sectional study	200 men and women aged 25–60 years was randomly selected in 10 neighbourhoods	Adults	Soft drinks, Sweets, Vegetable oil	No definition reported	3 non-consecutive 24-hour food recalls. Local cups, bowls, spoons, plates and glasses commonly used in the study area served as visual aids to increase the accuracy of portion size estimations.	Gram per day	Transitional cluster	**Diet quality and socio-demographics**: Compared with the 'traditional diet', the 'transitional diet' was associated with a slightly but significantly higher percentage of energy from fat (17.6 vs 15.5%), saturated fat (5.9 vs 5.2%) and sugar (6.3 vs 5.0%). The 'transitional diet' also provided significantly more cholesterol (136.6 vs 76.1mgday-1) and less fibre (29.8 vs 34.9 g day_1). The 'transitional diet' was more diversified, but it also showed a lower HS (healthfulness score) than the 'traditional diet'. MAS (micronutrient adequacy score) tended to be higher in the 'transitional diet'

											compared with the traditional type.
(Steyn, Maunder, Tygerberg et al 2006)	South Africa	1999	Cross-sectional study	2818 children aged 12 - 108 months old randomly selected in the National Food Consumption Survey	Children	Margarine, Squash, Carbonated cold drink	No definition reported	24-hour food recall. Dietary aids were used to assist in the determination of portion sizes of foods and drinks consumed	Gram per day	Combined	**Energy, macronutrient and micronutrient intakes**: Maize porridge and bread contributed 27% and 14.8% to total energy, 19.1% and 15.7% to protein and 40% and 17.2% to carbohydrate intake, respectively.
(Steyn, Nel and Casey 2003)	South Africa	Data from the National Food Consumption Survey (NFCS) in 1999 provided primary data on children. Data on adults: from 8 different studies (secondary sources) conducted from 1983 to 2000	National representative survey	Children and adults: 1 to 5 years; 6 to 9 years and 10+ years.	Children (1-5 years)	Vegetable oil	No definition reported	24-hour recall. The NFCS provided a database on dietary intakes of children aged 1–9 years. Data on adults were integrated from eight different studies (one unpublished) undertaken in different provinces and ethnic groups (ref 6–32).	Gram per day	Combined	

(Theron et al., 2007)	South Africa	November 1998	Matched controls	Urban (n= 74) and rural (n= 58) stunted and non-stunted children from two informal settlements in urban Gauteng and two villages in the Limpopo Province.	Children (12-24 months)	Cold drink, carbonated, Maltabella, Ice cream, Bread/rolls (white), Vetkoek (fat cake), creamer	No definition reported	Quantitative FFQ	Gram per day	Urban informal settleme nt and rural	Nutrient intake and stunting
(Vahatalo, Mikkila, Rasanen 2005)	Namibia	September and October in 2002, during the dry season	Cross-sectional study	43 town children and 10 Rrual children aged 8 to 15 years of age	Children	Fat cake, Margarine, Sugared Beverages, Jam and sweet spreads	No definition reported	24-hour recall interviews. Local dishware, food photographs, and food models were used as aids for estimating food quantities.	Gram per day	Urban	**Energy intake**: The mean intakes of energy were 6.7 MJ/day for children living in town and 4.7 MJ/day for rural subjects. The intakes of vitamin A, vitamin C and folate were inadequate in both groups.
(Wolmarans et al., 1989)	South Africa	1979	Cross-sectional	15% subsample of participants in the CORIS study baseline survey (n=1113, 454 males and 659 females, 15 - 64 years old) of the white population in Robertson, Swellendam and Riversdale districts.	Adults	Confectionery	No definition reported	24-hour recalls	Grams per week	Urban	Dietary fat/cholesterol

(Zeba et al., 2014)	Burkina faso	2010	Cross-sectional study	330 subjects aged 25–60 years	Adults	Local sweetened juices, soft drinks	No definition reported	Two non-consecutive 24 h recalls	g/4184 kJ (1000 kcal))	Combined	The ‘urban’ cluster exhibited a higher intake of fat and sugar, whereas a higher intake of plant protein, complex carbohydrate and fibre was observed in the ‘traditional’ pattern.

The 24 included studies reporting portion sizes covered 21 SSA countries, including one multi-country study. Out of these, the highest number of studies (10)[25] were conducted in South Africa followed by Ghana (Frank et al., 2014; Galbete et al., 2017; Premji et al., 2008) and Ethiopia (Asayehu et al., 2017; Holmes et al., 2018; Premji et al., 2008) being captured in three (3) studies each. There were two studies each from Benin, Burkina Faso, Cameroon, Kenya, and Uganda, with one study capturing Tanzania (see Table 4.3).

The studies reporting frequency of consumption covered 16 SSA countries. South Africa was the most studied country being the focus of seven (7) of the studies (Feeley et al., 2012, 2016; Feeley & Norris, 2014; Feeley et al., 2013; Steyn et al., 2011; Van Zyl et al., 2010; Venter & Winterbach, 2010). This was followed by Nigeria with four (4) studies (Fadupin et al., 2014; Lateef et al., 2016; Ogunkunle & Oludele, 2013; Olatona et al., 2018) . Ghana (Adamu et al., 2012; Frank et al., 2014) and Seychelles (Cardoso et al., 2013; Leyvraz et al., 2018) were covered in two (2) studies each with Malawi, Senegal, Burkina Faso, Benin, Guinea, Mozambique, Uganda, Zambia, Tanzania, Ethiopia, Kenya, and Zimbabwe covered in one study each. This includes one multi-country studies.

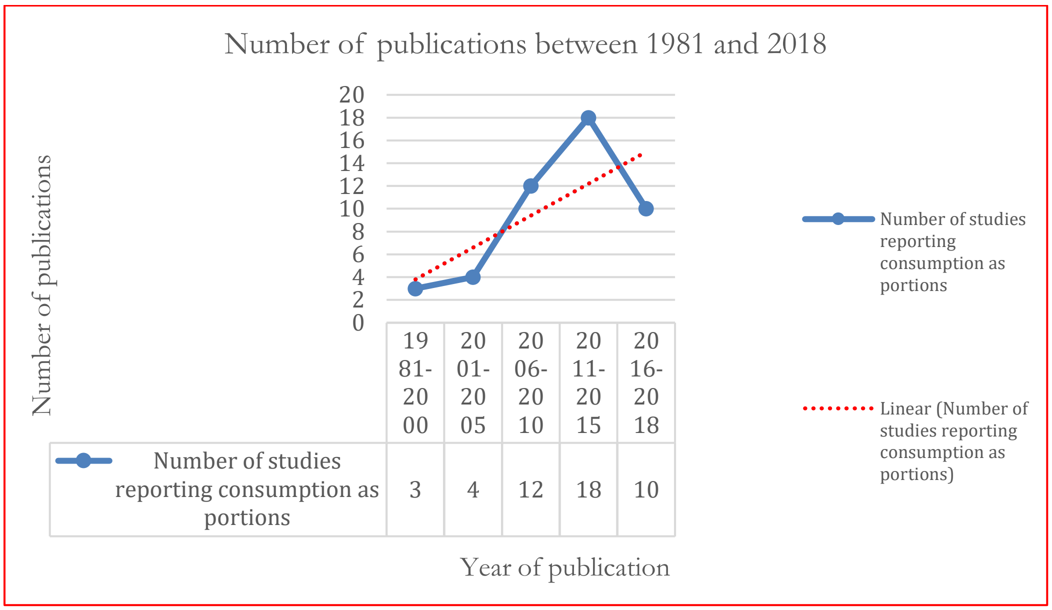
Just over twenty-one percent (10 (21.74%)) of the 46 studies (covering only one country) were conducted in lower income countries, 18(39.13%) in lower-middle income countries, 17 (36.96%) in upper-middle-income countries and 1 (2.17%) in high income countries based on World Bank country income classifications for the 2019 fiscal year (The World Bank, 2018). Two studies (Holmes et al., 2018; Leyvraz et al., 2018) included two or more countries that cut across World Bank country income classes.

[25] (Bourne et al., 1994; Charlton et al., 2005, 2008; Holmes et al., 2018; Oldewage-Theron & Kruger, 2011; Ronquest-Ross et al., 2015; Steyn et al., 2006; Steyn et al., 2003).

The studies included in this review were published between 1981 and 2018. Date of data collection for these publications span from 1975 and 2015. However, 13 studies[26] did not report this data.

A secular trend analysis (bibliometrics) of the number of publications over the years appears to indicate research on UPF consumption in SSA may have reached its highest between 2011 and 2015, with relatively more recent publications reporting UPF consumption as frequency of consumption than as portion size (Figure 2). The lines of best fit (trendlines) indicate a sharp growth in UPF-related research in SSA since the early 1980's, which may perpetuate into the near future.

Figure 4.2: Number of publications between 1981 and 2018



24 studies (reporting portion size) reported the consumption of various UPFs based on the NOVA Classification system (Monteiro et al., 2019; Monteiro et al., 2010). Of the 24 studies, (8) 33.33% included children only population, (15) 62.50% looked at adults only

[26] (Adamu et al., 2012; Anderson et al., 2010; Anteneh et al., 2015; Charlton et al., 2005, 2008; Fadupin et al., 2014; Galbete et al., 2017; Lateef et al., 2016; Ogunkunle & Oludele, 2013; Olatona et al., 2018; Oldewage-Theron & Kruger, 2011; Van Zyl et al., 2010; Venter & Winterbach, 2010).

and (1) 4.17% studied both children and adults. Out of the 23 studies reporting frequency of consumption, the majority (12, 50.00%) were conducted among adults whilst those conducted among children and adolescents represented (6) 25% respectively.

4.6.2 Study design

Most of the studies reporting portion size[27] were cross-sectional (n= 19); followed by analysis of FAOSTAT data and data synthesis (n= 2)(Ronquest-Ross et al., 2015; Steyn et al., 2003) and a pair-matched control (Theron et al., 2007). The sample size ranged from 49 to 2818, with nine (9) studies using sample sizes more than 500 participants, although one study (Ronquest-Ross et al., 2015) did not report this data.

Nearly all studies (21) conducted on the frequency of UPF intakes adopted the cross-sectional study design[28], this was followed by, longitudinal studies (2) (Cardoso et al., 2013; Frank et al., 2014) and an experimental study (Caswell et al., 2015). The least sample size used was 100 and the highest was 3287. Thirteen studies included more than 500 participants.

[27] (Amare et al., 2012; Anderson et al., 2010; Asayehu et al., 2017b; Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Charlton et al., 2005, 2008; Galbete et al., 2017c; Holmes et al., 2018; Kyamuhangire et al., 2013; Maruapula et al., 2011; Mwaniki & Makokha, 2013; Nago et al., 2010c; Nkondjock & Bizome, 2010b; Oldewage-Theron & Kruger, 2011; Smith et al., 1981; Sodjinou et al., 2009a; Steyn et al., 2006; Vähätalo et al., 2005b; Zeba et al., 2014).

[28] (Adamu et al., 2012; Allain et al., 1997; Ansa et al., 2008; Anteneh et al., 2015; Åstrøm & Masalu, 2001; Becquey et al., 2010; Fadupin et al., 2014; A. Feeley et al., 2012, 2016; A B Feeley & Norris, 2014; Alison B Feeley et al., 2013; Ferguson et al., 2015; Hansen et al., 2011; Kiwanuka et al., 2006; Lateef et al., 2016; Leyvraz et al., 2018; Ogunkunle & Oludele, 2013; Olatona et al., 2018; Pries et al., 2017; Van Zyl et al., 2010; Venter & Winterbach, 2010).

Table 4.4: Characteristics of included studies reporting frequency of consumption

Author(s)/ year	Country of study	Date of Data Collection	Age cohort	Study Population/Sample	Study Design	Variable(s) of Interest Reported (Meat/ Fruit/ Vegetable)	Author's definition of variable(s) reported	Dietary Assessment Method (FFQ/24H Recall/FBS/Portion Size)	Setting (Urban, Rural, Combined, etc.)	Reported Health Implications/ Associations
Adamu et al., 2012	Ghana	Not reported	Children	100 (children) participants were randomly selected from class 4, 5 and 6 in five basic schools in the Tamale Metropolis in the Northern region of Ghana.	Cross-sectional study	Drinks, Ice cream, Biscuits	No definition reported	FFQ (over two weeks period)	Urban	79% had normal BMI. 7% had risk of overweight. 4% were overweight and 10% were underweight.
Allain et al., 1997	Zimbabwe	October 1994 and March 1995.	Adults	278 adults (154 women, 174 rural), aged >60 years (range 60-92), living at home randomly recruited from within a rural district innorth-eastern Zimbabwe called Uzumba-Maramha-Pfungwe and in high-density residential areas in Bindura(population 21 167) and Marondera.	Cross-sectional survey	Fried foods, Margarine, Bread	No definition reported	FFQ	Urban, Rural	BMI, SFT (subscapular skinfold thickness (SFT)) and WHR all related significantly to the frequency of eating meat and fried food and BMI was significantly higher in those with more years of education ($r = 0.16$, $P < 0.01$).
Anteneh et al., 2015	Ethiopia	01 June 2014	Adults	681 adult residents (aged 30 years or more) of Bahir Dar city using multistage sampling techniques.	Cross-sectional study	Sweets	No definition reported	Questionnaire adapted from WHO STEP wise approach	Urban	74% had normal weight, 15.3% were overweight, 2.9% were overweight and 5.5% were underweight. Out of underweight participants, 4 had hypertension, 33 did not have hypertension. Out of Normal weight participants, 100 had

										hypertension and 402 were not hypertensive. Out of overweight participants, 48 had hypertension and 56 did not have. Out of Obese participants, 11 had hypertension and 9 did not have hypertension.
Åstrøm & Masalu 2001	Tanzania	May to July 1999; and March to May 2001	Adults	635 adult university students recruited in 1999 from the Muhimbili University College of Health Sciences (MUCHS) at the University of Dar es Salaam (UDSM) in Dar es Salaam, Tanzania.	Cross-sectional survey	Chocolate/candy, Soft drinks	No definition reported	Self-completion questionnaire	Urban, rural	None
Cardoso, Bovet et al., 2013	Seychelles	1989, 2004, 2011	Adults	Analysis was based on adult participants aged 25–44 years: 493 subjects in 1989, 599 in 2004 and 471 in 2011	Longitudinal cohort study	Processed meat, Salty snacks, Commercial juice, Soft drinks, Sweet snacks	No definition reported	FFQ	National	On bivariate analysis, obese participants consumed less rice, snacks (sweet and salty) and soft drinks than nonobese, but this difference was no longer significant after adjusting for gender and age.
Caswell, Talegawkar, et al., 2015	Zambia	August to September 2012	Children	938 children aged 4 to 8 years recruited by a census of all households accessible by vehicle in Mkushi, a rural district in central Zambia	Part of a large-scale cluster randomized trial	Sweet snack, fritter/donut	No definition reported	Tablet-based 24-hour recall.	Rural	The median energy intake over the previous 24 hours was 6146 kJ (1469 kcal).
Fadupin, Ogunkunle et al., 2014	Nigeria	Not reported	Adults	376 adult students (age 17-26 years) of the University of Ibadan, Nigeria	Cross sectional survey	Alcoholic wine, Beer, Spirits, Beverages, Energy drinks,	**Sugar-sweetened beverages:** were defined as all sodas, soft & carbonated,	FFQ	Urban	BMI (Underweight, Normal weight, Obesity)

						Malt drinks; Soft, Carbonated & Soda drink	fruit drinks, energy drinks, low-calorie drinks, non-alcoholic wines/malt and cocoa beverages.			
Feeley & Norris 2014	South Africa	1989	Adolescents	1451 adolescent participants aged 17 to 18 years residing in Soweto in the longitudinal birth cohort study, the Birth to Twenty (Bt20) Plus cohort, started in 1989.	Part of a longitudinal birth cohort study	Confectionery; Sweetened beverages/ Carbonated/Soft drinks, sweets, fruit juice, cakes, chocolate, ice cream, squash, crisps, popcorn	No definition reported	Interviewer-assisted Questionnaire	Urban	Sugar, Dietary salt/sodium intake
Feeley, Coly et al., 2016	Senegal	Between April and June 2014	Children	293 mothers of children (12 to 17 months) attending child health clinics in Dakar	Cross-sectional study	Breastmilk substitutes (infant formula, follow-up formula, and growing-up milks); Commercially produced complementary food (infant cereal, puree, infant snacks); Commercially produced snacks (savory snacks/chips, sweet biscuits/cookies, candy/sweets/chocolate, cake/doughnuts, soft drinks)	No definition reported	Standardized questionnaires	Urban	None

Feeley, Musenge et al., 2012	South Africa	1990	Adolescents	1451 adolescent participants (49.1% male, 89% black, and 11% with mixed ancestry) at ages 13, 15, and 17 y old of the Bt20 cohort study which started in 1990.	Longitudinal birth cohort study)	Fast food, Confectionery and beverages: Chocolate; Sweets; Fried chips; Fried fish; Vetkoek; Bwors; Chicken burger; Hamburger; Hot dog; Pizza; Samoosa; Crisps; Diet drink; Ice cream; Soft drinks; Squash; Cake; Doughnuts	No definition reported	Questionnaire	Urban	None
Feeley, Musenge, Pettifor and Norris 2013	South Africa	2002	Adolescents	1298 adolescents (Males n 645, Female n 653) of the Bt20 cohort, which started in 1989 in the Soweto-Johannesburg municipality	Longitudinal cohort study data	Confectionery; Sweetened beverages	**Confectionery items** (sweets, chocolate, doughnuts, crisps, ice cream and cake); **Sweetened beverages** (soft drinks and squash/cordials)	Interviewer-assisted questionnaires on dietary behaviours	Urban	Longitudinal soft drink consumption was positively associated with both increased BMI Z-score and fat mass in males only (P<0.05).
Feeley, Musenge, Pettifor and Norris et al., 2016	South Africa	Between April and June 1990	Adolescents	1298 adolescents aged 13, 15 and 17 years (49.7% male) in the Bt20 cohort study which started in 1989 in Soweto-Johannesburg	Longitudinal cohort study data	Fast-food consumption, confectionery consumption and sweetened beverage consumption	Fast-food items (e.g. fried chips, vetkoek (fried dough balls), pies, fried fish, boerewors (a local sausage), hot dogs, hamburger, pizza, samosa, chicken burger, filled pita), confectionery items (sweets, chocolate, doughnuts, crisps, ice cream and cake) and sweetened beverages	Interviewer-assisted questionnaires on dietary behaviours	Urban	

							(soft drinks and squash/cordials)			
Frank, Kroger et al., 2014	Ghana	Between August 2007 and June 2008	Adults	679 adult controls were recruited from the outpatient department and among hospital staff	Longitudinal study	Soft drinks, sweets, vegetable oil, milo, margarine	No definition reported	locally specific FFQ (number of servings per week)	Urban	**Type 2 diabetes**: The 'purchase' dietary pattern (characterised by high intakes of sweets, rice, meat, FV) was inversely associated with type 2 diabetes (OR per 1 SD 0·41, 95% CI 0·33, 0·50); the 'traditional' dietary pattern (characterised by high intakes of fruits, plantain, green leafy vegetables, fish, fermented maize products and palm oil) increased the odds of diabetes per 1 SD by 54% (95% CI 1·35, 1·81).
Hansen et al., 2011	Kenya	August–November 2005	Adults	1163 (61% women) adults in rural Kenya Luo, Kamba and Maasai, with a mean age of 38.6 (range: 18–68) years	Cross-sectional	Sugar and sugary products, soft drinks, snacks	Meals and snacks were defined in terms of size (number of items or amount) of the meal or snack allowing an intake of three meals per	24-hour recall	Rural	Rates of underweight, overweight and obesity

							day comprising breakfast, lunch and dinner. Other food intakes were recorded as snacks.			
Kiwanuka, Astrøm, Trovik, 2006	Uganda	January to March 2004	Children	614 randomly selected school children (mean age 12.4) in Kampala.	Cross-sectional study	cakes/biscuits, chocolate, ice sticks, soft drinks, coffee, tea, sugared desserts and sweets/ candies	No definition reported	FFQ and Food Behaviour Checklist	Urban	None
Lateef, Njogu et al., 2016	Nigeria	Not reported	Children	515 randomly selected participants (174 male and 343 females) aged 5 to 19 years from 8 public secondary schools in Nigeria	Cross-sectional analytical design	Salad dressing/ mayonnaise; Chocolate drinks; Spaghettis and noodles; Whole Milk/ Milk shakes; Burgers/hot dogs; Butter/Margarine; Ice-cream/frozen yoghurt; Malted drinks; Soda drinks/soft drinks; Biscuits/Doughnuts; Vegetable oil	No definition reported	24-hour recall and FFQ	Urban	150 of 515 participants were underweight, 340 had normal weight, 25 were overweight. Nutritional status for both boys and girls indicated that underweight was (47.7 and 19.8%), overweight was (0.6 and 6.7%), obese was (0 and 0.3%) and normal weight was (51.7 and 73.2%), respectively. Relationship between food consumption and nutritional status of participants was positive but not significant ($r = 0.012$, $p = 0.785$).
Leyvraz, Mizéhoun-	Benin, Guinea, Kenya, Mozaomb	January 2012 and April 2013.	Adults	588 convenience sampled participants aged 25 to 65 years selected from urban areas of Benin, Guinea, Kenya,	Cross-sectional survey	Breakfast cereals, Sweets and pastries; Processed meat;	No definition reported	Questionnaire adapted from World Health Organization	Urban	Women added salt and other salty condiments during cooking more often than men ($p = 0.045$

Adissoda et al., 2018	ique, Seychelles			Mozambique, and Seychelles using three-stage convenience sampling.		Red meat; Milk; Pizza; Savoury snacks; Cheese; Soft drinks		(WHO) instruments		and p = 0.006, respectively) and added salt less often at the table (p = 0.043).
Ogunkunle, Oludele et al., 2013	Nigeria	Not reported	Adolescen ts	302 adolescents between the ages of 10 and 19 years was randomly selected from each of the six schools	Cross-sectional descriptiv e study	Milk and Milk products; Soft drinks, sweets and snacks	No definition reported	Pretested food frequency questionnaire (FFQ) and 24-hour dietary recall	Semi-urban	Consumption of carbohydrates, protein and fats was below the lower-recommended limit in 14.2%, 42% and 3% of the adolescents, respectively. The difference in the proportion of males and females who consumed the recommended intake of carbohydrates, lipids and proteins was not significant (p-value> 0.05). 93% of the adolescents' intake of calcium was below the recommended limit, while 52% reported an intake of iron that was below the recommended limit. The difference in the proportion of females and males who had an inadequate intake of iron was statistically significant (p-value < 0.05).

Olatona, Onabanjo et al., 2018	Nigeria	Not reported	Adults	503 undergraduate students (aged 15 to 41 years) randomly selected from three universities in Lagos state (University of Lagos (UNILAG), Lagos State University (LASU) and Caleb University)	Cross-sectional study	Alcohol; Fruit; Refined grains; Whole grains; Legumes; Margarine; Fish; Meat; Milk; Groundnut oil; Soft drinks; Vegetable	No definition reported	FFQ	Urban	The prevalence of abdominal (central) obesity was 5.0% (1.3% in males and 8.4% in females) based on waist circumference and 20% (12.3%) in males and 26.5% in females) based on the waist-to-hip ratio (WHR). Abdominal obesity was statistically significantly associated with hypertension in this study even though high BMI was not associated with it. ($p < 0001$). Prevalence of abdominal obesity was significantly higher among females compared to males ($p < 0.001$) for both WC and WHR.
Pries, Huffman et al., 2016	Senegal	December 2013 to November 2015.	Children	146 randomly sampled children aged 12 to 23 months through mothers utilizing child health services in Dakar, Senegal	Cross-sectional survey	Commercial infant cereal; Chocolate-based or malt-based; Grain-based foods; Infant formula; Tinned or powered milk; Condensed milk; Soft drinks; Yoghurt or cheese; Commercial snack foods	No definition reported	A precoded list of foods read to mothers, who then reported if their child had or had not consumed these in the previous day	Urban	None

Steyn, Labadarios, Nel 2011	South Africa	2009	Adults	3287 participants aged 16 and older drawn from all ethnic groups, and provinces in South Africa	Cross-sectional survey	Sweets & biscuits; Savoury snacks; Soft drinks	No definition reported	non-quantified 24-hour recall	Nationa l	None
Van Zyl, Steyn & Marais 2010	South Africa	Not reported	Adults	341 adults aged 19 to 30 years who resided in in three different socio-economic areas (SEA) in Johannesburg and South African residents	Cross-sectional study	Fries; Pasta; Fried chicken; Burger; Hot dogs; Pizza; Schwarma; Sushi	No definition reported	An interviewer-administered questionnaire was developed by the researchers	Urban	None
Becque, Savy et al., 2010	Burkina Faso	April/May 2005	Adults	A total of 1072 women and men aged 15 to 65 years randomly selected from an exhaustive list of inhabitants.	Cross-sectional study	Sweetened products, Sweetened drinks	No definition reported	Qualitative FFQ	Urban	Higher intakes of “modern foods” was associated with a higher prevalence of overweight after accounting for confounding factors (OR = 1.19 [95% CI 1.03-1.36]) but there was no relationship between overweight and the “snacking”.
Venter, Winterbach et al., 2010	South Africa	Not reported	Adolescen ts	A random sample of 168 adolescent learners (89% response rate) attending public schools in the Bellville/Durbanville area	Cross-sectional study	Hamburgers or cheeseburgers; Hot dogs, frankfurters, salami, russians, sausage; Cold cuts, lunch meats, ham (with fat), etc.; Salad dressings, mayonnaise;	No defnition reported	Screening questionnaire	Urban	None

4.6.3 Method of dietary data collection

For studies reporting portion sizes, food consumption was assessed using three different methods. Fifteen of the studies[29] used 24-hour recalls; four (Holmes et al., 2018; Nkondjock et al., 2010; Theron et al., 2007) used food frequency questionnaires (FFQs), two (Amare et al., 2012; Oldewage-Theron & Kruger, 2011) applied both 24-hour recall and FFQ; and one study (Galbete et al., 2017) used food propensity questionnaire. One study (Ronquest-Ross et al., 2015) was based on data gathered from trade sources, national statistics and secondary sources. One study (Smith et al., 1981) did not report this data.

In studies reporting frequency, the instrument for data collection for most studies was the FFQ. However, there were slight variations in the type of FFQ used as most of the studies tailored the FFQ to meet the demographic characteristics of their participants. Two studies used a combination of 24-hour recall and FFQ (Lateef et al., 2016; Ogunkunle & Oludele, 2013). One study (Caswell et al., 2015) used a quantified 24-hour recall only whilst another (Steyn et al., 2011) used a non-quantified 24-hour recall. Kiwanuka et al. (2006) used a both an FFQ and a food behaviour checklist.

4.6.4 Ultra-processed foods consumption

Overall, the review shows that the distribution of UPF product intake varied widely between and within countries covered by the studies included. This section summarises the age and gender differences and the rural-urban gradient in consumption of UPFs found in studies conducted in the various SSA countries.

4.6.4.1 Studies reporting portion size

Adults

With the exception of powdered milk and a few others, Ronquest-Ross et al. (2015) reported an increased annual per capita consumption of UPFs in South Africa between

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[29] (Anderson et al., 2010; Asayehu et al., 2017; Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Charlton et al., 2005, 2008; Kyamuhangire et al., 2013; Maruapula et al., 2011; Mwaniki & Makokha, 2013; Nago et al., 2010; Sodjinou et al., 2009a; Steyn et al., 2006; Nelia Patricia Steyn et al., 2003; Vähätalo et al., 2005; Wolmarans et al., 1989; Zeba et al., 2014).

1999 and 2012. The category with the largest consumption increase was 'baked goods' which accounted for 43.0 kg/capita in 2012 (6.4% increase) including sweet/savoury biscuits & crackers (57.1% increase), bread (4.7%), and breakfast cereals (36.4%). The next largest category at 3 kg/capita consumption in 2012 (a 57.9% increase from 1999) was 'sauces, dressings and condiments.' This was followed by the 'frozen processed foods' category at 2.8 kg/capita in 2012 including subcategories like frozen ready meals and frozen pizza. Other UPFs also saw significant growth in consumption, including sweet and savoury snacks (53.3% increase), soft drinks (68.9%), confectionery (13%), dried processed foods/dehydrated soup/noodles (25%), seasoning/spices (100%), margarine (13.6%), spreads (25%), and baby milk formula (50%), flavoured milk drinks (16.7%), sour milk and yorghurt (73.7%) in the dairy category.

Charlton et al. (2005) also found that Black South-Africans, mixed ancestry South Africans and White South-Africans, respectively, consumed 134.6g, 117.7g, 109.8g of bread per day. Breakfast cereal consumption was also highest in White South Africans (165.8g/day) followed by mixed race South-Africans with 101.2g and black South-Africans eating 61.1g/day. Savoury snacks/crisps & chips consumption was highest in whites at 100.5g/day followed by 80.3g/day in black participants, and 76.9g in mixed ancestry South-Africans. In terms of sausage consumption, blacks consumed 150.9g, followed by 131.3g mixed ancestry and 109.9g in white South Africans. Black South-Africans also ate more (181.1g) pizza, steak pies and other commercial processed meat products compared to 159.3g in mixed race and 133.7g/day in whites. Urban Black, Mixed ancestry, and white South African adults respectively consumed 9.2g, 6.4g, 17.2g of margarine/spreads per day. Powdered soups or aromat intake was reported at 92.0g/day in blacks South-Africans only (Charlton et al., 2005)**.**

Urban women in Ethiopia consumed significantly more sweets than men (1.84g ± 2.21g vs 1.16g ± 1.83g, p=0.003) and yoghurt (3.60g ± 2.18g vs 2.42g ± 2.11g, p=0.000) in a day (Amare et al., 2012). Individual income and level of education were both positively associated with sweets (p<0.01) and yoghurt (p<0.01) consumption.

In Ghana, Galbete et al. (2017) found that urban adult residents ate more cakes and sweets than their rural counterparts (≈21g/day vs ≈15g/day, ±≈2) and drank nearly thrice as much soda than rural people (151g/day vs 54g/day, ±2). Urbanites than rural dwellers consumed significantly more processed meat products (≈10.5 vs ≈3.5g/day, ±1.5), but there were no significant rural-urban differences in terms of condiments (≈53g/day vs ≈49.5g/day), sweet spreads (≈0.5g/day vs ≈0.5, ±0.2) and margarine (≈3g/day vs ≈3g/day, ±0.1) intake.

In a multi-site study (Holmes et al., 2018), rural Ugandan men consumed more yoghurt than rural women (0.39 vs 0.00 servings/day) and peri-urban men and women (0.11 vs 0.15 servings/day). However, in the same study, South African women ate more yoghurt than men (0.71 vs 0.39), with a similar gender gradient (0.21 vs 0.14) found in Tanzania (Holmes et al., 2017). Again, rural Ugandan men drank more soda than rural women (0.43 vs 0.03 servings/day) and peri-urban men and women (0.39 vs 0.24 servings/day). A similar gender difference in soda consumption was observed in Tanzania (0.47 vs 0.42), compared to a higher consumption in South African women than men (0.53 vs 0.43). But peri-urban men in Uganda took more diet soda than their women (0.22 vs 0.15 servings/day), and rural men and women (0.19 vs 0.00 servings/day). On the contrary, women drank slightly more diet soda than men in both Tanzania (0.13 vs 0.10 servings/day) and South Africa (0.25 vs 0.19 servings/day). Women consumed more sweets than men in all three other sites, except in rural Uganda, where men took more than women (0.35 vs 0.00). In both Tanzania and South Africa, women consumed more margarine and spreads than men (0.17 vs 0.08 servings/day and 1.42 vs 1.08 servings/day). However, in both rural and peri-urban Uganda, men consumed more margarine and spreads than women (1.07 vs 0.03 servings/day and 0.43 vs 0.29 servings/day) (Holmes et al., 2018).

In Botswana, elderly people in urban (0.1servings/day ±0.3) and semi-urban (0.1 servings/day ±0.5) areas reported the same levels of soda intake, with no consumption in rural dwellers (0.0 servings/day ±0.00) (Maruapula & Chapman-Novakofski, 2008).

Mean soft drink consumption was 125.6g/day, doughnuts 30.6g/day, spaghetti and pasta 26.7g/day, cakes and cookies 8.3g/day, jam (including honey) 1.4g/day, sweets 0.8g/day and, chips and popcorn 0.8g/day among members of the defence forces in urban Cameroun (Nkondjock et al., 2010).

South African women living in a peri-urban informal settlement consumed 304g of cool drinks, 239g of bread, and 102g of boerewors per day (Oldewage-Theron & Kruger, 2011).

In rural Africa, Anderson et al. (2010) found that UPFs like sweets, disserts, beverages and condiments made up about 20% of food sources reported by 50 rural Senegalese men. For women, a cross-sectional study in South Africa, Oldewage-Theron & Kruger (2011) found that South African women resident in a peri-urban informal settlement consumed 304 g of cold drink (squash) and 102 g of Boerewors daily.

Using data from the Dikgale, BRISK, THUSA and CORIS surveys (Steyn et al., 2003) found that South African adults consumed 165g of brown bread, 163g of white bread, 19g of margarine per day.

Zeba et al. (2014) also found higher consumption of soft drinks in the 'urban' diet pattern compared to the 'traditional' diet regime (6.6 g/4184 kj vs 0.1 g/4184 kj; p=0.001), and the consumption of local sweetened juices (68.1 g/4184 kj vs 20·9 g/4184 kj; p<0.001) among adults in Burkina Faso. Urban Beninese adults following the transitional diet consumed more sweets (34.5g) and soft drinks (35.3g) than those who followed the traditional dietary pattern (Sodjinou et al., 2009a).

Adolescents

Among adolescents in Benin, UPF ['Sweet foods' (consisting of energy-dense foods such as sweet beverages, candies, chocolate and lollipops) and 'cereals & cereal products' (including wheat bread, maize-based dough and porridges, rice and pasta)] was responsible for 40% or more of the daily weight of food consumed, out of which street foods contributed 86% (Nago et al. 2010). 'Sweet foods' and 'cereals & cereal products' were the most consumed out-of-home foods in urban adolescents in Benin (Nago et al., 2010). High consumers of out-of-home foods consumed significantly more 'sweet foods' with out-of-home foods accounting for 84% of daily 'sweet foods' (p<0.001) intakes at a mean intake of 246 g.

Private-school adolescent students from rural areas in Botswana consumed less servings of savoury snacks than those of other locations (p<0.05). However, servings of sweet snack consumption did not differ by residence. Students of higher socio-economic status reported higher intake of savoury snacks (1.00 vs 0.41), sweet snacks (0.71 vs 0.40) and fizzy drinks (0.42 vs 0.11) and ate more snack-food servings (2.14 vs 0.92), all with P<0.01, compared with public-school students of lower socio-economic status. Urban residents took more fizzy drinks than students from rural villages (P<0.05). The same rural-urban gradient was observed for snacks consumption (P<0.01) (Maruapula et al., 2011).

Children

Children consumed 2.23 portions of margarine per day in urban South Africa (Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994). In Kenya, primary school children ate 3.8g of spreads including margarine, butter and jam a day (Mwaniki & Makokha, 2013).

Steyn et al. (2006) using the National Food Consumption (NFC—a nationally representative survey) data found that children (1-9 years) in South Africa consumed 4.5g of margarine, 68.5g of brown/white bread, 45.6g of squash, and 16g of carbonated cold drinks daily. In another study (Steyn et al., 2003) using the same data from the NFC survey data and other surveys (BRISK, CORIS, Lebowa), children aged 6-9 years consumed 119g of white bread, compared to daily consumption of 83g of white bread in children aged 1-5 years. They (1–5-year-olds) also consumed 105.29g of infant formula/foods, 75.25g of supplements, and 11.62g of condiments per day. In 6–9-year-olds infant foods consumption was 23.33g/day and 34.27g of condiments.

In cross-sectional study in Namibia, urban children ate 10g of margarine, 251g of SSBs, 57g of fat cake, 16g of jam and sweets compared to rural children who reported zero consumption for these UPF products (Vähätalo et al., 2005).

4.6.4.2 Studies reporting frequency of consumption

Adults

Van Zyl et al. (2010) found that fast food intake among 21% of urban South African adults (19 to 30 years) was at least once a week, while 27.6% ate it two to three times a week. More men than women ate fast food frequently (p<0.01). Poorer people (65%) consumed fast food more frequently, with nearly half (42%) of the employed participants spending more than 4% of their monthly income on fast food. UPF like burgers (69.5%) and pizza (56.6%) were the most frequently consumed fast foods, with soft drinks being the most popular (56%) beverage.

In Åstrøm & Masalu (2001), more University students of urban origin than those from rural areas (51% of 216 vs 29% of 59, P < 0.001) in Tanzania consumed soft drinks weekly in 1999 and in 2001 (56% of 341 vs 44% of 154, $P < 0.001$). A greater proportion of urban male students than females consumed soft drinks more frequently in 1999 (53% vs 49%; $p< 0.001$) but slightly more urban females than males likely to consume soft drinks in 2001 (55% vs 54%). The reverse was the case among rural students (25% vs 42%; $p< 0.05$) in 1999 but no gender difference in soft drinks intake was observed in 2001. More urban than rural students were more likely to consume chocolate/candy in both 1999 (12% vs 5%; $p< 0.05$) and 2001(9% vs 4%; 0.05) every week. During both years, a greater proportion of urban female students than male consumed chocolate/candy weekly (1999: 20% vs 6%; $p< 0.001$; 2001: 16% vs 6%; $p< 0.001$).

Cardoso et al. (2012) also found in a multi-centre cohort study that between 1989 and 2011, the proportion of adults consuming salty snacks (1 +/week) increased from 22 to 64% and sweet snacks (1 +/week) from 38 to 67% ($P < 0.001$ for both) in adults aged 24 to 44 years in Seychelles.

In a multi-country cross-sectional study (Bohicon in Benin, Conakry in Guinea, Mombasa in Kenya, Maputo in Mozambique, and Victoria in Seychelles), Leyvrez et al. (2018) reported infrequent intake of processed foods high in salt, such as processed meat, cheese, pizzas, and savory snacks, but salt-rich foods, such as soups or bread and salty condiments, were consumed frequently among adults in all five countries. In Benin, Guinea, Kenya, respectively, 78% (70–84), 50% (41–59), 47% (36–58) of adults added condiments (bouillon cubes, Aromat powder, soy sauce, food spreads (e.g., Vegemite, Marmite), and similar items) everyday during the preparation of all meals. The average prevalence of condiments use per day in all meals for all five countries was 42% (38–47). More than 85% (79–91) of adults in Benin engaged in the intake of 'foods high in salt' (salted fish, salted meat, salami, salted peanuts, food spreads, pizza, and other typical local meals rich in salt) daily. Fifty-four percent (45–64) of Kenyans ate 'foods high in salt' 3 to 4 times a week.

More urban than rural residents engaged in daily intake of margarine (35% vs 10%), bread (51% vs 24%), and fries (45% vs 6%) in elderly Zimbabweans (aged 60 plus) (Allain et al., 1997).

For students, the majority of urban Nigerian undergraduate students (17 to 26 years) consumed soft carbonated & soda drink (59.8%), energy drink (68.1%), malt drinks (67.4%), beverage (74.7%) 4-5 times/week or on a daily basis (frequent consumers)

(Fadupin et al., 2014). However, Olatona et al. (2018) found that 29.0% of Nigerian students consumed carbonated soft drinks daily. Nearly half (44%) of them ate pastry snacks daily.

Adolescents

In adolescents, (Feeley, Musenge, Pettifor & Norris, 2013) used the 5-year Birth to twenty (Bt20) longitudinal cohort (13, 15, and 17y old) data and found that more than 66.7% of adolescents ate fast foods and sweetened beverages three or more times in a week. The same proportion of adolescents consumed confectionery seven or more times per week. Females ate significantly more than males at ages 15 and 17 ($p<0.05$).
Using the same Bt20 longitudinal data, Feeley & Norris (2014) reported that the consumption of fast foods among urban South African adolescents (13, 15, 17 years) was 11 (7-16) items per week in both male and female. Females consumed sweetened beverages more frequently than males (10 (6-11) vs 8 (5-11) times/week; $p<0.02$). Confectionery was consumed 13 (9-17) and 11 (8-15) times/week by females and males, respectively ($p<0.01$). For salty snacks, both sexes reported median intakes of 7 (5-10) times/week.

Another study based on the Bt20 data reported that weekly fast-food consumption increased with age from 4.8 (±3.9) to 5.1 (±4.8) and to 5.3 (±4.2) for each age group, respectively ($p= 0.001$) among urban South African adolescents (Feeley, Musenge, et al., 2012). The five most popular foods in both males and females included fast foods (fried chips, vetkoek (fried dough balls), pies, and boerewors (local sausage) rolls) constituted over 74% of total fast-food intake. No gender differences in fast food intake were observed, except at the 17th year, when females ate slightly less fast-food items.

In Feeley, Musenge, Pettifor & Norris (2012) also using the Bt20 longitudinal data. confectionery consumption changed slightly per week over the 5-year period (from 9.4 (±4.8) to 9.6 (±5.3) and to 9.5 (±4.9)). However, females consistently (at year 13, 15, and 17) consumed significantly more confectionery than boys (9.6 (±4.9) versus 9.1 (±4.6); 10.2 (±5.2) versus 8.9 (±5.2); 10.1 (±5.1) versus 8.9 (±4.7), $P < 0.02$)). Sweets, crisps, and soft drinks made up over 65% of confectionery/beverage items consumed as the three most popular confectionery/beverage subgroups. Average beverage consumption also increased with age (from 3.1 (±2.5) at 13 y to 4.0 (±2.5) at 17 y ($P < 0.001$)).

Ogunkunle et al. (2013) also found that over 51% of adolescent public school students in urban Nigeria consumed soft drinks, sweets, and snacks everyday, while 32.7% took them 4 to 6 times per week. For bread and cereals, nearly 60% of participants ate them on a daily basis with 17.6% consuming it 4 to 6 times, and 21.8% taking them up to 3 times in a week.

Children

For children, Adamu et al. (2012) found that 68% percent of primary school children in northern Ghana took snacks two or more times daily, including UPFs like sweetened beverages, biscuits, ice cream, and spaghetti. Apart from five staple foods, soft drinks and biscuits were the two other popular food types consumed respectively by 100% and 96% of all urban school children.

Feeley, Coly, et al. (2016) also found that in urban Senegal, 20.2% of children 6-23 months old, consumed breastmilk substitutes (infant formula, follow-up formula, and growing-up milks) every day. More than 49% took commercially produced complementary foods (infant cereal, puree, infant snacks), and 58.7% ate commercially produced snacks (savoury snacks/chips, sweet biscuits/cookies, candy/sweets/chocolate, cake/doughnuts, soft drinks) daily.

4.6.5 Contribution of UPF consumption to energy intake

Of the included studies, eight papers (Amare et al., 2012; Asayehu et al., 2017; Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Nago et al., 2010c; Steyn et al., 2006; Vähätalo et al., 2005b; Zeba et al., 2014) reported some information on energy intake. Out of this, two studies (Nago et al., 2010; Steyn et al., 2006) reported the contribution of UPF (out-of-home foods) (Nago et al., 2010) and (squash and carbonated drinks) (Steyn et al., 2006) consumption to daily total energy intake which was at more than 40% and 16.4%, respectively. In Bourne et al. (1994), “non-basic foods” (including jams, cold drinks, cakes, savoury snacks, sugar, puddings, tarts, and pies) accounted for 12.9% of total energy and 3.3% of total fat intake in 3- to 6-year-olds in urban South Africa. Another study (Zeba et al., 2014) also found that the intake of total energy was significantly higher in ‘traditional’ diet cluster (exhibiting higher intake of plant protein, complex carbohydrate and fibre) ($P < 0{\cdot}001$) than in the ‘urban’ diet (characterised by higher intake of fat and sugar from imported cereals, oilseeds, red meat, eggs, milk and milk products, vegetables other than greens, fruits, local sweetened juices and soft drinks). However, the contribution of sugar to energy intake for both the ‘urban’ and ‘traditional’ diets was above the World Health Organisation (WHO) recommendation for the prevention of NCD, and significantly higher in the ‘urban’ cluster compared to the ‘traditional’ diet (Zeba et al., 2014). Similarly, fibre intake in consumers of both diet clusters were below WHO recommendations.

4.6.6 Relationships between UPF consumption and health/other nutritional outcomes

4.6.6.1 UPF consumption and non-discretionary salt or sugar intake

Based on samples from South Africa, two studies (Charlton et al., 2005, 2008) looked at the contribution of some UPFs [e.g. commercial meat pies, beef sausage (boerewors), potato crisps, commercial cookies and biscuits and processed meats (polony, Vienna sausage, salami, ham, and other sausages), seasoning, and soup powders] to non-discretionary salt/ dietary sodium intake in adults. Apart from processed meat products in which White South Africans consumed more salt than Black South Africans, White South Africans consumed less salt than Black South Africans through bread and cereals and cereal products. Cereal and cereal products accounted for oat least, nearly half of reported total non-discretionary sodium intake in all three ethnic groups captured in the study (48.6% of 1459 mg/day in Black urban South Africans; 45.9% of 1922 mg/day in White urban adults; 45.9% of 1761 mg/day in adults of Mixed ancestry) followed by bread (25.2% to 40.5%); processed meat products (PMP) and commercial meat pies at 20% to 23.6% (Charlton et al., 2005). Compared to rural South African adults, cereal and cereal products accounted for 74.8% of 759 mg/day in blacks in 1998 (Charlton et al., 2005); 70.3% of 1070 mg/day in another Black rural adult population in 1992 (Bourne et al., 1993 cited in Charlton et al., 2005); and 37.2% of 2293 mg/day in White rural adults in 1983 (Steyn et al., 1997; Wolmarans et al., 1989). Bread contributed (24.6% of 2293mg/day to 73.1% of 759mg/day); and processed meat products (10.2% of 759mg/day to 28.9% of 2293 mg/day) in both black and white rural subsamples (Charlton et al., 2005; Wolmarans et al., 1989). Soups, soup powders, and seasoning/aromat accounted for 5.25% of non-discretionary dietary salt intake. Total salt intake was highest in blacks than whites and adults of mixed ancestry South Africans, although all three subsamples exceeded the recommended daily limit.

In (Charlton et al., 2008) all foods included in the study contained at least 50mg Na per serving with the following UPFs contributing significantly to higher dietary Na intake per serving: aromat/seasoning (240.3 mg/serving or 24030 mg/100g); gravy powder (1712.6 mg/serving or 4893 mg/100 g); breakfast cereal (processed) (484.4mg/serving or 1211mg/100g); popcorn (776 mg/serving or 1940 mg/100 g); PMP (611.4 mg/serving or 1019 mg/100g); and potato crisps (300 mg/serving or 1000 mg/100g).

For adolescents, the consumption of UPFs (fast foods, sweetened beverages, confectionery, and salted snacks), overall contributed to an estimated mean dietary salt intake of 4803 mg dietary salt per week for adolescent males and 4761 mg/week for females, respectively ($p>0.05$) and sugar intake of 561.6 g/week for adolescent males and 485.3 g/week for females, respectively ($p=0.02$) (Feeley & Norris, 2014).

Cool drinks (squash) and carbonated drinks accounted for 16.4% of sugar in the diet of children aged 1 to 8 years in South Africa (Maunder et al., 2015). Mean sugar intake and percentage of energy from sugar (from cool drinks, carbonated drinks, and white sugar) was significantly higher in children in urban areas (32.4g and 10.3%, respectively) than in rural (20.9g and 7.5%, respectively) South African children. Consistent with this, children with higher percentage of energy intake from sugar and sugared/carbonated drinks were more likely to be obese/overweight (Maunder et al., 2015).

4.6.6.2 UPF consumption and fat/cholesterol intake

Two studies (Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Nago et al., 2010) assessing the contribution of food groups (including or constituted by UPF items) to fat intake respectively reported that UPFs accounted for 36.4% and 43% of daily fat intake in children and adolescents.

Another set of two studies (Sodjinou et al., 2009a; Zeba et al., 2014) which identified dietary patterns also assessed their relationships with fat intake. Sodjinou et al. (2009) found that 'transitional' diet (characterised by food options including sweets, soft drinks and fats), accounted for significantly more cholesterol (136.6 vs 76.1mg) intake per day and less fibre than 'traditional' diet (characterised by high intake of grains, vegetables, legumes and fruits) among urban adults in Benin. In urban Burkina Faso, Zeba et al., 2014) also found that adults who followed the 'urban' diet characterised by high intake of UPFs (including local sweetened juices and soft drinks) exhibited significantly higher intake of fat, sugar and higher fat contribution to energy.

4.6.6.3 UPF consumption and obesity

A set of three studies reporting portion sizes (Amare et al., 2012; Holmes et al., 2018; Maruapula et al., 2011) looked at the relationship between sweets/dietary regimes encompassing some UPF products and BMI/waist-to-hip ratio. All three studies reported a positive correlation. Out of these, two papers (Amare et al., 2012; Maruapula et al., 2011) assessed the link between BMI/waist-to-hip ratio and savoury snacks/ sweets found significantly positive association in adults (Amare et al., 2012) [$r = 0.124$; $p < 0.05$] with the same direction of association in children reported in another paper (Maruapula et al., 2011). Obese and overweight children consumed more snacks than children in the underweight category (Maruapula et al., 2011) [1.55 v. 0.83 servings, $P<0.01$].

In another study (Holmes et al., 2018) assessing association of UPF with obesity, women consuming processed foods (characterized by high intakes of salad dressing, cold cuts and sweets) were more likely to be both overweight and obese compared to men. Women in the highest tertile of the Processed diet pattern score were 3.00 times more likely to be overweight (95% CI 1·66, 5·45; prevalence=74 %) and 4·24 times more likely to be obese (95% CI 2·23, 8·05; prevalence=44 %) than women in this dietary pattern's lowest tertile (both $P<0·0001$; prevalence=47 and 14 %, respectively). Men in the highest tertile of intake of the Processed Diet pattern had 2·08 times the odds of being overweight (95% CI 1·07, 4·02; prevalence=45 %) and 3·59 times the odds of being obese (95% CI 1·20, 10·71; prevalence=20 %) than men in the lowest tertile (linear trend $P<0·001$ for both associations; prevalence=29 and 5% respectively).

For studies reporting frequency of UPF consumption, a higher proportion of adult undergraduate students in Nigeria who were frequent consumers (daily or 4 to 5 times/week intake) of soft, carbonated & soda drinks were overweight than being of normal weight (45.2% vs 14.1%; $p= 0.0013$) (Fadupin et al., 2014). Similarly, significantly greater proportion of frequent consumers (daily or 4 to 5 times/week intake) of various sweetened and carbonated drinks were overweight compared to normal weight:

energy drinks (44.7% vs 26.1; p= 0.0015); malt drink (57.2% vs 11.7; p= 0.0002); and beverages (65.2% vs 8.8%; p=0.0001) (Fadupin et al., 2014). Allain et al., (1997) also reported a significant positive correlation between BMI, subscapular skinfold thickness (SFT) and waist-to-hip ratio (WHR) and frequency of eating fries ($r = 0.16$, $P < 0.01$).

On the contrary, Cardoso et al. (2012) found that obese participants consumed less snacks (salty and sweet) and soft drinks compared to the non-obese adults and the differences were significant. However, after adjusting for age and gender, there was no significant difference in the consumption of all the UPF foods except sugary snacks among the two groups. Olatona et al. (2018) on the other hand did not report any significant association between pastry and soft drinks consumption with general and abdominal obesity ($p > 0.05$) in adult Nigerians.

In adolescents, sweetened beverage consumption was positively and significantly associated with fat mass ($p<0.05$) and BMI Z-score ($p<0.001$) for male adolescents only (in urban South Africa) in both unadjusted and adjusted models addressing confounding (household assets, in this case fridge ownership) (Feeley et al., 2012a).

For children, Adamu et al. (2012), found that snacking had an influence on nutritional status. In that, 8 out of 32 of Ghanaian school children who snacked once a day were underweight whilst those who snacked twice or more per day were either overweight or at risk of overweight.

4.6.6.4 UPF consumption and hypertension/ healthiness of diets/ type-2 diabetes

Two studies (Nkondjock et al., 2010; Zeba et al., 2014) evaluated association between hypertension and the consumption of some UPFs as part of dietary patterns among adults in urban Burkina Faso and Cameroon, respectively. Both studies found no visible association between the "meat pattern” (characterised by elevated bush meat, poultry and red meat consumption, with reduced intake of sweets, cakes and sugar) as described in (Nkondjock et al., 2010) and the “urban” cluster in (Zeba et al., 2014) (characterised by high intake of higher consumption of soft drinks, processed foods, animal products and other foods high in fat, and sweets). Nago et al (2010) also found overweight and obesity prevalence at 8.3% and 4%, respectively in out-of-home food consumers, with no significant difference between high and low out-of-home food consumers (Nago et al., 2010).

The only study (Sodjinou et al., 2009a) that evaluated the 'healthfulness' of diets reported a low healthfulness score for diets characterised by a significantly higher intake of bread and pasta, milk, milk products, fats and sweets.

Similarly, the only study that assessed the relationship between type-2 diabetes in urban adults in Ghana and the intake of soft drinks, sweets, vegetable oil, milo, and margarine which were included in the "purchase" dietary pattern based on frequency of consumption data found an inverse association (Frank et al., 2014).

4.6.7 Quality Appraisal

Out of the studies reporting portion size, 5% and 67% were respectively rated as being of low or satisfactory quality. Publications that met the criteria for high quality constituted 29%. Regarding studies that reported frequency of consumption, 74% and 26% were respectively rated as being of intermediate or good quality. The scores are displayed in Appendix 4.1 and Appendix 4.2.

4.7 Discussion

There is limited research focusing on the assessment of UPFs consumption, either in portion sizes consumed or frequency of consumption in SSA populations, with 46 publications based on data collected between 1975 and 2018. The studies that exist appear to show increasing UPFs consumption e.g.: from longitudinal studies from Seychelles (Cardoso et al., 2012) and South Africa (Ronquest-Ross et al., 2015) examining data from the late 1990s to 2012. It also appears that urban populations consume more than rural populations. For example in Botswana (Maruapula et al., 2011; Maruapula & Chapman-Novakofski, 2008), Ghana (Galbete et al., 2017), Namibia (Vähätalo et al., 2005), Tanzania (Åstrøm & Masalu 2001), and in Zimbabwe (Allain et al., 1997). Consumption of UPFs again appears to increase with age and females seem to consume slightly more than males, although some between-country variations were observed. Importantly, UPFs consumption (measured as portion size or frequency of consumption) is positively associated with obesity/overweight/BMI in SSA populations based on findings from the eight studies (two in children and six in adult populations) that assessed this association. This finding is consistent with recent systematic reviews reporting a positive association between UPF consumption and body fat (Costa et al., 2017), obesity and other adverse health outcomes (Elizabeth et al., 2020). However, two other studies in this review that assessed this association reported divergent findings. Two studies evaluating the association between hypertension and the consumption of some UPFs as part of dietary patterns also found no discernable association. In Elizabeth et al.'s (2020) systematic review, all 43 studies included in the review (based in populations from North and South America, Europe, UK, and Malaysia) reported an association between UPFs exposure and an adverse health outcome. In summary, while this review sheds some light on UPF consumption research in SSA and the relationship between UPF consumption and health/nutritional outcomes in SSA populations, it also reveals that there is limited research on this topic.

In terms of the quality of identified studies, it is important to indicate that out of the 43 studies included in this review, only 10(Amare et al., 2012; Anteneh et al., 2015; Asayehu et al., 2017; Charlton et al., 2008; Kyamuhangire et al., 2013; Nago et al., 2010; Oldewage-Theron & Kruger, 2011; Pries et al., 2017; Steyn et al., 2011; Zeba et al., 2014) reported the parameters used in calculating sample size, with only 7 studies reporting statistical power calculation (Amare et al., 2012; Asayehu et al., 2017; Kiwanuka et al., 2006; Kyamuhangire et al., 2013; Nago et al., 2010; Olatona et al., 2018; Zeba et al., 2014). Many of the studies that did not report this data also used relatively small samples (for instance, Anderson et al., 2010; Vähätalo et al., 2005) which may undermine studies' internal and external validity and reduces statistical power. Consistent with this, up to 71% of the included studies were rated as being of low or satisfactory (intermediate) quality based on quality assessment using a tool adapted from from Louw et al. (2007) and subsequently used in systematic reviews by (Wong et al., 2008) Davids and Roman 2014; Davids et al., 2016; and Roman and Frantz 2013), among others. The remaining 29% (representing only 12) of included studies were within the high/good quality class score. In addition to this, apart from one study which was longitudinal, the majority of the studies were cross-sectional (similar to (Meneguelli et al.'s (2020) review), which are less valid for examining cause and effect relationships, as they especially provide no information with regards to the influence of time on the variables measured (Wang & Cheng, 2020). For dietary studies, longitudinal studies are most preferred to describe dietary patterns and the direction and magnitude of change (Sempos et al., 1993; Wang et al., 2017). It is recommended that future dietary studies seek to replicate these findings in larger samples and longitudinal research, to ensure high quality dietary research with robust and generalizable findings.

Most of the studies included in this review did not focus on UPF items only. In many of these studies individual food items that fall within the definition of UPF were captured as part of a list of food items in general dietary surveys, often with a study aim focused on understanding dietary diversity. None of the studies used the NOVA food classification system per se, which reinforces the absence of a standardised definition for the various food items/groups assessed by the individual studies. For instance, the sugar-sweetened beverage category was the most researched ultra-processed food group but was defined differently to encompass different items in different studies. For example, Fadupin et al. (2014) defined SSBs to include all sodas, soft and carbonated, fruit drinks, energy drinks, low-calorie drinks, non-alcoholic wines/malt and cocoa beverages, while Feeley et al. (2013) defined it to cover only soft drinks and squash/cordials. Indeed, a previous systematic review (Elizabeth et al., 2020) (with a different geographic focus: UK, Europe, Malaysia, USA, Canada, Lebanon, and Brazil) identified only two studies that have applied the NOVA classification in assessing UPF consumption association with nutritional outcomes apart from body fat levels (Caroline Santos Costa et al., 2018). Research in SSA should take advantage of the nascence of UPF research in the subregion to develop and adopt a standardised definition of food groups based on the NOVA food classification system. This will permit more meaningful cross-country comparisons of UPF consumption to inform useful dietary guidelines.

Moreover, the studies employed different dietary data collection methods which vitiates the between-study comparability of the findings from the studies selected for this review. The majority of the studies employed single 24-hour recall (e.g. Asayehu et al., 2017; Kyamuhangire et al., 2013; Zeba et al., 2014; Anderson et al., 2010) compared to the other methods, and the most frequently used dietary assessment method in LICs (R. Gibson et al., 2017; Shim et al., 2014). Gibson et al. (2017) attribute this to 24-hour recalls being adaptable to different cultures and requiring little or no respondent literacy. But given the tendency for single 24-hour dietary recalls to overestimate energy and nutrient intake (Fisher et al., 2008), multiple-pass 24-hour recalls are recommended as adequate to minimize the effect of random error (Burrows et al., 2010; Gibson et al., 2017).

Weaknesses (inconsistencies and skewness) in the data did not permit a meta-analysis or secular trend analysis of UPF consumption in SSA. The bibliometrics of the number of publications over the years indicates/suggests a peak in the 2011-2015 period, with relatively more recent publications reporting UPF consumption as frequency of consumption than as portion size. Portion sizes have however been found to be a more effective way of reporting/presenting food/nutritional information as it offers a standardised basis for within-study, between-studies, and cross-country comparison (Kirwan et al., 2016). In comparing the consumption of 156 food items across seven EU countries, Kirwan et al. (2016) found no significant differences in the individual country mean portion sizes for 84% of the food items. However, frequency of consumption differed for 58% of the food items (Kirwan et al., 2016). The trendlines as shown in Figures (2&3) indicate a growth in UPF-related research in SSA which may perpetuate into the near future. Future research offers the opportunity to collect and report more UPF consumption data as portion size to provide more meaningful assessment and estimation of UPF products intake in SSA populations.

In a similar vein, and especially for those studies that identified/derived dietary patterns, varying sets of UPF items were used, also impairing the between-study comparability of the various findings. Assessing the consumption of UPFs in the context of dietary patterns has the potential to providing a realistic picture of what (the combination of food products) people are eating (Tapsell et al., 2016). The "planetary health diet" for example, recommends a combination of portions of various food types. However, UPFs are a key source of energy intake, although they are just one of the possible food sources of energy. Therefore, in assessing the effect of UPF on energy intake, the contribution of UPF to energy intake must be isolated from other possible sources. Given the lumping of UPFs with non-UPFs in the derivation of dietary patterns, with non-UPFs not subsequently adjusted for in many of the studies selected for this review, the findings may therefore contain residual confounding. In Zeba et al.'s (2014) study for example, UPF contribution to energy was not disentangled from that of the other food items in their 'urban' dietary cluster. In a similar vein, in the same study Zeba et al. (2014) and in (Nkondjock et al., 2010), isolating the effect of non-UPFs may have resulted in a clear association between UPF consumption and hypertension or non-UPF consumption and hypertension. Nkondjock et al. (2010) used a 1-year FFQ (focusing on diets in the year preceding the survey). It is possible memorization/recall bias may have been introduced as respondents were required to rely on their memory to report their food intake retrospectively over a prolonged period of a year.

Among the studies (Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994; Nago et al., 2010) that evaluated the correlation between food groups constituted by UPF items accounted for over 36% of fat intake. It is unclear whether these findings may also reflect residual confounding as both studies do not report the full complement of the food items constituting the various food groups. In Nago et al. (2010) the "Sweet foods" group was defined as "energy-dense foods such as sweet beverages, candies and chocolate" but does not report those food items actually captured by the study. In a similar vein, (Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al., 1994) explained "Non-basic foods" group to mean "Foods not included in the five basic food groups, e.g. sugar, jam, cold drinks" but does not report the full list of food items underpinning the results reported. The current review takes the view that fuller details on the constituent food items would be a good guide towards interpreting the studies' findings in the appropriate context.

It is important to emphasise that nearly a quarter of research focused on South Africa, followed by Ghana. This may be attributable to the suggestion that South Africa and Ghana are two of the few SSA countries reported to have reached an advanced stage of the nutrition transition a decade ago, where changes in dietary patterns are affecting health outcomes in a significant section of the population (Abrahams et al., 2011) and may have attracted diet-related research attention.

Despite the limitations highlighted in the foregoing, this work, to the best of the authors' knowledge is the first to systematically synthesise research evidence on UPF consumption and its links with health and nutrition outcomes focusing on SSA populations. Apart from providing an integrated synopsis, up-to-date empirical trends, and evidence in SSA on UPF consumption, it gives an indication of a possible positive association between UPF consumption and obesity in sub-Saharan Africans. More high-quality studies, addressing some of the limitations in the included studies and outlined in this review, replicating, or contradicting this finding in SSA samples are urgently required to provide a clearer contextual understanding of the theme to forestall the temptation to assume/apply findings imported from other geographical regions, which may be misleading.

4.8 Conclusion

This review has provided useful insights regarding the consumption of ultra-processed foods in Africa and its contribution to health and nutrition outcomes, especially the observed positive association between high UPF intake and obesity/excess energy intake in sub-Saharan African populations. The evidence also found no association between UPF consumption and a positive health outcome. These findings are however based on limited research and may thus be inconclusive. In the future, research prioritising activities to develop the body of evidence for this theme should seek to disentangle/isolate the consumption of UPFs from other food types, as well as isolate its effect on obesity and other health/nutritional outcomes in SSA populations and include cohort and clinical studies highlighting the influence of UPF consumption on specific health outcomes independent of others. A standardization of application of the NOVA classification from the outset of UPF research in SSA is also essential. In addition to the afore-mentioned, it shows potential for building a body of quality UPF consumption-related evidence that promotes the development of tailored nutrition guidelines and other nutrition policy actions that can steer Africa's nutrition transition in a sustainable direction.

CHAPTER FIVE

TYPE, DENSITY, AND HEALTHINESS OF FOOD-OUTLETS IN A UNIVERSITY FOODSCAPE: A GEOGRAPHICAL MAPPING AND CHARACTERISATION OF FOOD RESOURCES IN A GHANAIAN UNIVERSITY CAMPUS.

5.1 Chapter summary

Background: Food environments are viewed as the interface where individuals interact with the wider food system to procure and/or consume food. School food environment characteristics have been associated with health outcomes including obesity and NR-NCDs in studies from high income countries. Systematic reviews have reported limited research in sub-Saharan Africa characterising food environments, confirming a significant gap in knowledge of the dynamics of the SSA university foodscape and how it relates to the on-going nutrition and epidemiologic transitions.

Objectives & Method: This study set out to use Open Data Kit and Quantum Geographical Information System (QGIS) methods to identify and map the food-outlets within a Ghanaian university campus. Geographical Information System spatial analysis techniques including kernel density, buffer, and average nearest neighbour analyses were performed to assess outlet distribution, density, and proximity. A classification system was developed to assess the healthiness of food-outlets within the University foodscape.

Results: Food-outlets were unevenly distributed over the University foodscape, with many outlets clustered closer to student residencies. Informal food-outlets were the dominant food-outlet types. Compared to NCD-healthy food-outlets, NCD-unhealthy food-outlets dominated the foodscape (50.72% vs 39.86%) with 9.42% being NCD-intermediate, suggesting a less-healthy university foodscape. More NCD-unhealthy food outlets than NCD-healthy food outlets clustered around halls/hostels of residence. This difference was statistically significant for food outlets within 100-meter buffer ($p=0.00$) of student residence and those within 100 and 500 meters from departmental buildings/lecture halls ($p=0.05$ and $p=0.00$, respectively).

Conclusion: Further action, including research to ascertain how the features of the University's food environment have or are influencing students' dietary behaviours are needed to inform interventions aimed at creating healthier foodscapes in the study University and other campuses and to lead the way towards the creation of healthy food environments at the home, work, and community levels.

5.2 Introduction

In findings from Study Component 1 in Chapter 3, we see increased meat consumption per capita over a 30-year period, with higher consumption observed in urban, richer populations, and as age increases. But fruit and/or vegetable consumption remain significantly below standard dietary recommendations, especially in urban individuals. However, results from the narrative synthesis in Chapter 4 suggests increasingly high UPFs in the diets of urban individuals. In this chapter, I use GIS tools to identify, map, and characterise the features that constitute the physical food environment (in a case study elite urban community in Ghana) to help understand or gauge how they may be supporting or inhibiting UPFs, MFV consumption or other dietary behaviours in an example urban SSA setting.

5.3 Objectives

1. To identify and map the distribution of food-outlets within the University of Ghana campus.
2. To ascertain the type of food-outlets that make up the University of Ghana food environment.
3. To assess the healthiness of the various food-outlets distributed over the University of Ghana campus.

5.4 Methods

5.4.1 Study area/ setting

The University of Ghana is the oldest and the largest public university in Ghana, located about 13 kilometers north-east of Accra and with a land size of about 99.3 hectares, including a 23-hectare botanical garden. The University has three campuses, namely Legon (main campus), Korle-Bu and Accra City, which are suburban areas, comprising a total student population size of 39,249 including both undergraduate (85.36%) and graduate (14.64%) students. The majority (97.86%) of the population is Ghanaian, 1.54% of other African nationality and 0.60% of other nationality. The University's Legon campus has 14 halls of residence (six traditional halls[30] and eight new residencies[31] commissioned in 2011), the International Student Hostel I and II, and the Valco Trust Hostel which altogether house about 52% of students of the Legon main and Korle-Bu campuses. The remainder lived in private hostels, rented accommodation from private landlords, and other living arrangements. This study covered outlets in and around departmental buildings, on-campus accommodation facilities and accommodation facilities like the African Union, Bani, James Topp Nelson Yankah, and Evandy halls, which are usually classified as off-campus facilities among students due to being distant from central campus. The University operates a collegiate system which includes four colleges namely: the College of Basic and Applied Sciences, College of Education, College of Health Sciences and the College of Humanities. Students spend an average number of six (6) hours/day at their departments/lecture halls.

5.4.2 Data collection

The data collection was undertaken in three phases namely (1) remote mapping (2) ground-truthing, and (3) food-outlet survey. The remote mapping phase includes online mapping and online validation. There was an initial update of OpenStreetMap (OSM) based on freely available satellite imagery of the study area to create a vector base map made up of footprints of building structures and routes. All building structures and routes within the boundary of the University campus were mapped and validated online using the Humanitarian OpenStreetMap Team's (HOT) collaborative mapping process in OpenStreetMap (Tasking Manager web-based interface to coordinate mapping task and edit OpenStreetMap using map editors such as iD editor) (Humanitarian OpenStreetMap Team, 2019).

The ground-truthing activity involves field verification of building structures and routes mapped during the online remote mapping and validation. All data were obtained through ground-truthing survey and direct observation by me, and two research assistants

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[30] Commonwealth Hall (the only male hall of residence); Akuafo Hall; Mensah Sarbah Hall; Volta Hall (the only female hall of residence); Jubilee Hall; and Legon Hall.

[31] Alexander Kwapong Hall, Hilla Limann Hall, Jean Nelson Hall, Africa Union Hall, Bani Hall, Elizabeth Sey Hall, Evandy Hall, James Topp Nelson Yankah Hall (source: https://africavarsities.com/university-of-ghana/).

recruited for this study, in collaboration with up to 20 well-trained University of Ghana (UG) YouthMapper volunteers stationed at six different clusters of the University campus (namely: the Main campus area; Vice Chancellor's residence; Athletic oval; Diaspora area; and Botanical gardens; and Pentagon area). Atlases of the verified base map were generated and printed using a web-based interface (Fieldpapers.org) for generating A4 field paper maps (hereafter, FieldPaper sheets). FieldPaper sheets (FPS) were used to guide the ground-truthing survey and to directly observe and verify the location and typology of all structures in the study area, with particular interest in residential structures and food outlets. Data were recorded using a questionnaire instrument developed using open source software namely OpenDataKit (ODK) (Open Data Kit, 2020) and OpenMapKit (OMK) (Open Map Kit, 2019) which were loaded into Samsung Galaxy S5 and Alcatel 3V android mobile phones. The verified structures were also annotated on the FPS for accuracy and as back-up reference when updating OSM. Each FPS has a quick-reference (QR) code which allows scanned FPS to be oriented when overlaid on OSM. The ODK questionnaire was piloted and modified prior to its usage. Volunteers were paired to conduct the actual ground-truthing survey between 8th October and 7th November 2019 by walking through the streets of the entire study area.

Volunteers were trained to follow a standard protocol as follows. First, the shape on the FPS representing the building structure was traced out in pencil. Where there was a new structure, a representative shape was drawn on the FPS. Structures were assigned serial numbers starting with 1 (as a three-digit number—001) for the first structure visited using a naming convention (detailed in Table 5.1) that assigned a unique 13-digit structure ID number to each structure. Secondly, the name, location/street address, structure type/use (e.g., residential, classroom, office, or food outlet, etc.), corresponding details on individual structures captured on the FPS were recorded in ODK collect where the unique 13-digit structure identification (ID) is generated. The Geographical Positioning System (GPS) coordinates of the structure were thirdly recorded using the OMK feature in the ODK questionnaire. Finally, a front-view photograph of the structure was taken. Data collected were quality checked by team leaders before submitting to the ODK Server hosted by the Institute for Global Sustainable Development (IGSD). Identified discrepancies were discussed with volunteers in WhatsApp group chat and at weekly meetings and subsequently corrected.

Table 5.1: Naming convention for assigning unique 13-digit structure ID's

The naming convention is as follows:
First letter/alphabet unique to the study ('**N**' in this case) followed by
Field paper sheet code which should be three characters (this was **A01** in this study) followed by
Three-digit enumeration area code (for e.g., **111** for Pentagon area) followed by
Field worker identification code (3-digits, e.g., **550**) followed by
Last three digits indicated serial numbering of structures, with 1 (entered as **001**) being the first structure visited by the fieldworker.
Finally, the unique 13-digit structure ID for the first structure visited, for example, would be **NA01111550001**

Adapted from NIHR Global Health Research Unit, 2018

In the food-outlet survey, a survey instrument was developed based on insights from the Nutrition Environment Measures Survey (NEMS) instruments for restaurants (Saelens et al., 2007) and stores (Glanz et al., 2007) by Glanz and colleagues to assess food outlets (mapped in step 3) within the University of Ghana food environment using ODK collect. The assessment tool captured information on the type of food outlet and food options available—including FV, carbonated/sugar-sweetened beverages and salted snacks, fast-food, and other prepared/cooked foods—opening hours, advertising material, availability of seating, etc. The location of food outlets as captured in step 3 was also validated to ensure accuracy. The assessment tool was pilot-tested in the Main campus and Diaspora clusters with four different volunteer groups and subsequently revised based on a comparison of results, including the classification of food outlets, to ensure accuracy.

A food outlet classification system was developed given the non-existence of a standard food outlet classification regime for the study country. This was based on the literature (Dake et al., 2016; Green et al., 2020; Kroll et al., 2019; Roy et al., 2019) and the characteristics of the food outlets. Food outlets were initially classified into two broad categories—food stores and food service places—based on the service type. These were further divided based on the features of the structure or edifice the food outlet operated from (i.e., movable/permanent, size, seating availability and type, number of vendors, etc.), key aspects of business practice (i.e. self-service, take-away/delivery service, operating hours, etc.), and type/variety of foods.

As the NEMS concept inspires/stimulate the capturing of both healthy and unhealthy food options available at eating venues, food outlets were also categorised as either NCD-healthy, NCD-intermediate or NCD-unhealthy based on whether or not the food options on offer are known risk factors for obesity, hypertension, other cardiovascular or NCD; or whether or not the food options are known to offer protection against NCDs (after Maimaiti et al., 2020). The NCD-unhealthy food outlets category encompassed those that sold no fruit and/or vegetable choices, they offered ultra-processed foods (UPFs), high-fat, and energy-dense choices that encourage excess calorie intake. NCD-healthy food outlets included outlets that had FV, other plant-based food options, and low-fat food choices on offer or have been associated with healthy eating (Willett et al., 2019; WHO 2020). The NCD-intermediate category comprised of food outlets that did not fit neatly into either of the NCD-healthy or NCD-unhealthy categories and the contribution of the foods/food outlet types to BMI, hypertension, or other NCDs is inconclusive. See Table 5.2 for the summary of the criteria.

Table 5.2: Food outlet healthiness classification and definition as NCD-healthy, NCD-unhealthy, or NCD-intermediate.

Outlet healthiness category	Definition
NCD-healthy	This included outlets that had FV, other plant-based food options, organic foods, and low-fat food choices on offer or have been associated with healthy eating (Willett et al., 2019; World Health Organization (WHO), 2020). E.g., Store/stall/table-top vendor specialising in selling fresh fruit and/or vegetable options only; Organic food store/stall/table-top vendor specialising in stocking only fresh organic fruit, vegetable, and other plant-based food options; Store/shop/stall/table-top vendor selling drinking water only; Fruit juice/smoothie/puree stand; Food service places (Restaurants) serving vegetable soups/sauces/stews, legume soups/stews/sauces, and vegetable salads as main part of menu.
NCD-unhealthy	This encompassed food outlets that sold no fruit and/or vegetable choices, they offered ultra-processed foods (UPFs), high-fat, and energy-dense choices that encourage excess calorie intake (Costa et al., 2019; Costa et al., 2018; Nardocci et al., 2019; Piernas et al., 2016; Rauber et al., 2018, 2020; WCRF/AICR, 2018). E.g., Store/stall/table-top vendors selling confectionery, carbonated/SSBs or drinks; ice creams; sugared/salted snacks including cookies, cakes, and biscuits; frozen pizza; jams and cheeses; bouillon/stock cubes or powders; packaged instant noodles, salted fish/meat (WCRF/AICR, 2018b), blended kenkey (ice-kenkey). Food service places offering stir-fried rice, instant noodles, *kelewele*, deep-fried foods (Grootveld et al., 2018), sausages, khebab/other processed meat/salted meat, salted fish, burgers, hotdogs, chicken nuggets (Burgoine et al., 2018; WCRF/AICR, 2018b), alcoholic drinks, milk shake.
NCD-intermediate	This included food outlets that did not fit neatly into either of the NCD-healthy or NCD-unhealthy categories and the contribution of the foods/food outlet types to obesity/overweight, hypertension, or other NCDs is inconclusive or stocked proportionate mixture of foods known to be NCD-healthy as well as food known to be NCD-unhealthy.

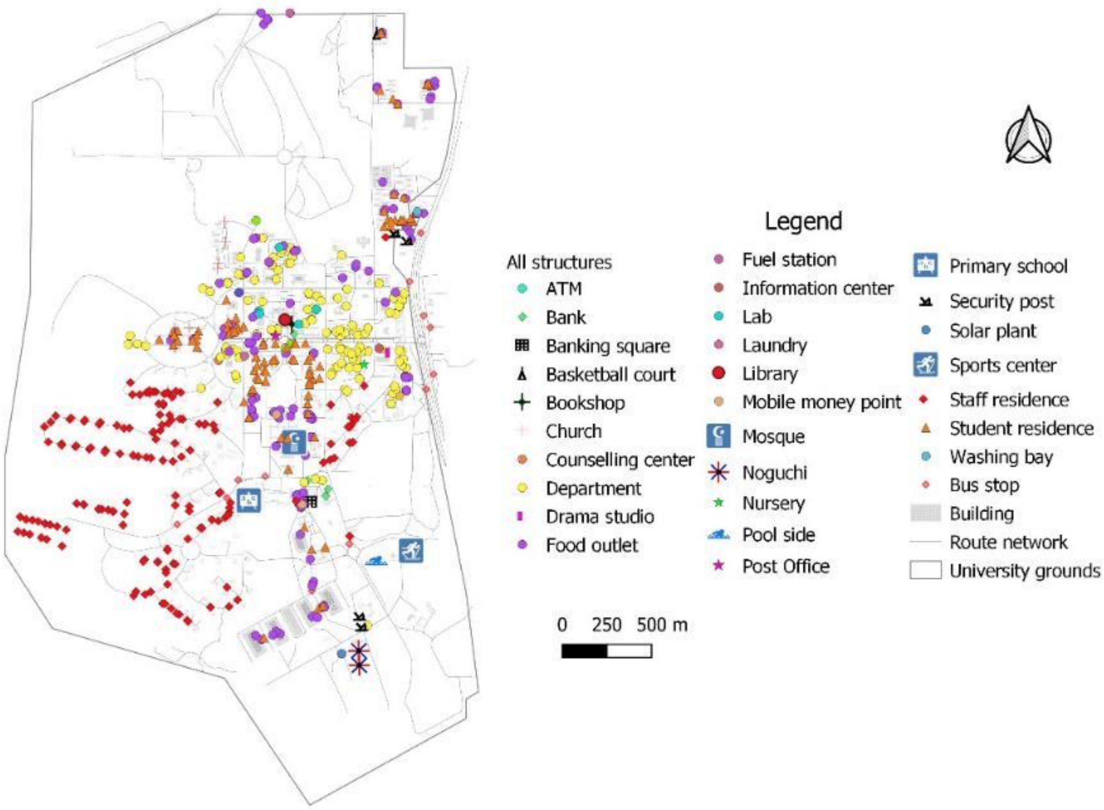
5.5 Data analysis

Geocoding and a food retail environment spatial distribution analysis were undertaken using Quantum Geographical Information System (QGIS) Desktop software version 3.10.0 with Geographic Resources Analysis Support System (GRASS) software version 7.6.1 and Microsoft Excel Spreadsheet. The density of the various outlets per kilometer square over the University foodscape was assessed. In a nearest-neighbor analysis, the distance between two outlets of the same type was determined. Distance to nearest hub (points) analysis was applied to determine the distance between food outlets and classrooms, and between outlets and students' residences. Two-sample t-tests were ran in MS Excel Spreadsheet to compare the differences between NCD-healthy and NCD-unhealthy food outlets in terms of their proximity to student residencies. The same statistical analysis was ran to compare the proximity of NCD-health outlets and that of NCD-unhealthy food outlets to departmental buildings/lecture halls.

5.6 Results

After several trips through the streets within the University boundary, five hundred and fifty-eight (558) structures were identified and mapped. The structures comprised food outlets (138, 24.7%), student hostels/halls (96, 17.2%), lecture halls/other departmental buildings (including administrative offices, conference, or meeting rooms) (124, 22.2%), staff accommodation (154, 27.6%), libraries and bookshops based on the focus of this study. Figure 5.1 shows the distribution of the various structures. Student hotels/halls (hereinafter, student residence) were mostly large storey/muti-storey buildings compared to staff accommodation which were usually small bungalows. The study focused on university-managed student residences. Rented rooms from private landlords were excluded, as these were farther from the University campus.

Figure 5.1: Distribution of structures on the University of Ghana campus



5.6.1 Food outlet characteristics

Out of 138 food outlets 58% were food service places with 42% being food stores. About 27.54% of all food outlets were table-top operations offering mainly water, carbonated/sugar-sweetened drinks and biscuits; bread with omelets (fried egg); or instant noodles. A few table-top vendors sold fruit, roast-groundnuts and/or water, millet porridge and other cooked breakfast cereals (such as oats). This is followed by traditional/local sit-down restaurants serving prepared meals including mainly rice dishes with vegetable salad (sold separately), *banku/kenkey* with grounded pepper or vegetable sauces (sold separately), *banku/fufu* with soup, and beans with gari/fried plantain (red-red). Together with other food service places (standard sit-down and take-out restaurants), they made up over 35% of food-outlets, suggesting a high prevalence of eating-out among students. Convenience stores had the third highest proportion (16%) of food-outlets. In addition to other everyday items, the convenience stores stocked mainly water, soft drinks, biscuits, packaged snacks and other confectionery, and instant noodles. Each hall/hostel of residence had a convenience store inhouse. Interestingly, fruit store (Fruit stores+ Fruit juice stand+ Organic food shop together) ranked eighth, representing

3.62% of food-outlets. Food-outlets that fell under the Supermarket category were not full-service supermarkets and offered ultra-processed/packaged foods and drinks only, with no fresh food products. Figure 5.2, Table 5.3 and Appendix 5.1 show the typology and the proportion of each food-outlet type in the University foodscape.

Table 5.3: Types of food outlets in

Food outlet type	No.	%
Table-top	38	27.54
Traditional sit down	18	13.04
Convenience store	16	11.59
Standard sit-down restaurant	16	11.59
Take-out restaurant/fastfood	15	10.87
Food court	13	9.42
Khebab stand	7	5.07
Grocery shop	5	3.62
Fruit store	3	2.17
Supermarket	2	1.45
Drinking bar	1	0.72
Organic food shop	1	0.72
Fruit juice stand	1	0.72
Snack bar/Ice-cream shop	2	0.72
Total	138	100

The distribution of food-outlets was somewhat uneven over the University campus and appeared to be concentrated around the halls/hostels of residence, especially towards the south. There was a limited number of food outlets towards the east where many departmental buildings or lecture halls were located (Figure 5.3). These areas were dominated by temporary table-top vendors mainly stocking water, carbonated/SSBs and pastries/biscuits. This may shape the eating habits of students, as the department is where they spend most of their day/time during term-time.

Figure 5.2: Food outlet typology

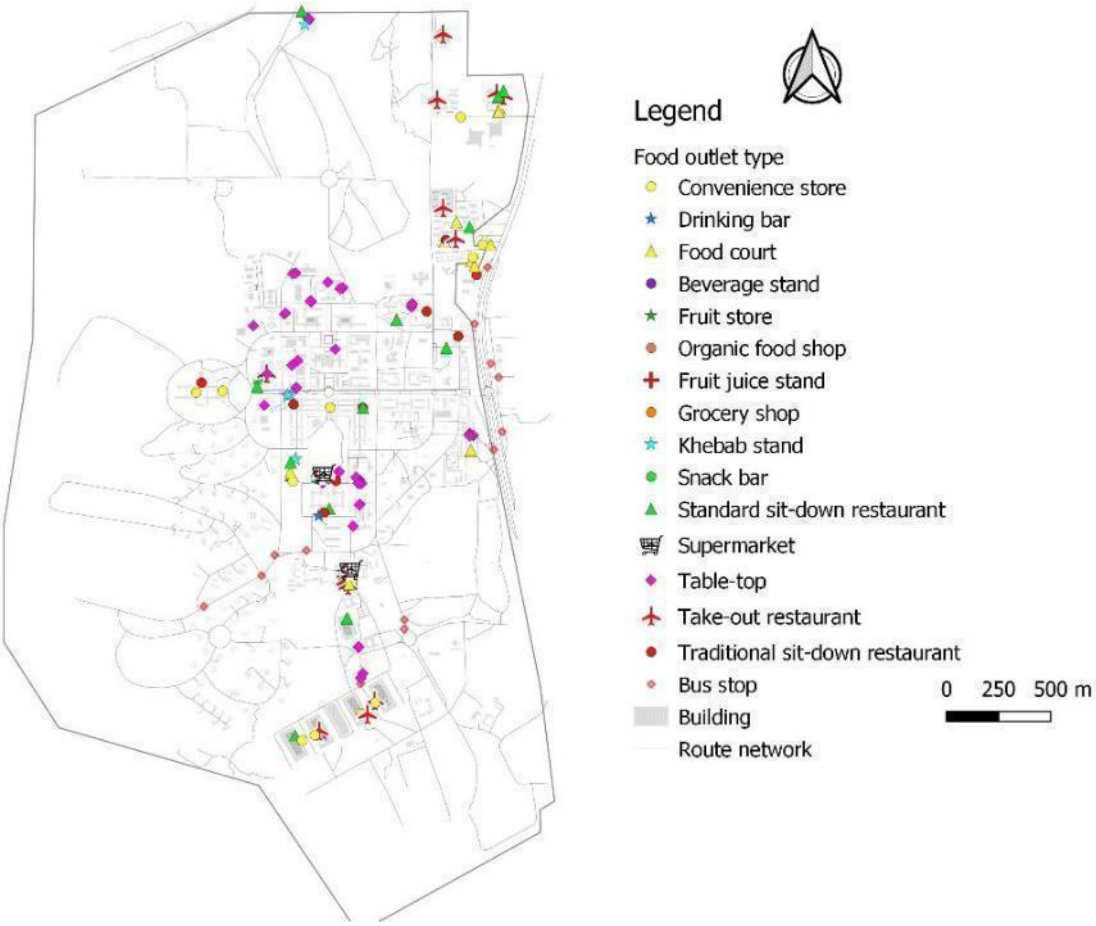
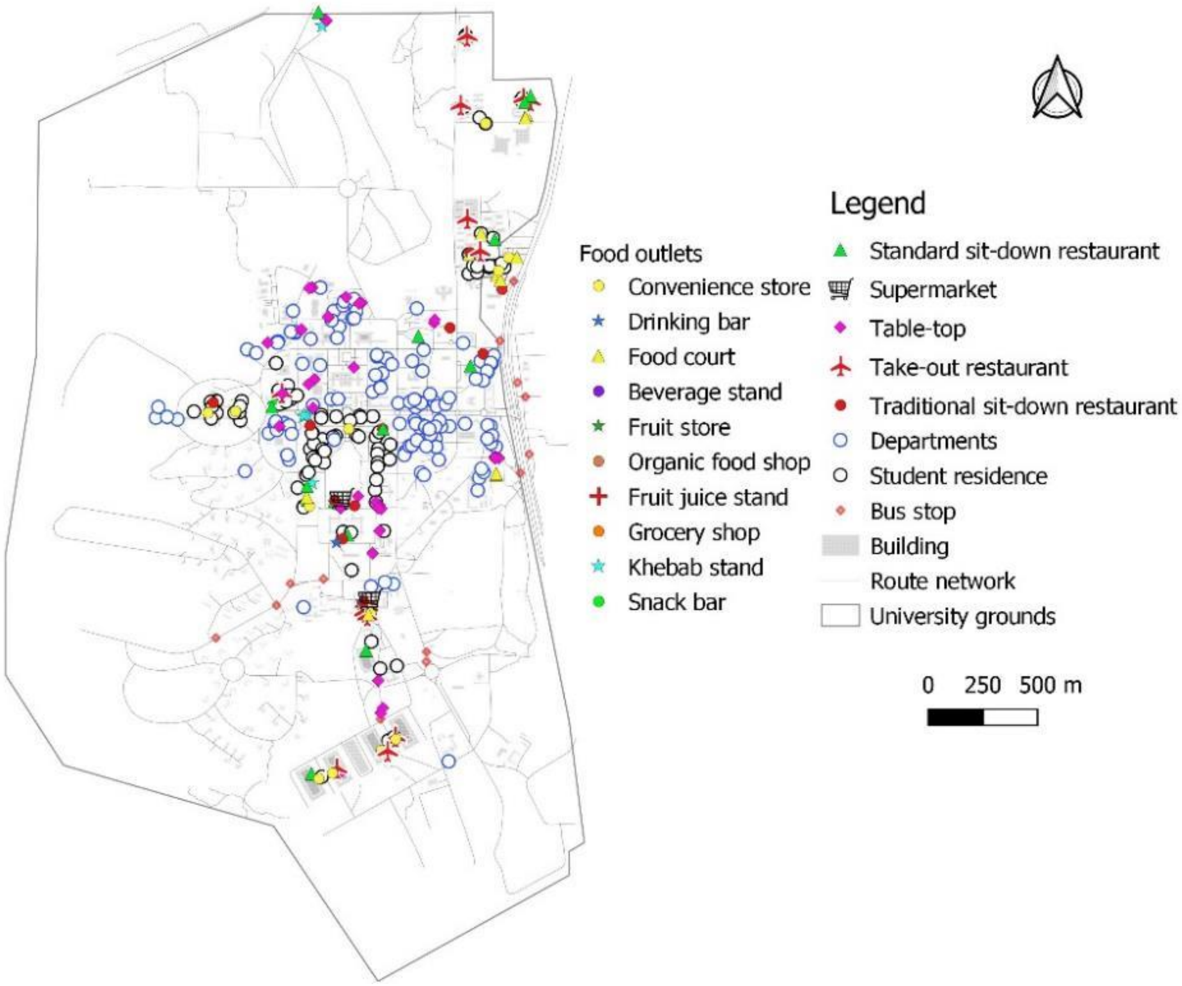


Figure 5.3: Food outlet types in relation to departmental and residential structures



Food delivery service arrangements appeared to offer the opportunity to bridge the distance gap. The study identified four (4) main third-party delivery companies, including "Delivery on Point", that operated through dispatch riders (on mopeds and motorbikes) stationed at major food-courts who took phone orders from students, procured the food (as requested by student) and delivered it to them. Through dispatch riders, students could buy food from any food outlet or vendor of choice inasmuch as they could afford the cost of delivery. Other food outlets had their own dispatch riders to deliver telephone orders to students. In addition to this, some standard sit-down and take-out/fastfood restaurants like the Basement Plus, Icy cup, Meluv's Restaurant were listed on online food ordering and delivery platforms like Swyftlyfefood, Bolt food and Jumia food, which also enabled students to order food from outlets both within and outside the University foodscape.

5.6.2 Healthiness of food outlets

Food outlet assessment showed that there were more NCD-unhealthy (50.72%) than NCD-healthy food outlets by nearly 11 percentage points and 9.42% of food outlets being NCD-intermediate. Figure 5.4 shows the distribution of NCD-healthy and -unhealthy food outlets. The heat map shows the density of NCD-unhealthy food outlets (Figure 5.5). The density of NCD-unhealthy food outlets is highest towards the south of the campus followed by parts of the middle belt of the foodscape close to a high number of student residences. About 89%, 89% and 98% of NCD-unhealthy food outlets were respectively within 100 metres, 200 metres and 500 metres buffer of halls/hostels of residence. This compares to about 85%, 85% and 94% of NCD-healthy food outlets within 100, 200, and 500 metres of student residence, respectively. See Figures 5.6A, B, and C. Statistical analysis showed that the difference between the proportion of NCD-unhealthy food outlets and NCD-healthy food outlets within 100 meters buffer of student residencies was statistically significant ($p<0.05$) but not for food outlets within 200- and 500-meter buffer as shown in Table 5.4.

Table 5.4: Two sample t-tests of NCD-health and NCD-unhealthy food outlets within 100/200/500m buffer of student halls/hostels

	100-meter buffer		200-meter buffer		500-meter buffer	
	NCD-hfo	NCD-ufo	NCD-hfo	NCD-ufo	NCD-hfo	NCD-ufo
Mean	46.61	61.04	114.39	121.08	282.47	286.52
Variance	874.97	676.39	3342.80	2496.76	17219.15	15915.13
Observations	111	120	311	368	1050	1316
df	220		617		2209	
t Stat	-3.92		-1.60		-0.76	
P(T<=t) one-tail	5.86		0.05		0.22	
P(T<=t) two-tail	0.01		0.11		0.45	

Figure 5.4: Food outlet healthiness

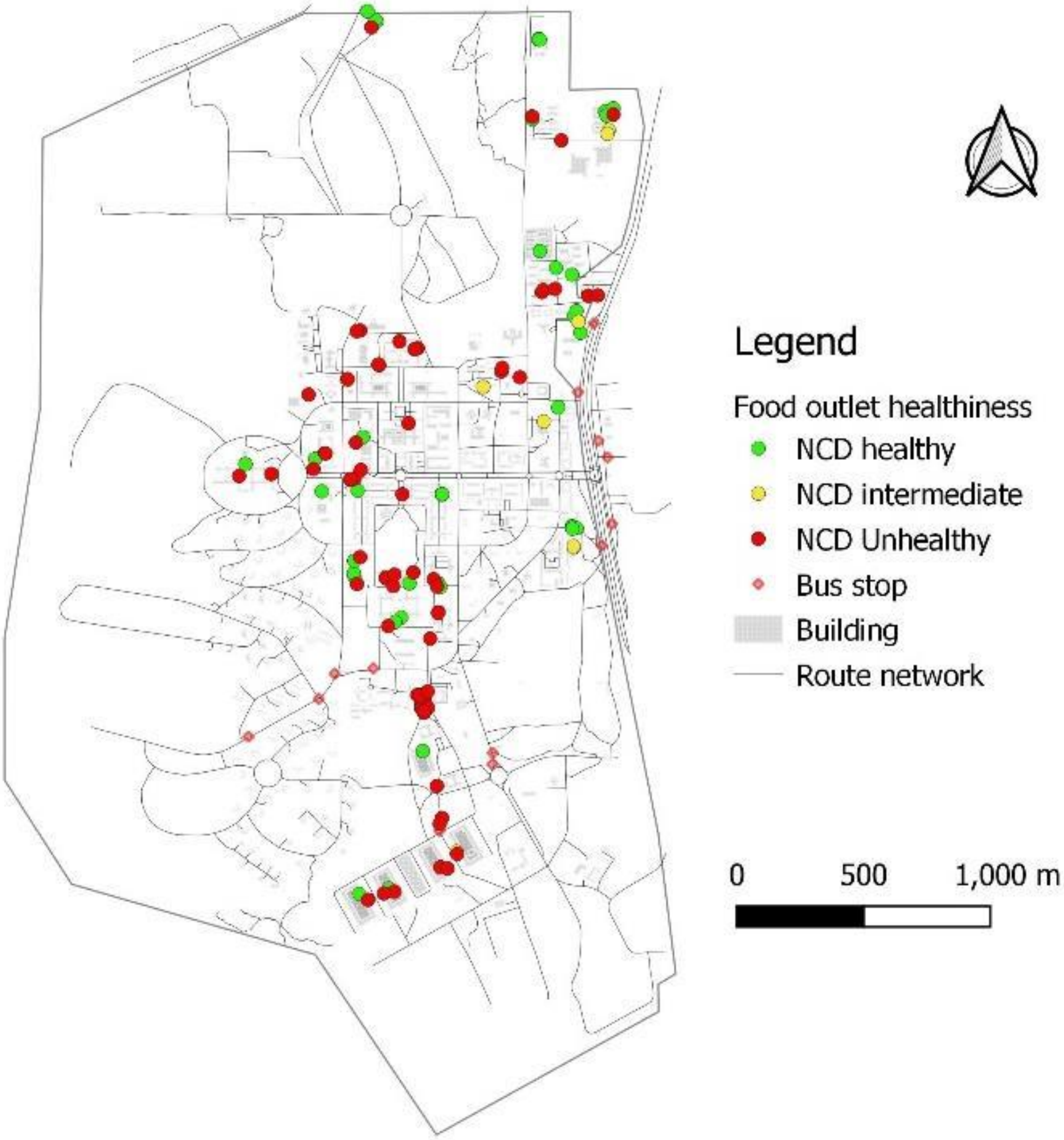
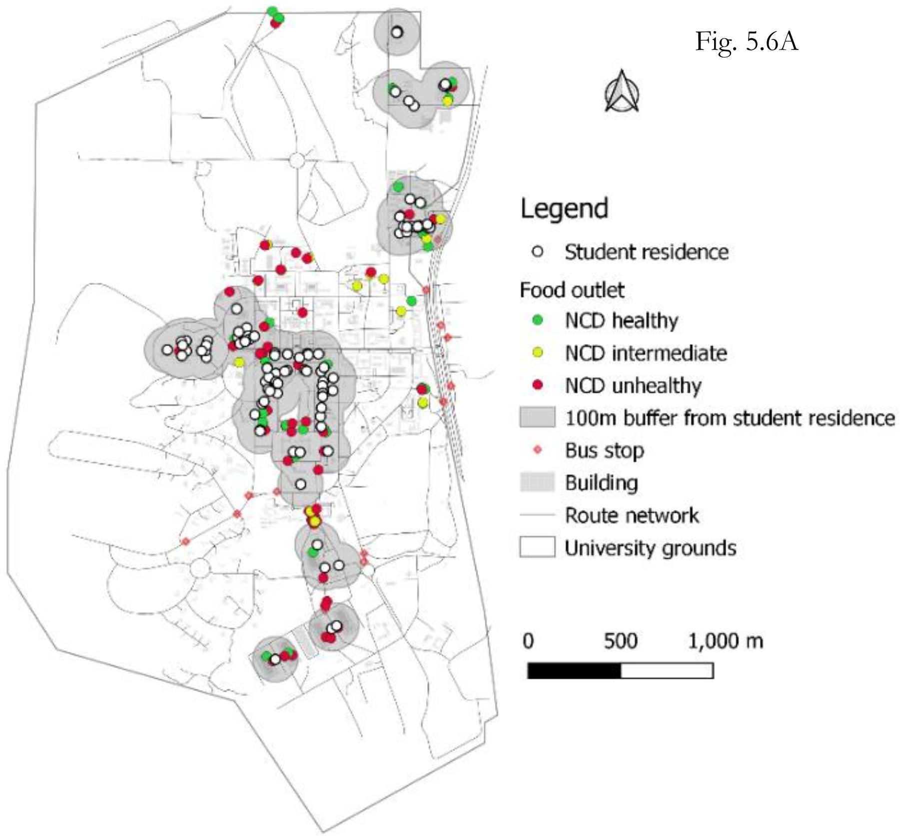


Figure 5.5: Kernel density map showing concentration of NCD-unhealthy food outlets

Figure 5.6A, 6B, 6C: Healthiness of food outlets within 100, 200 and 500m buffer of student residence



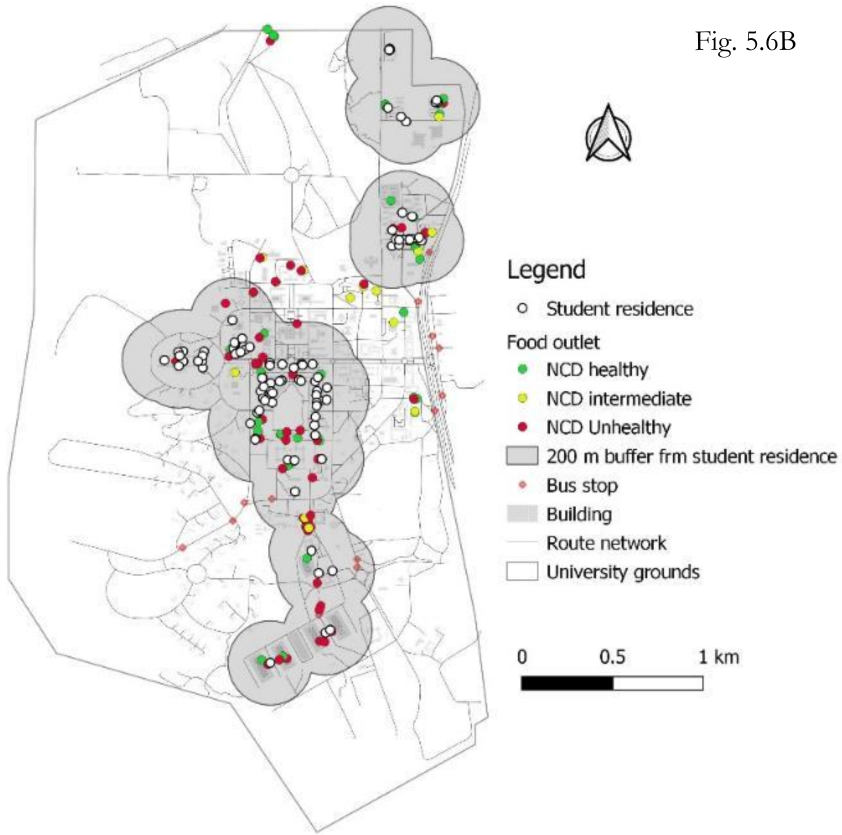
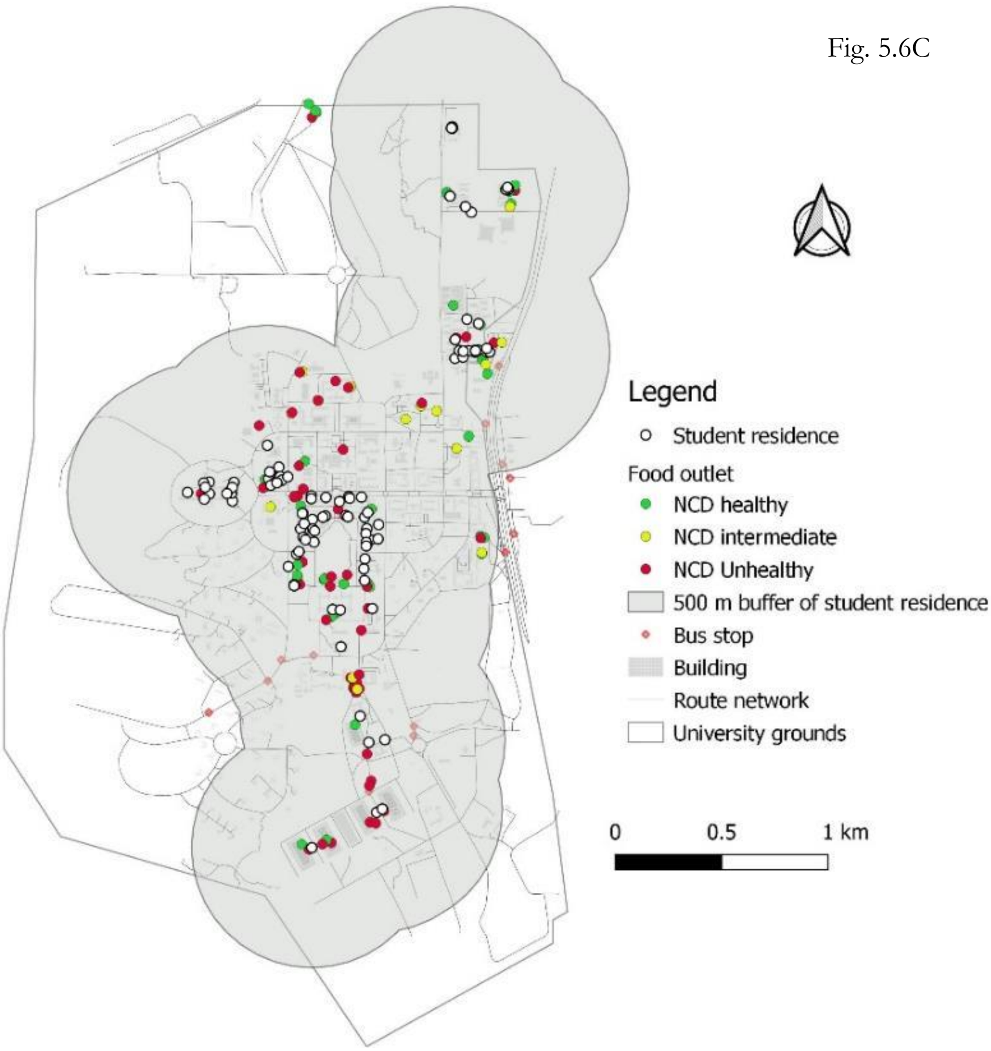


Fig. 5.6C



Regarding distance between departments and food outlets, 46%, 64% and 94% of NCD-unhealthy food outlets were respectively within 100, 200, and 500 metres buffer of departmental buildings/lecture halls (Figures 5.7A, B, C), compared to 32%, 48%, and 74% of NCD-healthy food outlets. As shown in Table 5.7, the differences between NCD-healthy and NCD-unhealthy outlets within 100m and 500m buffer of departments were statistically significant (p=0.049, p=0.00). These clustering were confirmed in the nearest-neighbour analysis (NNA). The NNA suggested that the average distance between one and another NCD-unhealthy food outlet was approximately 25 m, while the average distance between two NCD-healthy food outlets was 28 m. These results suggest that the University foodscape appears to be less healthy by making more unhealthy food options easily accessible (closer) to students. It is also important to add that more than 42% of all table-top vendors clustered around departmental buildings.

Table 5.5: Two sample t-tests of NCD-health and NCD-unhealthy food outlets within 100, 200, 500m buffer of departmental buildings

	100-meter buffer		200-meter buffer		500-meter buffer	
	NCD-hfo	NCD-ufo	NCD-hfo	NCD-ufo	NCD-hfo	NCD-ufo
Mean	69.32	63.61	124.44	119.20	311.39	299.61
Variance	581.92	563.21	2161.75	2375.67	12701.69	18559.42
Observations	132	142	383	277	1999	1089
df	272		658		3086	
t Stat	1.98		1.40		2.57	
P(T<=t) one-tail	0.02		0.08		0.01	
P(T<=t) two-tail	0.05		0.16		0.01	

Figure 5.7A, 7B, 7C: Food outlets within 100, 200, 500m buffer of departmental buildings

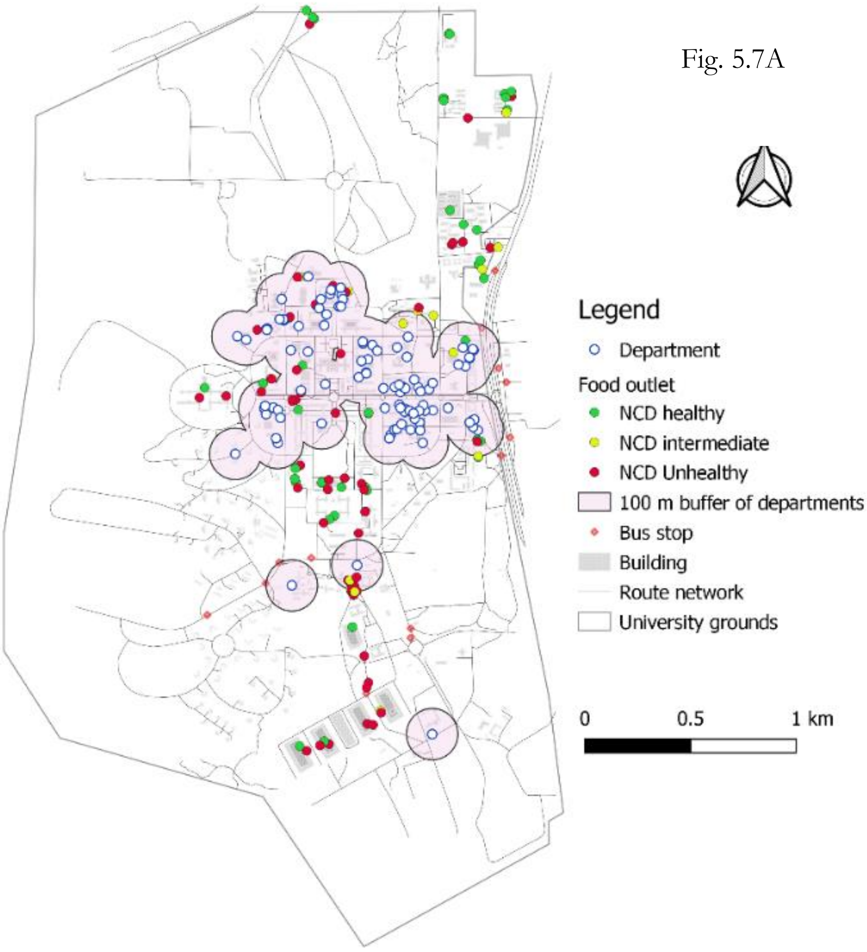


Fig. 5.7B

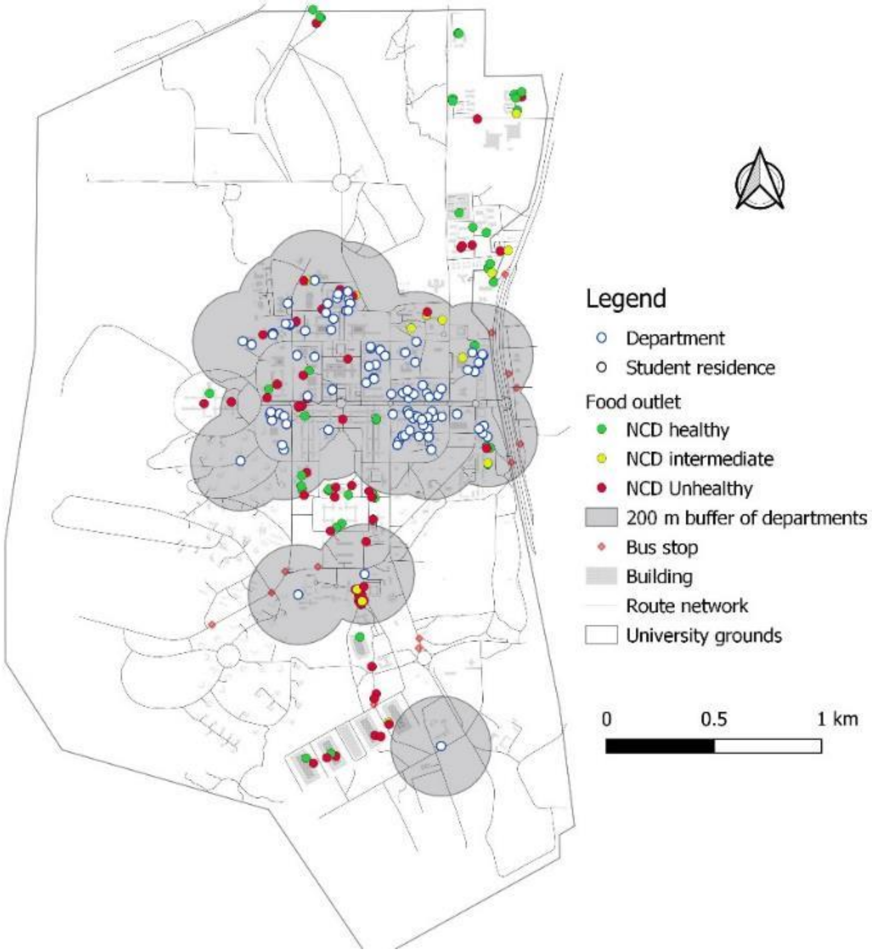
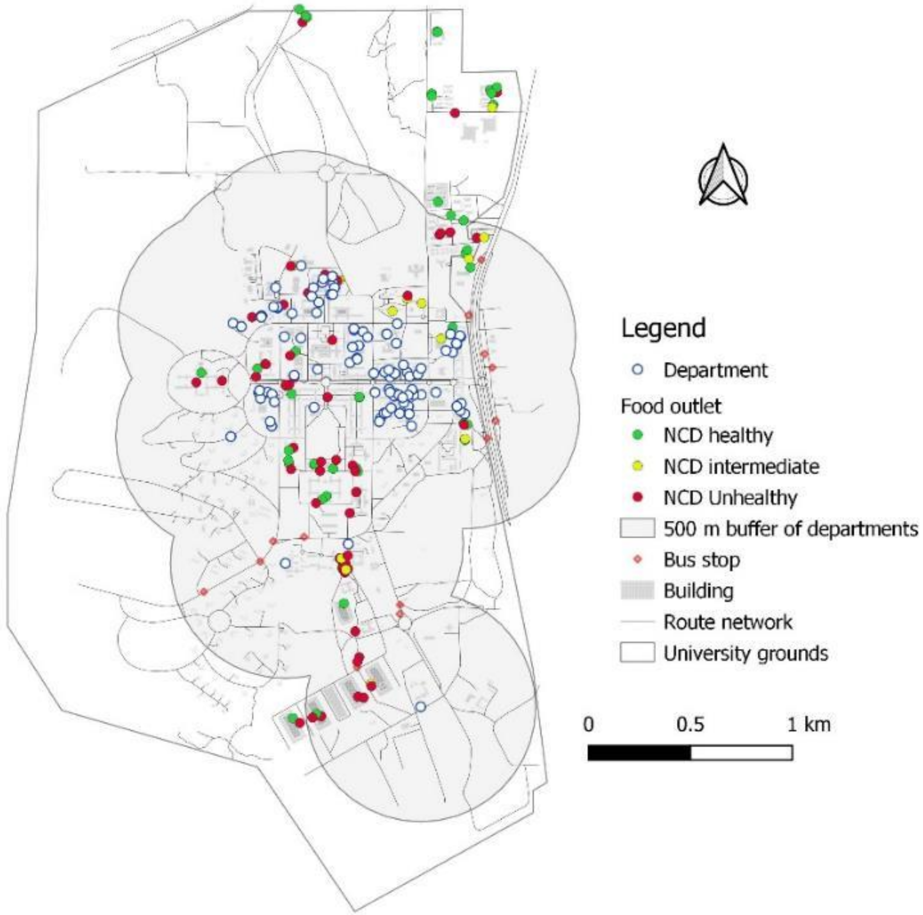


Fig. 5.7C



5.7 Discussion

This study used Geographic Information System (GIS) to characterise the foodscape in the University of Ghana campus. This is the only study to use GIS methods to characterise the features of the food environment within a Ghanaian university community context. The study identified a total of 138 food-outlets in the University foodscape, which were unevenly distributed. Table-top operations ranked the single-largest food-outlet type (27.53%), although all restaurant types (traditional sit-down (18%), standard sit-down (16%) and take-out restaurants (15%)) put together constituted nearly half of all food-outlets identified. A little over 50% of food-outlets were NCD-unhealthy, about 10 percentage points more popular than NCD-healthy food-outlet availability over the foodscape. More food-outlets were clustered around student residences with limited availability of food-outlets around departmental buildings and lecture halls. The kernel-density analysis confirmed that NCD-unhealthy food-outlets also clustered closer to student residences, creating/suggesting an unhealthy food environment.

Food service places dominated the campus foodscape, making up about two-fifths of all outlets identified. This suggests a high eating-out among students in this campus. That is, the prevailing characteristics of the University foodscape may be a materialised reflection of students' longstanding preferences. Qualitative research among UK and Bangladeshi students have suggested that academic demands on time and the lack of cooking skills among young university students make eating-out a convenient choice (Deliens et al., 2014; Kabir et al., 2018). While these reasons may not be the case among students at our study university due to differing cultural contexts, the findings here are consistent with the results from an urban poor non-student community in Ghana using the GIS method (Dake et al., 2016) and the Xi Hu district of China (Maimaiti et al., 2020) showing a high number of out-of-home cooked food and fast-food restaurants, respectively. Using the Ordnance Survey's Points of Interest (POI) geo-data and the UK Household Longitudinal Study (UKHLS) Penny et al. (2018) found that a higher density of away-from-home food-outlets around the home/neighbourhood in relation to all other food-outlet types, showed greater odds of UK households expending a higher proportion of their monthly food expenditure eating out (Penney et al., 2018). There is convincing evidence associating eating-out (food away from home) with poor diet quality (Kobayashi et al., 2017; Watts et al., 2017; Zang et al., 2018) and high total energy intake, low micro-nutrient and FV intake (Lachat et al., 2012; Llanaj et al., 2018), and high BMI among adolescents and adults (Bhutani et al., 2018; D. Kim & Ahn, 2020; Watts et al., 2017) including university students (Llanaj et al., 2018). However, in the Dake et al. (2016) study conducted in the same city as in the current study, every additional away-from-home food-outlet in the study area was associated with a 0.1 kg/m^2 less BMI among a non-university adult population. It could be postulated from systematic review evidence (Janssen et al., 2018) that the determinants of away-from-home food consumption in this student community should be considered in future research to inform tailored interventions aimed at reducing the influence of the local foodscape on the adoption of unhealthy dietary behaviours.

The study identified that food-outlets were not evenly spread over the university foodscape. This is consistent with findings from a non-university context in China in a study that used the GIS method (Maimaiti et al., 2020). The study assessed the proximity/clustering of food-outlets around departmental buildings (including lecture rooms) and halls/hostels of residence, as these are the places students spend most of their time on campus. There was limited availability of food-outlets closer to departments, with most food-outlets located around student residencies. Many of the food-outlets around departments were informal temporary table-top structures selling snacks, biscuits other confectionery and carbonated/SSB, similar to the level of prevalence observed in informal communities in South Africa (Micklesfield et al., 2013) where informal food vendors were the most the popular. Specific to university settings, Pulz et al. (2017a) used a cross-sectional descriptive design and also found more unhealthy food options and snacks sold at a university's food service facilities in Brazil. Franco et al. (2020) and Barbosa et al. (2020) also found that UPFs dominated the campus food environments at the expense of fresh and healthy food options in their assessment of the food environments in different public universities in Brazil. In HICs, similar findings have been reported in historically black USA universities in studies using GIS methods (Vilme et al., 2020). In cross-sectional surveys (Martin Payo et al., 2020; Roy et al., 2019), direct observations (Ng et al., 2019), qualitative interviews (Dhillon et al., 2019a; Hilger-Kolb & Diehl, 2019) have also found the relative availability of less-healthy food options at university campus food venues in Spain, New Zealand, Australia, and the USA, respectively, including vending machines (Grech et al., 2017; Ng et al., 2019).

Although the observed prevalence of informal food-outlets may not be expected in a highly regulated and 'elite' community like the study area, there may be cultural and normative underpinnings to this finding. It may encourage frequent ultra-processed food (UPF) consumption and lead to unhealthy dietary habit formation over time (Clary et al., 2017)—

including meal skipping, excess calorie intake. In that, the majority of students spent approximately 50% of their weekday at their departments and returned to their residences later in the afternoon or evening time. Previous research suggest that food-outlets consistently encountered by individuals in their daily routine and commuting routes trigger intentions to eat/buy and shape choice and preferences, including emotional attachment to particular food-outlets (Burgoine et al., 2013; Clary et al., 2017). However, a systematic review found limited evidence associating characteristics of the school food environment with students' food consumption patterns (Williams et al., 2014). Indeed, there was no included study from an African setting. It is suggested that universities in the study country take advantage of their powers as semi-autonomous bodies to consider healthy school foodscape interventions (especially at departments) to lead the way in national efforts towards creating healthy food environments around the home, work, and other school environments.

Another important finding from our analysis showed a higher proportion (over 50%) of NCD-unhealthy food outlets than NCD-healthy food-outlets available within the University foodscape. These outlets including traditional sit-down and take-out restaurants, convenience stores and table-top vendors offered energy-dense meals, deep-fried (fatty) foods, SSBs and other UPFs, and operated for long hours. A similar pattern of distribution between healthy and unhealthy food-outlets have been reported in both high- and low-income countries (Bodor et al., 2010; Maimaiti et al., 2020; Patel et al., 2017; Zhang & Huang, 2018), including Ghana (Dake et al., 2016). In this study, many of such NCD-unhealthy food-outlets clustered closer to student residencies and dominated the food market around the residencies (as evident on the heat map in Figure 5 and buffer maps from departmental buildings (Figures 7A, B& C)) in the face of limited availability of grocery shops stocking organic/inorganic FV. None of the two identified supermarkets were full-service, stocking mainly ultra-processed/packaged foods only with no fresh food products. The availability of unhealthy food-outlets (such as SSB vending machines, fast-food, convenience stores) within 1km buffer of schools has been found to increase the consumption of SSB's (Godin et al., 2019), deep-fried salty snacks, junk foods or other unhealthy foods and low FV intake among students in Canada (Godin et al., 2019), the UK (Shareck et al., 2018), Ireland (C. Kelly et al., 2019), and Brazil (Azeredo et al., 2016). Neighbourhoods with relatively limited outlets stocking fresh food options have been associated with significantly low FV consumption (Duran et al., 2016; Moayyed et al., 2017) and healthy food consumption in general (Elizabeth et al., 2020). In Ghana, for every other convenience store in a poor non-student urban community in the same city as this study, BMI in persons aged 15-59 years increased by 0.2 kg/m^2 (Dake et al., 2016). In this study, the long operating hours of outlets (including convenience shops, table-top vendors selling bread with omelets and kelewele, and khebab) closer to student residences may encourage less healthy late-night eating habits among students. Further research could consider the influence of this campus' food environment features on students' food choice and eating behaviours.

Most studies characterising the food environment have focused on a limited selection of food-outlet types. This study included all food-outlet types available within the study area. Another strength of this study is the use of a robust classification instrument to categorise all available food-outlets as NCD-healthy, NCD-intermediate or NCD-unhealthy based on relevant research (Caroline Santos Costa et al., 2018; Elizabeth et al., 2020; Grootveld et al., 2018; WCRF/AICR, 2018b).

Despite the strengths, this study had limitations. There was bad satellite imagery in sections of the study area during the online mapping and validation to create the study's base map. A few of the tasks on the University of Ghana campus HOT Tasking Manager appeared invisible, because there was cloud cover obstruction. Those parts could not be digitised and some structures may have been missed at the online mapping stage. However, such structures would have been captured during structure verification/ground-truthing.

A second limitation could be the geographical inaccessibility encountered during the ground-truthing exercise. Access into some residential areas like the Vice Chancellor's area and the University Guest Houses, were not allowed for security reasons. As this could mean some outlets missing from the maps, its impact on the study's findings would be negligible, given that students were not allowed access into these areas.

In close relation to the above, the study may not have captured all outlets within the university foodscape given that some food vendors were mobile. This includes vendors who ported FV, pastries, ice creams, and snacks on their heads; or carted ice cream, SSBs, and pastries on bicycles to various points of the foodscape. However, the mobile food vendors constitute a small proportion of food resources in the study community to make a significant difference to the findings reported here.

Another limitation could be issues encountered during the upload of fieldpaper sheets to Fieldpaper.org after ground-truthing. Images of some updated fieldpaper sheets captured using the Samsung Galaxy S5 and Alcatel-3V phone cameras could not be uploaded to

Fieldpapers.org. Those parts of the map were therefore manually updated online with information captured on the fieldpapers during structure verification using the individual fieldpaper codes. This may have affected the accuracy of the point location for the structures entered manually. Although this was the case for an insignificant number of the structures identified and mapped, the findings of the study should be interpreted in the light of this and the foregoing limitations.

Many food items become unhealthy when consumed beyond recommended levels. Thus some of the food items used as markers of healthiness may become risks to personal health if not consumed in the most appropriate and recommended manner (Tapsell et al., 2016). Therefore, the food outlet healthiness categorisations—NCD-healthy, NCD-intermediate, NCD-unhealthy—developed in this study should be interpreted with circumspection and in the proper context.

5.8 Conclusion

This study set out to identify the features of a university food environment and to assess the healthiness of the food-outlets within the campus foodscape. The campus foodscape offers a variety of food resources but an imbalance in the distribution of the food-outlets was identified. However, there was a robust food delivery system with some food service places listed on online food ordering and delivery platforms. Nearly half of the food resources qualified as NCD-unhealthy food outlets which clustered around student halls/hostels of residence, suggesting a less healthy food university environment. Overall, our findings have important implications for further research and policy interventions towards identifying environmental risk factors associated with unhealthy food behaviours, overweight/obesity, NCDs, and other health outcomes among university students in Ghana during term-time. It is also suggested that interventions to formalise food-outlets in/around departmental buildings should be considered and leveraged to create a healthier foodscape in the vicinity of departments.

CHAPTER SIX

"WE THINK ABOUT THE QUANTITY MORE": FACTORS INFLUENCING EMERGING ADULTS' FOOD OUTLET CHOICE IN A GHANAIAN UNIVERSITY FOOD ENVIRONMENT: A QUALITATIVE ENQUIRY.

6.1 Chapter summary

Background: In recent decades, the food environment has seen rapid transformation globally, altering food availability and access along with how people interact with the food environment and make food-related choice.

Objectives & Method: This explorative study was to identify the factors that shape the decision-making process for food outlet choices among emerging adults in a Ghanaian University food environment. The study uses focus group discussions in combination with novel dyadic interviews with best friend pairs. Verbatim transcripts were analysed thematically using NVivo 12.

Results: Drawing on socio-ecological model (SEM) of behaviour, the study identified three interwoven levels of influence shaping emerging adults' choices of food outlet. The main factors influencing food outlet choice were identified as price of food, convenience of access, hygiene, purchasing power, quantity/satiety, and craving. Overall, the findings suggest that the location of a food outlet, solely, does not make an outlet a preferred choice for use or patronage, but how much the food outlets' characteristics accommodate emerging adults' social and individual needs, goals, constraints, and preferences in a specific situation. The findings shed light on the complexities of the decision-making process for food outlet choices and on the influences of the food environment on dietary behaviours and vice-versa.

Conclusion: Although food pricing intervention that regulates food prices may reduce some access barriers to healthy food, multi-component interventions that combine such structural level intervention in food retailing along with reducing the proportion of unhealthy food outlets, and individual level components may be more effective, although this needs to be researched.

6.2 Introduction

In Study Component 3, the research mapped and characterised the healthiness of the resources that constitute that constitute the physical food environment in a case urban university (or elite) community in Ghana. As discussed in Chapter 2, the food environment is the interface where individuals interact with the wider food system and make food choices. Although choosing where to shop for food or buy from appear to be a simple act, it is the silent social transaction between the macro food system (food production, processing, supply) and individual consumer decisions. It is also viewed as a complex process connected to the dynamics of the physical environment.

It has been noted that emerging adults lack the skills to negotiate the multiple constraints posed by the current food environment causing them to often settle on unhealthy options in their food-related decisions (Malan et al., 2020; Matthews et al., 2016; Murray et al., 2016).

This chapter reports the results of applying the SEM to explore emerging adults' interaction with their university foodscape in their daily food shopping decisions in urban Ghana. The study uses focus group discussions in combination with novel dyadic interviews (involving best friends) to identify the factors that influence university students to decide to shop for and where to buy from. This is the first study to apply the SEM to explore the socio-ecological dynamics of food shopping among emerging adults in an urban foodscape in the SSA setting.

6.3 Methods

This study, using data from both best friend pair interviews (BFPI) and focus group discussions (FGD), is part of a wider project exploring the impact of the urban food environment in SSA on food-related behaviours of educated urbanites. The study was approved by the Biomedical and Scientific Research Ethics Committee of the University of Warwick (BSREC) (REF.: BSREC 115/18-19) and the Ethical and Protocol Review Committee (EPRC) of the University of Ghana (REF.: CHS-Et/M2—4.12/2019-2020). Informed written consent was obtained from all participants prior to both BFPI and FGD sessions. The study is reported following the Consolidated Criteria for Reporting Qualitative Research (COREQ).

6.3.1 Recruitment

The research recruited students from the University of Ghana campus. Participants were recruited from all colleges of the University through poster advertisements on residential, departmental and faculty notice boards as well as on social media platforms and through in-person invitations. Participation was voluntary and students at all levels of study were eligible to participate as long they were aged 18 to 25 years, the average age bracket for most university students in Ghana.

Focus groups consisted of a minimum of three and a maximum of eight participants. For best friend pair interviews, a participant and one friend only were eligible to participate. For the purposes of this study, a best friend (or close friend) was defined as "a person within participants' own age group who they knew very well; with whom they met regularly (at least, a couple of times per week), engaged in activities with, 'hang out', and/or had fun or 'chilled out' with, and with whom they shared emotional or difficult moments" (Sedibe et al., 2014). This could be someone from the same neighbourhood or the University, and not necessarily from the same faculty, department or hall of residence but must be a member of the university community. Eligible participants who expressed interest were given study information packs, including consent forms and a brief demographic questionnaire.

6.3.2 Data collection

A semi-structured approach was adopted with a topic guide used to inform the interviews and discussions. The topic guide was developed iteratively and piloted in a BFPI and an FGD with students from the study campus, data from which were later included in the final analysis as no significant modifications were subsequently made to the topic guide. This topic guide was developed to explore determinants relating to emerging adults' food outlet choices and eating/food-related behaviours. It also invited emerging adults' opinions on what changes to the food environment would support them to undertake healthy/sustainable food-related behaviours. All interviews and FGDs were conducted by the first author (DOM), who had previous experience and training in qualitative interviewing. Research assistants took turns in assisting DOM to take field notes and audio-record interviews and FGDs. FGDs and BFPIs were conducted within the University campus and at participants' convenience to minimise discomfort or distress. The study aimed for a minimum sample size of 48 using the principles of data saturation (Saunders et al., 2018) and maximum variation sampling (Palinkas et al., 2015), along with DOM's PhD time constraints. Data collection proceeded between November 2019 and March 2020. Each participant was given a ballpoint pen and airtime voucher in compensation for their time.

6.4 Analysis

Verbatim transcripts were analysed thematically after Braun & Clarke (2006) by DOM after reading transcripts many times to familiarise with the data. Transcripts were initially coded line by line using NVivo version 12 (QSR International Pty Ltd, 2018) and then indexed into data tables to create descriptive themes. Descriptive themes were compared to identify patterns in order to generate analytical themes. Based on the pragmatic double coding process as described by Barbour (2003), emergent themes were refined iteratively based on discussions with other members of the research team. Themes were presented to participants for authenticity checking.

6.5 Results

In total, 46 emerging adults participated in eight BFPIs and 7 FGDs, lasting 60-75 minutes respectively. Fieldwork was curtailed due to COVID-19 restrictions on campus and 46 participants was close enough to our intended sample size that we pursued data analysis at this stage, rather than delaying study progress indefinitely. The full demographic details are presented in Table 6.1. All interviews and FGDs were conducted in person on the University campus in an enclosed meeting room or at participants' residence (in one BFPI).

Table 6.1: Characteristics of participants

Variable		Number	Percentage
Gender	Female	21	46.7
	Male	25	53.3
Age range	18 to 24 (mean 21.2)	46	100
Nationality	Ghanaian	46	100
Ethnicity	Akan	17	37.0
	Ewe	14	30.4
	Others	12	26.1
	Prefer not to say	3	6.5
Level of study	Year 1	3	6.5
	Year 2	11	23.9
	Year 3	21	45.7
	Year 4	10	21.7
	Postgraduate (PG)	1	2.2
Religion	Christian	39	84.8
	Moslem	5	10.9
	Not religious	1	2.2
	Prefer not to say	1	2.2
College	College of Basic and Applied Sciences	7	15.2
	College of Humanities	29	63.0
	College of Education	5	10.9
	College of Health Sciences	5	10.9
< 18.5	underweight	9	19.6
18.5–24.9	normal weight	29	63.0
25.0–29.9	overweight	6	13.0
30.0–34.9	Obese	2	4.3
Accommodation type	Family/Guardian	1	2.2
	Private Hotel	12	26.1
	University-managed Hostel	33	71.7

6.5.1 Themes: Determinants of Food outlet Choice

6.5.1.1 Environmental Factors

6.5.1.1.1 The price or affordability of food

The cost of food was the most important factor most students (n= 32) considered in deciding where to eat from or shop for food. Students exhibited a complex thought process regarding which outlet to buy from to achieve value for money. They shopped for different food products at different outlets in order to get the best value. Students compared prices of food from various outlets and the majority expressed the importance they attached to outlets offering affordable and cheaper options. They demonstrated a good knowledge (although incomplete) of the University foodscape as well as relying on their social networks to identify outlets offering food at lower prices.

> "... I will also say the same thing. So anytime I'm going to buy food, there are two things I look at: the cost of the food, and then the brand name or the recognition" (R1, FGD 6).

> "The affordability… is the most important for me… Because I know I can't afford… so… I just either go to Bush Canteen, [or] Night Market ..." (R2, FGD 2).

Students emphasised the importance of price when they pointed out that food outlets that offered food at affordable prices were the most patronised and most popular among students on campus. Students were minded to shop at outlets that offered the best fit with their status as students and their income/ socio-economic status. Some food outlets appeared to be the preserve of university staff and were described by students as not being in their "league" as they were thought to be "really expensive."

> "Yeah, I think it's these two places: Bush Canteen and Night Market. Yeah…. these are the places students prefer to buy from… It's quite affordable for students." (R1, BFPI 5).

> "Ok so I think basically because of... the cost or the price of their foods. Again, to me basically I think its because of the price or the cost their foods that they... serve or they sell." (R1, FGD 6).

Some students sacrificed convenience in order to get the best deals. According to respondent accounts, a small section of students travelled long distances to buy from certain food outlets because of affordability. Such students avoided proximal food outlets, including those within their hostels or halls of residence, to patronise those that offered variety and value for their money even though they were usually far off.

> "I don't think distance really matters because sometimes you see people whose hostels or halls are like let me say about 2 kilometres or like people who are not even on campus coming all the way to… the Night Market just to buy food. So the motivation is… the… variety of foods and then the price." (R2, BFPI 6).

Convenience shops within halls and hostels, and campus supermarkets were viewed as expensive outlets unsuitable for "bulk food shopping." They were mostly used in emergencies, to buy snacks, beverages, and water.

6.5.1.1.2 Location or proximity of food outlet

Issues relating to the convenience of accessing food outlets were frequently reported by students. The majority of the young people considered proximity in deciding where to buy food from during term time. When hungry, most students would want to buy from the closest food outlet. Walking long distances to the bigger food outlets with a wider variety was something many students did not want to do. In many cases, some students thought it stressful or "too much work" to walk to a food outlet farther from them to buy food and would usually use food joints on their commute between their classrooms and hall/hostel of residence. Otherwise, they would only walk if the distance to the food outlet was "walkable far."

> "…. most of the time its rice I eat. And then as he said, sometimes if I'm hungry, I don't really want to walk far to go and get something.... And most of the time I go to Night Market because I see Bush Canteen as a little far from me." (R3, FGD 5).
>
> "Yes, and also… the distance… distance also determines. I know if I go to Night Market I'll get… kenkey to buy or rice... Maybe yam and kontomire, I know it's very nutritious but the distance I'll walk to Night Market is far. So, I'll just go and buy the heated rice..." (R2, BFPI 3).

There was an internal conflict in emerging adults, between a preference to eat from proximal food outlets (which did not offer variety and were sometimes more expensive), and yet the demonstration of a desire for affordability and to vary their diets. However, many students settled on those food options closest to them, despite this conflict, including the many "indomie" instant noodles joints dotted around the halls of residence, and savoury and sugar-sweetened snacks which were the most popular in grocery stores within hostels and halls of residence.

> "… I think about the closeness. Sometimes even though I've budgeted my money for the week, I'll still come here [dining hall in their hall of residence] because I feel it's hard work to walk all the way…" (R2, FGD 2).
>
> "Some people consider distance… walking from here to that place, come on, is too far. So we just find Indomie somewhere close. For Indomie, they're very near to us… two, three steps, we're there. You buy and then you just go back..." (R2, FGD 4).

For some other students, nothing else was important as long as the food was close to them. From respondents' account, whether this would make them follow a monotonous diet or eat unhealthy foods was inconsequential.

> "Where to buy the food…timing and proximity I think are the first things I consider. Then maybe the cost too will come. I am at the Diaspora Hall and if is in the afternoon I wouldn't walk all the way to Night Market for food. I'll rather buy what is available in the hall. Whether I've been eating rice for a long time or what not, once is near the hall, nothing matters; taste, cost, whatever doesn't matter…" (R3, FGD 3).

The few students that used private cars on campus also shared a similar view. Although they were the group that would usually buy prepared food from food outlets outside of campus, they wanted to eat from places closer to the campus and other places they would avoid traffic delays.

> "And then… the nearness or the... location of wherever I want to eat. That one too is important. Because if I'm really hungry I don't want somewhere far that I'll be in traffic and... so I'll just look for somewhere close to campus." (R2, BFPI 2).

6.5.1.1.3 Hygiene

Many emerging adults were concerned about hygiene. For many students, whether or not caterers/ vendors observed personal hygiene etiquette was paramount to their decision to buy from a food outlet. Participants expressed concern especially about whether food attendants covered their hair, and whether they chewed or talked over the food being served.

> "Your appearance, how you appear towards your customers. For instance, if you cover your hair… if you're woman and…like covering your hair with something when you're selling the food I would like to buy from you than someone who always leaves her hair." (R2, BFPI 5).

The environment within which the food outlet prepared food was also considered by many of the students in choosing where to go to eat. In many cases, students reported that they did not buy from certain food outlets because of the conditions under which they prepared their food.

> "The... problem is that usually, you see with big restaurants you don't see where they make the food. Unfortunately for us, with our places, especially Bush Canteen and the Night Market, you see where they make the food... For Bush Canteen for instance... where they sell, it's ok. I'm not going to say it's dirty. You understand? Or even Night

> Market. Like the environment is not really dirty. When you look at the back, where they actually do some preparation, that's the place that is nasty to me...” (R2, FGD 5).

Other students believed that certain dishes, especially soupy meals, required careful handling during preparation and therefore were careful where they purchased such meals from. They did not think that some food outlets were hygienic enough to safely manage the preparation of those meals, considering that many vendors of such foods did not have properly engineered kitchens and used ‘makeshift’ arrangements. Soupy dishes like fufu with soup and banku with soup were the food options mostly cited by emerging adults.

> “Then the environment too counts a lot. Inasmuch as I like to eat close to me, is not every food that I eat outside because of... I'm not so much ok with how they prepare soupy food and how they handle it outside. So the soupy food I'm very careful. Yes...” (R5, FGD 1).

Students also considered whether food outlets had a hygienic seating area where they could sit comfortably to eat. From respondents’ account, most of the popular places on campus did not have hygienic seating areas for eating. In many cases, students expressed concern about the presence of flies, which they saw as a nuisance and a health threat. See Table 6.2.

Based on hygiene concerns, a small minority of students did not buy food from campus food outlets and preferred to prepare their own food or bring food from their family or relations’ homes if they were near the University.

> “Yes. 'cause I don't really like buying around 'cause of like the hygiene and everything. Like I don't really like how they cook on campus; most of these Bush Canteen... and the Night Market vendors. Ha! I don't like how they cook and how like there are flies and... like everything around. Is not appetizing to me. So I mostly cook my breakfast and eat. Then... I can cook maybe jollof and keep some in the fridge. So when I come I'll heat it.” (R4, FGD 5).

There was evidence of students who had no option apart from buying from campus food outlets even though they expressed concerns about hygiene. This usually included those who lacked culinary skills or cooking equipment, and storage or refrigeration facilities as well as those that wanted to make time for academic work. Such young people bought from campus food outlets but usually preferred to “take away and eat” in their rooms. During the exams period, the majority of students reported not wanting to spend time cooking and had to resort to campus food outlets.

6.5.1.1.4 Variety of foods at the food outlet

Most students considered the variety of foods offered by food outlets in deciding where to eat. From respondents' accounts, many students preferred to go to food outlets that had variety of foods on offer.

> "And… then also they… have lots of varieties. Especially like these two places, compared to probably some food joints. They… have from rice… I mean different… different… banku… And its different people selling all foods." (R2, FGD 5).

> "Ok, is because over there you can find all manner of foods there. Like different types of food…" (R2, BFPI 6).

According to emerging adults, this meant that they had the chance to choose what they preferred. Students reported that they were sure to find some food if they went to food outlets serving a variety of dishes, compared to those that offered only one or two types of dishes where they were likely to be disappointed after walking "all the way".

> "… I also think it's because there are variety of foods there as compared to the other places. 'cause if you go to Night Market, for instance, you get rice, you get banku, fufu, like yeah, varieties. But as compared to the other places, sometimes is only rice you'll get over there. Or two or three. But for Night Market, you get a lot of food." (R3, FGD 1).

Some students considered food outlets that offered fruit options as part of the variety of foods on offer. From the account of some students who liked fruit, most food outlets, including those at the halls, did not sell fruit. They would therefore go to food outlets where they would get some fruits in addition to a variety of other food options.

> "… I think people also prefer those places or I prefer going there because they also sell other things some of the places in the halls do not sell. Like fruits, bananas and egg… Most… eateries in the halls do not sell those… and for someone like me who like enjoys having bananas, I definitely will want to go there and then buy." (R1, FGD 2).

Other students who considered variety of foods were also interested in food outlets where they could choose from a wide range of local dishes. They reported that such variety was not offered by most food outlets within or closest to student accommodation.

> "I think students also prefer those ones because there are more local foods at the Night Market and Bush Canteen. Because with the dining halls and the... halls, they don't have the variety in terms of the local food. They just have a few. Maybe the popular ones like the banku and

> fufu. But the Bush Canteen and the Night Market, you may get... kenkey with pepper, you can get the gari and beans, you can also get... TZ [tuo-zaafi].” (R1, FGD 4).

The most popular food outlets among students were reported to be those few that gave students a wide range of options. Almost all students agreed on two food outlets as being most preferred among students in terms of variety of foods on offer.

6.5.1.1.5 Hours of operation

The times at which food outlets opened and closed to students was also an important factor emerging adults considered in choosing which food outlet to eat from. This was a factor most students considered. The popular food outlets were those that operated nearly around the clock.

> “…food is never finished. There's always food there... They close but quite late. Probably at 12 midnight or so.” (R2, BFPI 2).

> “And I think because is 24/7... Almost ehm... 18 out of 24 hours...It's almost 99 point something… they run from morning till... Midnight.” (R1, BFPI 4).

From respondents’ account, many students stayed up late or studied into the night. Such students therefore considered food outlets from which they could access food when they felt hungry even at night. The language used by students who expressed this need used the idea that they placed value on a food outlet being reliable around the clock.

> “And the time too. The time Night Market operates is somehow better and they stay much deeper in the night. So, at any time of the day you go there you'll find something to buy.” (R1, FGD 1).

6.5.1.1.6 Food vendor attitude

Students were also particular about how food vendors treated them. They considered the attitude of food attendants in deciding where to buy their food. Whether or not vendors were polite in their speech or respectful in their attitude towards students determined students’ continued patronage.

> “I also consider attitude. Like the person selling the food. Your appearance, how you appear towards your customers… how you talk to people. Yes, so if you’re someone who always frowns… I won’t buy.” (R2, BFPI 5).

Indeed, some participants reported their decision not to buy food from certain outlets due to the attendant's attitude.

> "And then the servers' attitude… I've actually stopped buying food at some places in Night Market because of their attitude. Sometimes they make you feel like they don't need your money but they have also forgotten that without us they can't also survive. It's like a symbiotic relationship." (R1, BFPI 3).

In very severe cases, some student accommodation management had fired some food outlet operators based on reports regarding how they treated students. One respondent reported how a privately managed hostel dismissed some food outlet operators due to constant complaints from students.

> "The hostel managers 'cause when Evandy built their hostel, they sacked some of them out. And they take like students review. There was this was lady, she used to treat everyone badly. Like she's so rude. So they just sacked. Like that's how they regulate it. So if you have a complaint and you tell the hall or hostel managers, they'll do something about it." (R4, FGD 5).

Students gave an indication that such dismissals and regulation did not usually happen with food outlets in university-managed facilities including those in halls of residence. Students felt let down by those assigned with the responsibility to regulate food outlets and food sold within the immediate University food environment, if any.

6.5.1.1.7 The surrounding environment/ atmosphere

A section of the respondents also considered the ambience of the food outlet in choosing where to eat from. Emerging adults distinguished two atmospheres at food outlets within the university foodscape namely, "neat restaurant" or "continental" setting and the "local setting" or "typical African market experience". From respondents' account, the "neat restaurant" or "continental" setting was the formal Western-style restaurant environment where they felt one had to observe table manners or eating etiquette to avoid embarrassment. While it was reported that this made students feel "rigid" and "bound", emerging adults expressed preference for the "typical African market" ambience where they were free to make "noise" and behave freely with their friends. They did not have to follow any formal rules and table etiquette.

> "…when you go over there to Bush Canteen and Night Market, there is this unity and noise and everything 'cause that is why my friends and I

> would want to go and then eat. But then I can’t go to these restaurants and go and sit…even talk because you have to observe food etiquette but over there its more or less like we are in our own…” (R3, FGD 2).

> “I think that she’s talking about like the typical African market experience sort of. ‘cause then when you come here, even though they sell local dishes, it’s like continental because you have to join a queue, pay up, then they will give you the receipt…. It’s not like there [Night Market and Bush Canteen] where you get to get the typical African experience with the noise, the local stuffs...” (R1, FGD 2).

> “And I get the sense of like a local or you feel more free let me say... because of the local setting and all that.” (R1, FGD 4).

Other young people pointed out the importance of privacy at the seating or dining area of food outlets. According to respondents, when the dining area was not “enclosed” it created an uncomfortable atmosphere as all passersby and other customers would be watching while they ate.

> “Sometimes too the environment where…you get to sit and eat. Sometimes you go and its chocked or sometimes it’s like too open. If you’re eating everybody will be watching you. But for some places its quite enclosed…so you can feel free and eat over there. That’s why most at times I usually go to Bush Canteen.” (R1, BFPI 5).

Although young people expressed their preference for the traditional African restaurant atmosphere, they also considered some level of privacy at the dining areas of eateries in deciding where to eat from. These factors, according to them, together created the comfortable ambience within which they could “feel free and eat.”

6.5.1.2 Societal Factors

6.5.1.2.1 Peer influence

Another determinant of food outlet choice reported by young people had to do with social modelling, whereby other people’s choice served as a guide for where young people bought their food. Friends and roommates influenced young people’s food outlet choice. Based on the testimonial of peers, students would want to patronise certain food outlets to verify their friends’ endorsement.

> “...sometimes our friends recommend a particular to us. So you want to also taste the food. So a friend went to buy something from Night Market and was like… there are two people who sell kenkey and there's one that people like and there's one that people don't like… those kind of experiences will lure me to also buy food from those places…” (R3, FGD 1).

From respondent accounts, other young people got to know about new food outlets through their peers. Following such recommendations, some students would try food at a new food outlet.

> "And also based on other people's testimonial… if I hear that ok there's this new place, the food is really good, they treat people well and everything, I'll definitely want to try it." (R1, FGD 2).

6.5.1.2.2 The Occasion

Social gatherings also influenced where young people ate. This was reported by a small number of emerging adults. During special occasions such as birthdays, students did not eat at their usual locations.

> "…if it's outside campus then its the occasion... or... the event, first of all, what are we celebrating… is going to determine the location; where we should go." (R6 FGD 1).

> "And then the last one is the occasion. So if it's a special occasion like maybe... ok, maybe if it's a night out with friends or a birthday party or something like that, that'll also decide where I would go and eat." (R2, FGD 1).

Students reported that they came together with friends to celebrate such occasions and therefore would usually require venues large enough to accommodate their friends and guests.

> "... everything she said is like me... I look at the occasion and event. Like my birthday, for instance, I cannot... go to my Night Market to buy... beans. I mean, everybody knows you're celebrating birthday... all you went to do; buy just beans is, I mean, weird. But on your birthday, at least you have to glorify God through some kind of get together or something." (R4, FGD 1).

6.5.1.3 Intrapersonal Factors

6.5.1.3.1 My Budget/ "How much am I willing to spend"

One of the common personal level factors reported by young people as influencing their food outlet choice was how much and how often they received remittances. It was, in most cases, on the top of participants' list of food outlet choice determinants and usually the decisive factor for using one outlet over the other. They prioritised food outlets that enabled them to spend within their means. This tended to influence many young people to focus on the need for volume and satiety in order to defer another expenditure on food.

> “…it depends on your budget and how much you receive that will really affect where you buy your food from. If I receive like 100 cedis a month, I’ll certainly buy food always from the bush path because I know I can’t afford this. So… I think the better your income, the better your feeding. Something like that. So your money talks about everything...” (R1, BFPI 3).

Among the young people there was the widespread perception that the amount of money they had determined the quality of the food outlet they ate from and that “the better your income, the better your feeding.” According to students on low budgets, they would usually not join their “rich friends” to eat from the same food outlet.

> “Ha! Ha! Yeah. So when I have enough money... I prefer to buy Mr. Wu’s 'cause Mr. Wu’s is a lot and is like 18 cedis. So when I have too much money… oh, I don't care. Like African Choice is there, I can go there.” (R4, FGD 5).

For those that preferred to buy from food outlets outside of the University campus, this included not only the cost of the food itself but also other cost relating to transportation to and from the food outlet where their preferred food was sold.

> “…So if it's this food that I want to eat, how much am I willing to spend on the fufu that I want to eat? And then the money too in terms of transport because... I drive. So then I'm thinking about if I want to go to somewhere [off-campus] to go and eat fufu, like my petrol. So is it worth burning 20 cedis worth of petrol to go and eat 50 cedis worth of food and coming back?...” (R1, BFPI 2).

From the account of emerging adults who preferred to prepare their own food to cut cost, the cost of buying from an outlet included the cost of delivering the food to them.

> “Because if I don't have enough money, why would I want to eat out? Because if they don't do deliveries, I'll have to go myself. And if they do deliveries I'll have to pay for it; the delivery.” (R2, BFPI 2).

6.5.1.3.2 What I want to eat

According to some emerging adults, the food they craved for was a key determinant of where they bought their food from. Students reported that because they could not prepare certain dishes on campus, whenever they craved to eat those foods, they had to buy them from a food outlet.

> “So I first consider what I want to eat... so its kinda like cravings but not really craving but like maybe I want to eat fufu but I can't do fufu on

> campus. So now the next thing that I'll think about is where will I go and eat this fufu?...” (R1, BFPI 2).

6.5.1.3.3 *“We think about the quantity more”*

Majority of students considered the quantity of food per price they paid in choosing where to buy their food from. Considering that most students prioritised satiety and affordability, how much food they were given in exchange for their money featured prominently. In many cases, the distance between the hall of residence and the food outlet that offered “quantity” did not matter.

> “... I also consider the quantity of the food, especially when I'm buying from the canteen. I prefer coming to buy banku from the Night Market than Basket Market at Commonwealth [hall of residence]. Yes, so I sometimes come here to buy the food and I'll carry it back to eat… I prefer that to buying from Commonwealth although that’s my hall and its closer to me but I consider the quantity and then the soup...” (R5, FGD 5).

For other students, the quantity of food they got did not only determine which food outlet they bought from, but also the kind of food they usually or routinely patronised. From respondents’ account, this was premised on the perceived exploitation of students by most food vendors. Some students, as a routine, would therefore buy from vendors they thought gave them enough food for their money.

> “…most of the food vendors have a perception that students have money or something like that. So mostly the food is costly. So when I'm to buy food, I go to a food vendor I know I'll get the quantity that matches the cost.” (R1, FGD 1).

There were some emerging adults who prioritised quantity over the quality of the food they got from a food outlet. Students were aware of the level of quality of food served by most eateries on campus but would purposely buy from particular outlets for the quantity of food they knew would be served.

> “Also, it might be the kind of food they get from that place. In terms of quality or quantity. So let's say, if someone wants quantity than quality, the person will go to Abowoso. But if the person wants quality than quantity, the person will go to Perry's and all those Americana’s... you know those places.” (R1, BFPI 7).

6.5.1.3.4 Quality, including taste and freshness

A section of the emerging adults also considered the quality of the food served at the various outlets in deciding which food outlet to buy from. Some students prioritised the taste of the food served by a food joint and emphasised preference for nice taste.

> "And sometimes the quality because ehm…the food they sell at Bush Canteen, example 'gobe' [gari and beans], is way way nicer than they sell here at Maxi Catering Service." (R3, FGD 2).

Some emerging adults highlighted they would sacrifice price for taste once they were confident the food from the food joint would offer them the taste they preferred.

> "The taste comes before the prices because sometimes I don't really give too much for a price unless its outrageously high. If I know your food will give me like that taste and everything, no matter the price if is not very high, I can manage." (R6, FGD 1).

Other young people did not only prioritise taste over price, they were willing to also travel long distances to food outlets where they were assured of that preferred good taste. In one instance, a student reported that the transport cost to one of her favourite food joints was three times the cost of the food itself, but always preferred to buy from that outlet because of taste.

> "The taste of the food. I don't really care about the distance. I take Bolt [taxi] in and out for like 30 cedis. But because that's the waakye I want, I'll take it [taxi] and go and buy the waakye which won't even cost more than 10 cedis. The taste really really matters." (R3, FGD 3).

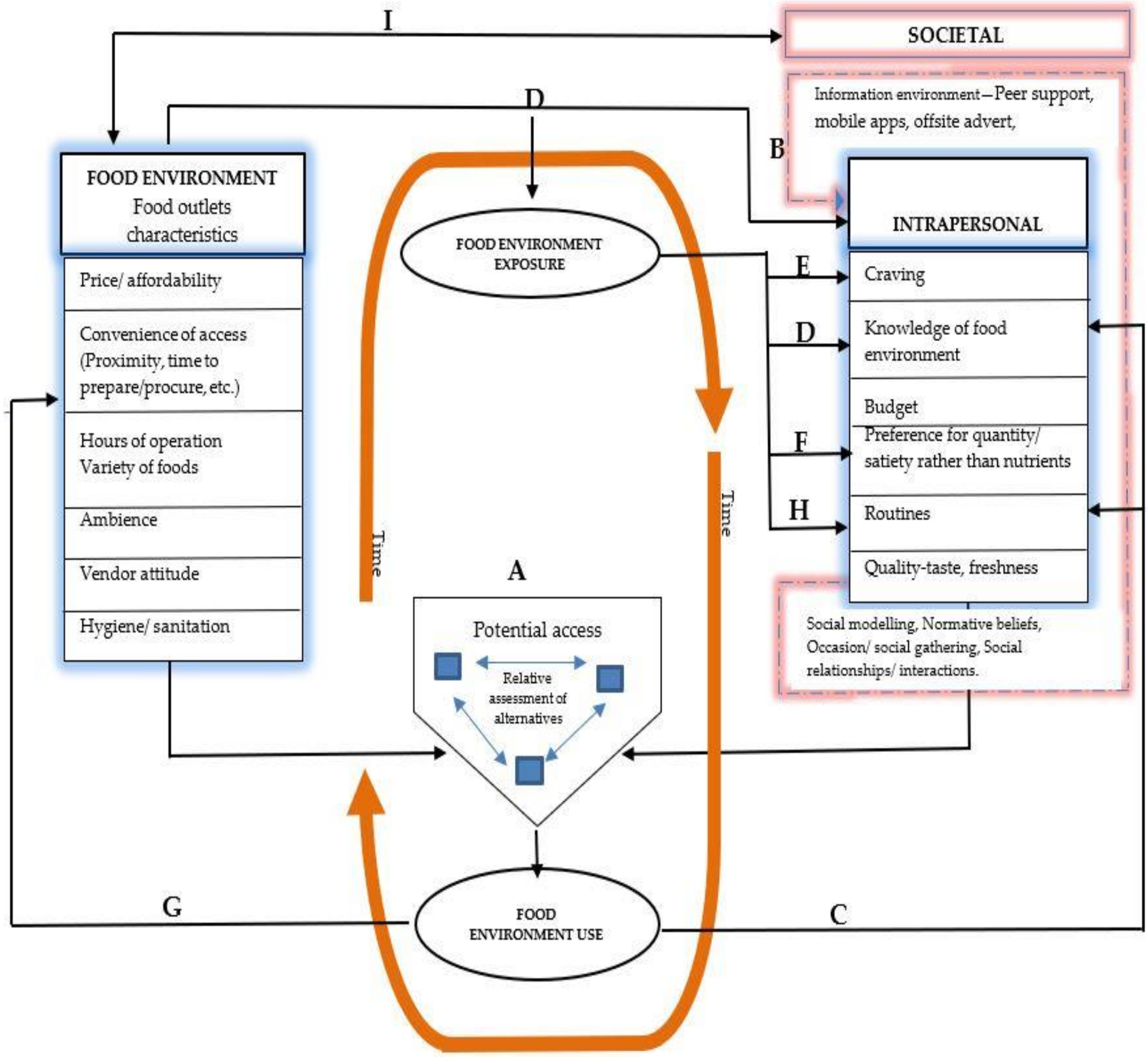
For other students, they would not buy vegetables and other food items from campus food outlets due to concerns with the quality of vegetables usually available. According to respondents, vegetables and other food items available at the food outlets on campus were usually not fresh. Therefore, to find fresh vegetables or foodstuffs they preferred to buy from outside of the University campus.

6.6 Discussion

This explorative study was to identify the factors that shape the decision-making process for food outlet choices among emerging adults in a Ghanaian University food environment. To my knowledge, this qualitative research is the first to explore this topic in the African setting. Drawing on SEM of behaviour, the study identified three interwoven levels of influence shaping emerging adults' choices of food outlet: intrapersonal, societal, and environmental. The main factors influencing food outlet choice were identified as price of food, convenience of access, hygiene, purchasing power, quantity/satiety, and craving. Overall, the findings suggest that the location of a food outlet, solely, does not make an outlet a preferred choice for use or patronage, but how much the food outlets' characteristics accommodate emerging adults' social and individual needs, goals, constraints, and preferences in a specific situation. The findings shed light on the complexities of the decision-making process for food outlet choices and on the influences of the food environment on dietary behaviours (and vice-versa). Figure 1, a model adapted from Clary et al. (2017) is used to discuss the study findings and describe the interrelationships among the levels of influence and sub-themes reported under the results subheading.

The findings show that students usually weighted characteristics of food outlet options available to them against their relevant criteria to settle on the option chosen. Food-related choices have largely been studied through a utility-maximization lens (Cannuscio et al., 2014; Dhillon et al., 2019b; Hilger-Kolb & Diehl, 2019). Drawing on this rationale, individuals are viewed as rational agents assessing food outlets against five facets of accessibility—including availability, spatial accessibility, affordability, convenience and acceptability—to settle on using the best available option (Clary et al., 2017; Clary et al., 2015; Pitt et al., 2017). Students' outlet choices in this study involved the relative assessment of all potential options (Fig. 6.1A). The analysis found the convenience of accessing food outlets as one of the recurrently reported factors students considered in their food outlet choice decisions. Similar to what others have reported (Cannuscio et al., 2014; Dhillon et al., 2019b; Hilger-Kolb & Diehl, 2019), convenience of access was described in the terms of walking distance to food outlets, outlet opening hours, access to cookware, and the time needed to procure or prepare food. Regarding availability, emerging adults felt that food outlets available in the foodscape were disproportionately distributed over the foodscape, and this impacted convenience of access by reducing proximity. A systematic review assessing the effect of spatial exposure to food outlets near the home in HICs (USA, Australia, UK/Ireland, Canada, Denmark) and Brazil—availability (count) versus accessibility (proximity)—on food-related outcomes found that availability may result in relatively more significant effect sizes than accessibility measures (Bivoltsis et al., 2018). However, increased proximity to FV outlets was associated with increasing FV intake in the same systematic review (Bivoltsis et al., 2018) and in longitudinal results from Western Australia after residential relocation (Bivoltsis et al., 2020). Other research also suggests that individuals from low income households are more susceptible to using unhealthy food outlets near the home (D'Angelo et al., 2011). Indeed, similar to what others have reported (Dhillon et al., 2019b), convenience of access closely interacted with other determinants such as perceived individual, socio-demographic, environmental, and/or other accessibility-related factors (including affordability which I discuss further in a subsequent section) to inform students' food outlet decisions. In Ghana and South Africa a study mapping the local foodscape, suggested that the availability of healthy neighbourhood food outlets did not reflect in the food products available in the household, highlighting the potential role of other factors referenced above (Kroll et al., 2019). Vehicle ownership and/or access to public or other transport vehicles, for instance, make it convenient for people to access outlets beyond their immediate foodscape, increasing their potential food outlet options (Bivoltsis et al., 2020; Shannon & Christian, 2017). This is less so for individuals from low-income families or on lower food budgets who are more likely to prioritise expenditure on food and other basic needs than expenditure on fuel or vehicle-related costs. Based on this analysis, it appears that demands from extra-curricular activities and limited access to transportation put students in a position that makes convenience a key motivation to settling on the closest outlet although it may be unhealthy.

Figure 6.1: Schematic representation of the relationships among the main themes



Previous evidence on accessibility as an influence on food outlet choice is not specific to university settings. However, the presence of fast-food outlets within one mile buffer of the home (Athens et al., 2016) and perceived higher travel time (Alves et al., 2019) to fast-food outlets have been found to influence fast-food outlet visits/ use in both adults and children. Also, proximity to supermarkets has been associated with lesser fast-food outlet use (Athens et al., 2016). University- or school-specific evidence in the literature has focused on accessibility and food choice or dietary outcomes (Deliens et al., 2014; J. Dhillon et al., 2019; Turner et al., 2020), but not on the nexus between accessibility and food outlet choice. Yet, consistent with the current study's findings, these studies confirm the importance of convenience to students' food-related choices due to exams and other academic demands (Deliens et al., 2014; J. Dhillon et al., 2019). There is greater likelihood that such food-related behaviours may perpetuate beyond campus life when young adults transition into the workplace. In SSA, changing lifestyles and shifts to more demanding occupations place an increasing number of people at similar risks—making them highly susceptible to patronizing ready-to-eat highway or street foods (Baidoe et al., 2020; Hill et al., 2016; Sseguya et al., 2020)—which have consistently been found to be unhealthy (Makinde et al., 2020; Mohd Nawawee et al., 2019). Modifying the school and workplace food environments in ways that incentivise healthy food behaviours have been proposed (Bowen et al., 2015; Micha et al., 2018) but requires further research. Encouraging healthy food-related choices by making healthy food outlets more ubiquitous, affordable, attractive, and convenient have been recommended to forestall dietary maladaptation within university communities (Deliens et al., 2014).

As rational consumers seeking to maximise satisfaction, students' outlet choices to a large extent appeared to be the product of a rational decision-making process based on their level of knowledge of the University foodscape. Consumers require knowledge of the full information about all outlets in their foodscape to make the best decisions. The findings of this study suggest that individual students had knowledge of many outlets within the foodscape, but not all, and mostly relied on their social network (friends, colleagues, and roommates) complimented by information from phone-based applications (also used to order food online) that constituted their information environment (Fig. 6.1B), followed by knowledge from their own past experiences of using the foodscape (Fig. 6.1C) and exposure to outlets they encountered in their daily classroom-residence journeys (Fig. 6.1D). However, students' outlet choices were sometimes without conscious deliberation, which contests the idea of rational decision making in all food-related choices. For example, food cues have been found to induce an automatic desire for eating (De Decker et al., 2016; Schüz et al., 2015). Respondents in this study referred to this as food craving (or "what I want to eat"), which in many cases automatically determined which outlet they patronized. It is common knowledge, backed up by evidence that a strong enough will is required to resist the temptation to eat when food is present (Schüz et al., 2015). A related finding from this study is the limited number of FV vendors, which according to young people, significantly reduced visibility of healthy options that could serve as cues to provoke healthy eating behaviours through healthy outlet choices. In HICs, altering the position or proximity of food products to make FV more visible and easily accessible in a university setting influenced healthy food and FV aisle visits and purchases (Walmsley et al., 2018) although, existing evidence suggests individual variability in food cue responsiveness (De

Decker et al., 2016; Schüz et al., 2015). Previous research has also highlighted the role of environmental cues like advertising (on-site or off-site) in shaping outlet choice (Fagerberg et al., 2019; Lucan et al., 2017) and other food-related behaviours (Masterson et al., 2019). The current study found limited food outlet advertising (print media or other physical signs) within the University foodscape. While this could be harnessed to steer outlet choices and dietary behaviours among students in the right direction, using healthy environmental cues, cue-activated crave for food may not necessarily/always lead to outlet use. This may be so due to food outlets being inaccessible because of affordability, accommodation, or acceptability issues. These dimensions are explored further in the next section. Altogether, the results are in line with Clary et al.'s (2017) argument that, food environment exposure influences "…individuals to form intentions…" to eat (craving) (Fig. 6.1E), but for them to eat or not is dependent on their ability to resist the cue-induced craving and/or their level of access to food outlets. However, recent systematic reviews assessing the effectiveness of choice architecture strategies, mostly in HICs, have identified that environmental cues can influence food-related decisions (Al-Khudairy et al., 2019; Bucher et al., 2016; Hummel & Maedche, 2019; Vecchio & Cavallo, 2019; Von Philipsborn et al., 2020) with median effect size of 21% (Hummel & Maedche, 2019). These strategies offer promise in terms of restructuring food environments in SSA to impact food-related choices to navigate the ongoing nutrition transition in a positive direction.

Another prominent finding is that emerging adults adapted their food outlet choices to their financial constraints. They matched cost of food at various outlets (environmental level) with their individual budgets (personal level). Consistent with other recent studies (Cannuscio et al., 2014; Kinsey et al., 2019), my findings suggest that a mismatch between individual budgets and food prices (as an environmental factor) influences students' decision to settle on food outlets offering cheaper food options. The mismatch impels young people to focus on the need for volume (or quantity (Fig. 6.1F) and satiety (Murphy et al., 2021), and to favor outlets offering more calories per price than nutrients. In other words, although food quality, variety and vendor attitude were important determinants, cost was recurrently expressed as the decisive factor in using one food outlet over the other, leading to the routine use of particular outlet(s) (Fig. 6.1H), which in turn may result in habit formation over time. Others had formed emotional attachment with particular outlets through repetitive patronage—as in the example of the young person who would go to a food joint for the typical African ambience—and it becomes difficult to replace. To avert the risk of purchasing unfamiliar food, such outlets may become the automatic choice during difficult decisions where one has to choose from a wider range of alternatives. That is, past satisfactory experience is used to inform future outlet choice decisions to avoid risk. Even though cheaper food options per-se may not necessarily be unhealthy (Clary et al., 2017; Coughenour et al., 2018), there is overwhelming evidence suggesting that cheap foods are generally not healthy or sustainable with healthy foods found to be largely expensive (Darmon & Drewnowski, 2015) and especially in LICs (Headey & Alderman, 2019). In this study, cheap outlets were reported to be unhealthy—offering high-fat and calorie-dense food options. In systematic reviews (Fergus et al., 2021; Hartmann-Boyce et al., 2018) and randomized controlled-trials (Brimblecombe et al., 2017; Franckle et al., 2018) of dietary interventions, fiscal or economic interventions, especially price discounts, have been found to significantly increase healthy food purchases in general and FV purchases specifically, in Australia, UK, USA, Canada and other HICs. Compared to other interventions, the impact of fiscal interventions did not differ by socio-economic status. In LICs like this study country where a relatively larger proportion of people live on lower-incomes, economic interventions like price discounts may be effective in affirmatively shifting food-related choices. Indeed, food price regulations that make healthy options like FV less expensive appeared to be the most frequently suggested and the most appealing intervention to emerging adults in this enquiry. Other evidence, including systematic reviews, point to the efficacy of nutrition education interventions (Yahia et al., 2016) especially when applied together with environmental and/or interpersonal facilitators (or multicomponent) interventions (Fergus et al., 2021; Roy et al., 2015a; Whatnall et al., 2018) in improving food-related choices among university students mostly in the short term. As have been suggested elsewhere (Yahia et al., 2016), research towards interventions that ensure long-lasting behaviour change is needed. In a similar vein, research on effective dietary interventions for this university campus is an important prerequisite, given that tailored interventions are reported to be more effective (Whatnall et al., 2018).

A closely related finding is that the university foodscape shapes and reinforces social class polarization. A typical example of this is cited among students who felt that certain outlets are out of their "league." This is a product of the interactions among food prices, emerging adults' ability to pay, and the socio-demographic characteristics of other customers in the reasoning or analytic assessment process of students to make food outlet choice decisions (Clary et al., 2017). The foregoing (here and in the previous paragraph) speak to three of the recent conceptualisations of Penchansky & Thomas (1981) model of access based on domains of interrelation: 1) Affordability, as the relationship between food prices and the customers' ability to pay; 2) Accommodation, as the relationship between how the food outlets are organized to accept customers (e.g. hours of operation, ambience, car-park, store loyalty cards) and the customers' ability to accommodate these factors; and 3) Acceptability, as the feeling of socio-cultural harmony with both staff (vendor or staff attitude), customers and food items (Clary et al., 2017; Clary et al., 2015). The health implications of this social stratification of food purchasers—including its strong association with unhealthy eating, obesity, and NCDs which unequally affect low income and disadvantaged groups—are well-documented (Cobb et al., 2015; Ibrahim & Damasceno, 2012). Similar findings have been reported in a USA sample based on mixed-methods research (Cannuscio et al., 2014). If underprivileged students should perpetually have social access to only less-healthy/unhealthy food outlets, such students may continually resort to high-fat and calorie-dense diets putting them at perpetual risk to NR-NCDs and/or malnourishment. These findings highlight the need for food environment interventions that remove social and financial barriers to accessing healthy food outlets.

Hygiene or sanitation at food outlets was also a key factor emerging adults considered in their food outlet choices. In contrast to findings on concerns about long-term health issues like hypertension and cardiovascular disease reported in previous research (Batz et al., 2013; W. F. Clark et al., 2010), the short-term health concerns like diarrhoea appeared to be more salient in this population. Interestingly or ironically, the two most patronized food outlets were associated with all the sanitation issues reported. Clary et al. (2014) have highlighted that the use of an outlet is facilitated or constrained by lack or availability of alternatives. In this study, there were no other outlets within the University foodscape offering food at same (affordable) or cheaper prices and more variety compared to the popular outlets referred to above. As utility maximizers, in most cases, students are pushed to patronize the best available option after evaluating options along their relevant criteria, including any of five above-named dimensions of access. The prevailing University food environment appeared therefore to be a product or reflection of the continuous patronage by students over the years (Fig. 6.1G) without strong calls for change. Following on from this, it has been argued that the relative densities of healthy and unhealthy food outlets within a foodscape may be a materialised reflection of consumers' choice of patronising unhealthy than healthy (or vice-versa) food outlets (GLOPAN, 2016). In another research, food outlet operators believed that their customers preferred unhealthy food options, reflecting the dominant food types they usually sold (Andreyeva et al., 2011). Moreover, in choosing a location for a new food joint, a vendor would prefer locations that offer enough customers' patronage to ensure economic viability of the outlet (Clary et al., 2016; Partovi, 2006). In this study, students reported a disproportionately limited number of FV vendors in the University food landscape relative to other foods. They believed that their perceived low FV consumption behaviours were underpinned by the normative influence of the limited number of healthy outlets in the University foodscape. Indeed, the spatial concentration of healthy food outlets around the home and school has been found to increase the odds of frequent FV consumption (Barrett et al., 2017; McGuirt et al., 2018; T. Zhang & Huang, 2018), inversely associated with sugar-sweetened beverage consumption (Godin et al., 2018), and diet quality (McInerney et al., 2016). However, it appears to be students shaping their food environment through their purchasing behaviours over time. In fact, the language used by students in this study demonstrated a high level of apathy towards FV consumption specifically (Mensah et al., 2020), and healthy or sustainable eating in general. Moreover, most emerging adults in this study's sample preferred to do their main foodstuff shopping, including for FV, from traditional markets outside the immediate University foodscape due to affordability or from home for students whose parents/guardians lived near the University. Consistent with this finding, previous research from HICs has also found that residents rarely do main food-shopping from outlets within their neighbourhood (LeDoux & Vojnovic, 2013; Vojnovic et al., 2021). Specific to students, Chortatos et al. (2018) have reported that nearly 70 percent of Norweigian students use outside food outlets rather than onsite school canteen. Although students' food-shopping occurred beyond the University foodscape, their food purchasing behaviours reflected the general nature of the University foodscape. Reporting a similar finding, Van Rongen et al. (2020) found that food purchasing/consumption behaviours reflect neighbourhood social food norms. Essentially, the increased exposure to more unhealthy food outlets within a university may shape norms (Fig. 6.1B) and preferences (Fig. 6.1F) that favour unhealthy food consumption, and these norms may stimulate actual unhealthy dietary behaviours. Evidence seemingly affirming this rationale have reported that students residing on University campus exhibited changes in eating behaviour since matriculation (Beaudry et al., 2019; Hilger et al., 2017; Kyrkou et al., 2018; Olansky et al., 2021) and in on-campus students compared to non-residents (El Ansari et al., 2012; Noll et al., 2020).

Similar to what others have reported, social relationships and social interactions featured in food outlet decisions not only as part of an individual's information environment, but also determined which food outlet feature(s) were the decisive factors for choosing one outlet over the other (Fig. 6.1I). For example, while a "noisy" informal African atmosphere was preferred for a regular social eating with friends, the same was considered a misfit for birthday parties. The atmosphere/ambience at restaurants has been found to significantly influence customer intention to patronise (Calvo-Porral & Lévy-Mangin, 2021; Li et al., 2015; Tsaur et al., 2015). On the other hand, food outlets and food-related behaviours have been found to stimulate social relations and cooperation between groups (Fiske & Schubert, 2012; Woolley & Fishbach, 2019), within groups (as in a nuclear family (Fielding-Singh, 2017) and between colleagues/ mates (including schoolmates, couples in romantic relationships, work colleagues (Bove et al., 2003; Gregersen & Gillath, 2020; Kniffin et al., 2015; Woolley & Fishbach, 2019) (Fig. 6.1I). According to (Bove et al., 2003), married couples in New York, USA, believed that shared food-related preferences connote like-mindedness and make food purchasing easier and faster, supporting the maintenance of the marriage. In Gregersen & Gillath (2020), multi-ethnic web-based participants preferred and would more likely date someone who shared similar food-related preferences. These suggest that food outlet/procurement and other food-related choices shape and strengthen social bonding, social relationships, and interactions. In this study, emerging adults used food outlets as sites for social interactions and bonding with their mates and/or friends as they engaged in various forms of social eating. They facilitate the use of individual and/or group food outlet choices to comply with peer pressure by adapting their choices to those of their peers (social modelling) or to portray a favorable impression of themselves to other people and/or their peers (impression management) (Higgs & Thomas, 2016). These contribute to self-sorting of outlet users by socioeconomic characteristics, which reinforces social segregation of shoppers (discussed above). Interestingly, the most preferred point-of-purchase ambience among young people in this inquiry were those offered by the informally organized outlets, perhaps because they also offered affordability and variety. These insights could be harnessed in the design of tailor-made interventions for behaviour change among emerging adults.

6.7 Conclusion

Food consumption has important impacts on personal health and the environment, and food outlet choice is a key antecedent to food acquisition and consumption. The food outlet choice decisions in this emerging adult group were the net results of a complex interplay between individual characteristics and environmental conditions to meet social needs. At least three of the six determinants are finance-related which may not be surprising for an LMIC where many people are at or below the poverty line. Situated in a ‘westernised’ city the multiplicity of food outlets may suggest choice in this university setting/foodscape. But the need to meet (financial and proximity) constraints appeared to restrict/limit access to food outlets offering healthy food options. This led emerging adults towards repetitive or routine use/patronage of certain food outlets which may result in habit formation. Although a food pricing intervention that regulates food prices within this university setting may reduce some access barriers to healthy food, it may not be enough to foster changes in food outlet choice behaviour in these emerging adults. Multi-component interventions that combine such structural level intervention in food retailing along with reducing the proportion of unhealthy food outlets, and individual level components may be more effective, although this needs to be studied. It is also recommended that further research investigates whether the determinants observed in this emerging adult group are replicable in the general population. Overall, this is a call to more localised research to inform tailored solutions to unhealthy eating antecedent to food outlet choice decisions in SSA.

CHAPTER SEVEN

BARRIERS AND FACILITATORS TO ULTRA-PROCESSED FOODS, FRUIT AND VEGETABLE CONSUMPTION AMONG EMERGING ADULTS IN A GHANAIAN UNIVERSITY.

7.1 Chapter summary

Background: Understanding the influences that shape food behaviours among emerging adults and their attitudes and perceptions is an essential precondition for food behaviour modification interventions. But there exists limited knowledge and research on these themes among emerging adults in urban SSA setting.

Objectives & Method: This qualitative study component examined emerging adults' knowledge and attitudes towards UPFs, fruit and/or vegetable consumption among emerging adult university students in urban Ghana. It also explored influences shaping the consumption of UPFs, fruit and/or vegetable, and barriers or facilitators to the adoption of healthy and sustainable diets in a university food environment. The study used the same methods adopted in Chapter 6.

Results: Emerging adults have to negotiate a complex set of barriers and opportunities operating at the three levels of the SEM of health behaviour to decide to eat UPFs, fruit or vegetable. While the influence of peers, training from home, and significant others, and body image ideals encouraged some students to consume fruit and vegetable (FV), issues of affordability, availability, nutrition knowledge, perceptions and misconceptions did not favour FV consumption, as did value satiety, local and wider societal food norms. However, affordability/price, availability and preference for satiety exerted more influence on this emerging adult group in favour of cheap, energy dense foods and UPFs, as did perceptions and misconceptions.

Conclusion: Emerging adults need support to make healthy food choice. Although food pricing interventions that regulate or subsidise healthy foods, especially FV may reduce some access barriers to healthy food in this emerging adult group, multi-component interventions that combine such structural level intervention in food retailing along with reducing the proportion of unhealthy food outlets, and individual level components may be more effective, although this needs to be researched.

7.2 Introduction

In Chapter 6, the thesis explored how emerging adults interact with their food environment to make decisions about where to buy or shop for food. While food outlet choice may influence what food individuals acquire, socioecological models suggest more specific influences on or determinants of food choice or dietary behaviour, as do research evidence emanating from HICs on emerging adults in university settings. This is a research gap among SSA emerging adults living in the university community as highlighted in the literature review in Chapter 2. This Chapter therefore set out to examine emerging adults' attitudes and behaviour towards UPFs, fruit and/or vegetable consumption among emerging adult university students in urban Ghana using the same methods adopted in Chapter 6. The study also explored factors that inhibit or facilitate the consumption of UPFs, fruit and/or vegetable among this emerging adult group during term time, with interest also in whether health and environmental sustainability are considered in decisions about food choices in a university food environment.

7.3 Results

7.3.1 Participant characteristics

In total, 46 emerging adult university students participated in eight BFPIs (or dyadic interviews with best friend pairs) and seven FGDs, lasting 60-75 minutes respectively. Participant characteristics have been described in Chapter 6 and summarized in Table 6.1.

The findings for the second part of the three-part qualitative study have been presented as themes organised around components of the ecological model of health behaviour adapted from Swinburn et al. (2013) and Glanz et al. (2005). These components include intrapersonal factors, societal (interpersonal) factors, and environmental factors and are reported in turn.

7.3.2 Barriers to fruit and vegetable consumption

7.3.2.1 Environmental factors

7.3.2.1.1 Fruit or vegetables are expensive on campus; 'Healthy is expensive'

The cost of FV was a very important/prominent factor to students. It was the most commonly identified barrier to FV consumption among emerging adults during term time. Most participants (n= 21) viewed the prices for FV within the foodscape to be unreasonably high especially being a university community compared to other markets outside of the University campus. Many students therefore expressed the perception that eating “healthy is expensive” on campus.

> “Their fruits are very expensive…. So I don't buy fruits. If you see me eating fruit, maybe someone bought it for me, on campus, then someone bought it for me... it doesn't even cross my mind that take… I mean who can? Two bananas for GH¢2.00. Ah, no! Me I won't buy it.” (R2, FGD 2).

In many cases students felt that they were being exploited by campus vendors. The cost of FV on campus was frequently quoted as being twice the retail price in off-campus retail markets. Considering that most FV are perishable, students could not buy them in bulk from cheaper sources outside the immediate University campus foodscape. The language used by emerging adults expressed the feeling that FV retailers had a notion that students have no option than to buy from them despite the price.

> “Well I buy fruits from campus... even though... it's still expensive 'cause sometimes banana, 3 cedis, and I'm like, eh! Why? I feel like they cheat us too much 'cause they know that we have no choice than to buy it. So... I think it's quite unreasonable sometimes.” (R2, BFPI 2).

The availability and distribution of FV outlets within the University food landscape was recurrently cited as a catalyst for price hikes. That is, a limited number of FV vendors on campus was also reported as a reason FV are expensive. Some students felt vendors capitalise on this near ‘monopoly’ to charge higher prices even when FV are in season. They expressed feelings of being let down by university management as it appeared, they had been left at the mercy of campus food outlet operators.

> “…. For me I think its expensive on campus. Depending on where I stayed before coming. The price is expensive. Its not common... those who sell it know it is not common... So they try to use it as... an advantage to make money out of us.” (R1, FGD 1).

On campus, apart from soups and sauces made with some vegetables, vegetables were mostly served as salads (accompaniment) sold at an extra cost or usually in the form of mixed vegetable rice or fried rice—some of the most frequently consumed foods identified. Emerging adults expressed concerns about vendors using small amounts of vegetables in preparing mixed vegetable dishes like fried rice and noodles (Indomie instant noodles) which made it unlikely for young people to consume any significant amount of FV from a meal. A similar concern was expressed about vegetable salads sold as accompaniments.

> "…and if you want to consider, most of the vegetables we eat is probably those one one ones roaming in our Indomie. Ha! Ha! Ha!… And the places too, the fried rice joints, they don't even like giving vegetables. They give you small. And vegetables are expensive. So you cannot say you're going to be buying vegetables and come and be making every day." (R2, BFPI 1).

7.3.2.1.2 "What is sold at what time"-food outlet opening hours

Convenience of access—the times when FV vendors opened or closed to student customers was also cited by some respondents as a key barrier to FV consumption. FV vendors were usually not open to customers early in the morning when students felt they could have grabbed some fruit and munched on them on their way to class. Although many campus outlets operated late into the night, students felt that FV retailers were on many occasions not available when they wanted to eat FV. While some young people viewed the business hours as advantageous because they could acquire "proper food" nearly around the clock, most students believed that this did not make it convenient to consume FV on campus.

> "But then fruits I believe... should be taken in as kind of breakfast. So that... if you're late for class, you can buy it and then just as you're on your way, you eat it…" (R3, FGD 2).

What food was sold at what time was therefore viewed as barrier to FV consumption. Young people felt that certain types of foods sold at night should rather have been made available in the early hours of the day and vice versa. "Heave foods" that they believed were difficult to digest dominated 'night food life.' Relative to FV outlets, "heavy foods" were reported to be disproportionately ubiquitous within the foodscape both during the day and at night. Many students expressed concerns about this adversely affecting their dietary habits as they had no option than to eat what the food environment offered them.

> "… one… addition that has joined the night life or…night food or something is…'kelewele' *[deep fried mixture of chopped ripe plantain, blended pepper, onion and ginger plus groundnut]*. Yes, and it's become a big dessert. A lot of people love it so… some people have also set up… joints at certain… vantage points to sell it. And they sell it at sometimes like 12pm, 1am, you can still get it." (R1, FGD 2).

Emerging adults expressed the reality of limited autonomy in their food choice decisions as they claimed to have limited control over food options available to them within the campus food environment.

7.3.2.1.3 Lack of storage or refrigeration

Young people also reported lack of storage as one of the hindrances to FV consumption on campus. In most types of student accommodation, students were to individually procure their personal refrigerators rather than management-provided ones or fridge sharing policies. Storing FV was therefore mentioned as a challenging thing to do on campus. Students felt this to some extent made them overtly reliant on FV vendors within the campus foodscape. That is, they had to buy from campus retailers as and when they needed to consume at a go rather than acquiring them in bulk from markets outside of the University campus, as have been reported above.

> "I also feel like storage is also a big part of the problem because... depending on the kind of fruit that you buy and how you store it. If I bought I don't know, like ten apples..." (R1, BFPI 2).

> "Ok for me, if I had maybe enough money I would prefer not buying out-of-home food. Because personally I'm on diet and I was told not to eat like oil, oily food, a lot of carbohydrates, highly spiced foods. If I had a fridge in the hostel, I'd just prepare the stew and soup I will need and I will just keep them and just be heating." (R1, BFPI 5).

7.3.2.2 Societal factors

The findings linked to social barriers to FV consumption are presented under the following themes.

7.3.2.2.1 Ghanaian food norm, culture, belief

Many young people believed that certain deep-rooted food norms and food culture/ practices were key barriers to many emerging adults consuming more FV. Young people reported that FV are conventionally not properly integrated into the Ghanaian food culture. Part of this concern meant that the culture of FV consumption had not been passed down to many of the younger generation. In other words, many young people felt that FV had not be an integral part of their food socialisation. In many cases, several students reported they did not consume FV frequently because "its not part of" them or not their "way of life".

> "It's something that… even I think the whole Ghanaian culture, the vegetable thing or the salad thing like is not something that's really engraved in our eating or in our diet. Fruits and vegetables, if you feel for it or you're walking and you see it, then you just buy it. But I don't think there is anyone that will just get up: I have to eat three bananas today." (R2, BFPI 1).

These norms appeared to govern emerging adults' food-related decisions. For instance, because of the normative beliefs, many young people considered expenditure on FV an extra cost. On several occasions, most emerging adults found it difficult spending their money on FV. This is manifest in the language used by participants. Typical examples were when participants made statements like "… if I'm okay [satisfied/ full] and I have some extra 1 cedi… to get it ehm… orange, fine" (R2, FGD 7); and "if I have more money I would try and then… probably get more fruits…" (R2, FGD 3).

> "I... think that most people mean... like Ghana if you say have everything, fruit is like an accessory for the food. That's how people have considered fruits and vegetables. 'cause sometimes… my friends are like ah! They feel like the salad is like an extra cost. That's how most people feel and they feel vegan stuff are expensive." (R4, FGD 5).

These subjective norms appeared to be cultivated and established through eating practices at home for most young people. As part of the perceived food norms, some young people reported that FV are normally treated as "special" foods at home, eaten during celebratory occasions such as birthdays, Easter and Christmas. It was suggested that these were typical of those bred in the city in contrast to people who were brough up in rural areas or people who have had prolonged contact with rural environments where FV cultivation is mostly done.

> "One thing I realised when I entered the secondary school and then coming here [to university]…I've observed around some people I've stayed with for some time, I realised that they think fruits are luxury goods in the sense that I mean it's only occasionally that at home let's say mum or dad would buy fruits and then bring them home for them to eat fruits, most people I've observed…I think December and Easter. But its never been that way for some of us, maybe because we lived in the village setting for a long time..." (R4, FGD 4).

This was confirmed by many respondents when they made submissions like "I thought salad is for Christmas" (R1, FGD 3) during discussions around the quantity or frequency of FV consumption.

7.3.2.2.2 Parental guidance or influence during childhood

Closely related to the above, many emerging adults gave accounts of how their upbringing or parental role during their childhood had influenced their FV consumption behaviour. Whether or not their parent/ guardian introduced them to FV had contributed to shaping their attitudes towards fruit or vegetable consumption.

> "While I was growing... we're... no... nobody cared about fruits. So like it has become part of me. Yeah... it has just become part of me. I don't even...

> seriously... I'll not even remember the last time 'eat fruits' came into my mind." (R2, FGD 9).

From the account of many of the respondents when they are "thinking about something to eat it won't come into 'their' head to go and buy an orange" (R1, BFPI 8) because "from childhood 'they weren't' taught to eat" (R1, BFPI 5). FV were not things they considered when they think food.

7.3.2.3 Intrapersonal factors

7.3.2.3.1 Lack of knowledge/ information

The lack of some nutrition knowledge or information was the most commonly identified 'personal' level barrier to FV consumption among emerging adults. Although knowledge of the health and nutritional benefits of FV was common to most participants, knowledge of the recommended intake levels was lacking. No participant was, for example, aware of the World Health Organisation's recommended daily intake for FV. From the account of most young people, quantifying how much FV they consumed was challenging.

> "Ah I don't know. A plate of vegetables or something. But the fruits, I don't think I can quantify how much is enough for a day." (R1, BFPI 1).

Many emerging adults were also not sure about what they knew regarding the health or nutritional benefits of FV. Most of the knowledge was based on information from basic school lessons. Some participants were uncertain whether such information was still valid.

> "When we went to primary or whatever, that the vegetables help to fight against diseases. So I don't know if it's still true… Yeah. But now I don't know. Now I heard that what we were thought when we were kids is not even that right." (R1, BFPI 1).

From various accounts, emerging adults did not know where to source credible nutrition information or verify nutrition information they had received. Part of the key nutrition information deficit highlighted was with regards to the difficulty in finding local names for some plant-based food items.

> "Like I said, I was trying to switch. So I used to read a lot about making healthier food choices. So for the plant protein is like quinoa, chickpeas and those things. You don't even know where to get some in Ghana. And most of us too we don't know the local names of the things. You see, you read the thing and you now have to go and ask somebody to ask their mother if they know the Twi name for this…" (R2, BFPI 1).

7.3.2.3.2 Value satiety

One of the most important attributes young people considered in deciding what to eat was satiety or how filling the food is. Most students prioritised food options that could offer them this full-feeling for the longest period. They expressed a notion that FV did not offer this full-feeling effect (what they sometimes referred to as "satisfaction") and therefore not worth their expenditure.

> "Fruits don't offer as much satisfaction as other food will do….I have to buy food that will give me satisfaction to last me throughout. I can't *[buy]* maybe 2 cedis *[worth of fruit]* and then food 2 cedis...it won't be enough to last me throughout that whole time. So even though they're not expensive and then I don't forget to buy them, unless I have cold I won't buy." (R6, FGD 1).

Most respondents bought more carbohydrates which they believed made them feel full for a longer amount of time. In many instances, this was because young people wanted to save money or spend according to their "tight" budgets. Spending on more "carbo" meant that another expenditure on food was deferred farther.

> "…it's money. Because I want to eat and then feel free. Like I want to feel full. If I buy more carbo., I get filled up easily compared to fruits. If you eat the banku, it can really take you like through the whole day. Yes. If I have more money I would try and then, you know, balance them; probably get more fruits..." (R2, FGD 5).

For many emerging adults, their budget at that stage gave room only to consider satiety. Things like FV consumption had to wait until "maybe after school" when they "get more money and can afford it…"

7.3.2.3.3 Out of sight, out of mind

Most emerging adults reported not taking FV because they hardly saw any. Once they had not seen any fruit or vegetable, it did not occur to them that they had to eat FV. Participants' accounts indicated that FV were totally forgotten once the same were not "in front" of them.

> "Mmm... ok, yes the main reason is that like I just forget because I like fruits and I like vegetables so if I get the chance, I'll buy it and eat. But then because it's not like always in front of me, if I don't make the conscious effort to remember to buy it, like I just forget." (R2, FGD 1).

Participants' appetite for fruit or vegetable was only stimulated at the sight of it. In many instances, participants cited this as the reason for their very low FV intake. A good case in point was when one respondent mentioned this as why they took fruits once in a week.

> "But the reason why I take it once in a week is that I hardly get it. Like it doesn't easily come to my mind when I go to the market to buy or when I'm walking I don't really think of buying fruits. I can't remember the last time I bought a fruit…And sometimes convenience too. Maybe the week you are between your hall [of residence] and your lecture hall but you've not come across any fruits or vegetables so definitely it won't come to your mind." (R2, BFPI 6).

The account of emerging adults suggests there appears to be limited advertisements or visual cues promoting FV consumption among students on the University campus. According to respondents, the only place on campus students saw any form of reminder to consume FV was when they attended particular food outlets and saw fruits or vegetables (or other forms of visual prompts, if any).

> "There are a lot [of fruits] but then remember we said we don't… we rarely go out to buy the food. We call delivery and so like, so we don't see it… Oh they do *[deliver fruits]*. If you ask… if you ask for fruits, they will buy it for you. But then because I haven't seen the… I don't really want to have it. I don't think of it. Is not part of me." (R2, BFPI 8).

7.3.2.3.4 Perceptions and misconceptions

Many emerging adults had certain perceptions which inadvertently became barriers to their intake of FV during term time. Some participants had a perception that the price of food gives every information about its nutritional value—the higher the price, the more nutritious the food is—"expensive is healthy". For that reason, participants did not consider the actual health or nutritional benefits of the food.

> "Usually, the cost or price tells me everything. So if the cost is low then perhaps the nutrition of the food is very low. The perception I have is that, high price goes with high quality of food. And if the quality of the food is that high, then it means that surely its going to be nutritious. So I don't usually look at the health or nutrition aspect but I think the cost or price of the food alone tells me everything about it." (R3, FGD 6).

Another respondent had the perception that taking FV with or after a lunch meal would digest all the food and one would not have the energy they need to work in the afternoon. They therefore believed FV were to be taken only in the morning and in the evening.

For some young people, FV were for periods when one was sick or had a health condition. When such periods had passed, they did not take any fruit or vegetable. This meant that participants' daily intake of FV was significantly limited.

> "Fruits, only when I'm having a health problem that needs fruits, then fine. And maybe something like constipation so needs roughages or something. So then like maybe for those two days, pineapple which I really like and apple. Yes. After it passes oh then, I'm done with fruits or vegetables until the problem resurfaces." (R3, FGD 6).

Some students also perceived that the amount of fruit or vegetable to be taken in day was determined by one's health status, and most importantly, how much food one could eat.

> "Ok, I think it would depend on first of all like you...do you eat a lot or do you eat like small? If you eat a lot, obviously you need more fruits. But if you eat...you don't eat a lot, you need less. And then also if you're not feeling well, I think you need to take more fruits than somebody who's feeling strong." (R2, FGD 1).

7.3.2.3.5 No conscious effort to eat healthy/ fruit and vegetable.

The account from many emerging adults suggested that most students did not make the effort to consume FV. There appeared to be apathy among many emerging adults towards FV consumption. Although most participants did not dislike fruit or vegetable, going out to buy was even considered a bother or too much work by some students.

> "Yes. Because I take the vegetables as part of the whole lunch meal. But then for the fruits, I take it when I crave for... I don't take it as a necessity as in I've finished eating and I probably want to take fruits. Yes. But then on...rare occasions do I want to buy fruits after. And then as I said earlier, the proximity. Its too far from me. And then lunch is in the afternoon and then in the afternoon you won't find there's fruit. I have to walk. No, I won't bother myself..." (R3, FGD 2).

Emerging adults appeared not to have any sense of motivation to consume or increase their intake of FV. According to some young people, they would eat fruit or vegetable if handed to them or if made available to them by some means other than by themselves.

> "I wouldn't mind. As in if the fruits and the vegetables are presented to me I would eat it. Like I wouldn't mind but not that I'm there and I'm trying to make a conscious effort to increase my intake of fruits and vegetables. If I go outside now and I see an orange seller I'll probably pass by her. But then if they are there, like I don't know maybe if my mother gives them to me or something, but me myself just buying fruits and vegetables… Ha!" (R1, BFPI 8).

7.3.2.3.6 Mistrust towards source of vegetable

Many young people also expressed feelings of mistrust for the source and quality of vegetables used by some food vendors within the University food environment, which were usually referred to as “food/ vegetable from outside” by some students. As most students lacked cooking appliances and did not have the luxury of time to cook every day, they expressed their preference to buy food from vendors. Many students however reported being cautious and selective when buying from “outside” due to the mistrust for the source and quality of vegetable used.

> “…my mum has thought me possibly every dish that she knows and then what goes into this dish, what is not supposed to go into this dish. So [food] I [prepare] tastes very fine. And then buying food from outside, I'll say usually sellers do not look at the consumers. Only some few outlets will do that. Usually the mind-set is to maximise profit. So sometimes all they can do is, for even tomatoes, use rotten ones. Whether it's spoilt or not, they'll just dump it into the food. So I'm very selective when it comes to buying dishes.” (R3, FGD 6).

In many cases, students expressed more confidence in buying rice dishes (mostly fried rice and jollof) rather than soups, and vegetable stews/ sauces from food vendors on campus. They did not trust how “outside” soup was prepared.

> “Oh! Most of the food they are on campus but they’re being sold and maybe you don’t prefer buying. Let’s say for instance, buying soupy foods like banku with soup, like I don’t prefer it because sometimes you don’t know the condition under which those foods are prepared.” (R1, BFPI 6).

> “…its not every food that I eat outside because I'm not so much ok with how they prepare soupy food and how they handle it outside. So the soupy food I'm very careful…” (R5, FGD 1).

Similar sentiments were expressed about vegetables and vegetable salads sold on the campus. Young people did not trust how vegetable salads were prepared. They felt that the vendors did not go through the painstaking and meticulous process required in salad preparation. Some young people also did not trust the salad creams or mayonnaise some vendors added to vegetable salads.

> “Sometimes too I don't really trust how people prepare their vegetables outside.” (R1, BFPI 7).

Many students therefore did not like to buy vegetable salads from outlets on campus and would choose spaghetti as an accompaniment over vegetable salad as they considered spaghetti to be safer. One respondent gave account of an experience they had when they purchased salad from one of the most popular outlets on campus as follows:

> "And then yes, this one time I bought... jollof at Night Market and I like salad so I bought the salad they mix with mayonnaise or something and it was nasty. Like it was really nasty. So that day I was like, I'm not going to buy jollof and salad again. I'll rather make it. It was really bad; the salad was watery. I don't know how they did it. So it made the food...its like 'akyɛ aa' *[its stale]*..." (R3, FGD 3).

Eating vegetable salads from some campus food outlets was something many students feared to do. One young person described the intake of vegetable salads from campus outlets as "a big risk."

> "…Even taking vegetables outside, it is a big risk 'cause you don't know...You don't know how they washed it... I mean, anything could happen..." (R2, BFPI 4).

7.3.2.3.7 Sensory aversion/ Dislike for fruit or vegetables

Some young people reported sensory vegetable aversion as a barrier to vegetable consumption. For them, vegetables in general were bitter and so did not like eating them.

> "I rarely do but then sometimes I do. Like I don't really like vegetables. Like I think they're bitter like so…I don't really like them." (R2, BFPI 8).

For other people, some fruits tasted bitter. This discouraged them from taking those fruits.

> "And the taste 'cause I don't know why its only me 'cause everyone takes pear *[avocado]*. In... local *[language]* we say 'paya nku' *[avocado]* is nice. But its very bitter when I taste it. I don't know why. People will tell you, "Oh! Its nice." But to me is bitter. So I think something that will demotivate me from taking is if it doesn't taste nice for me." (R2, FGD 2).

Other participants expressed multiple sensory aversion towards fruits. There were young people who reported being "put off" by the sight of other people eating certain fruit. The same individuals were also "put off" by the taste, texture and smell of some fruits which according to them significantly affected their intake of fruit.

7.3.3

7.3.4 Facilitators to fruit and vegetable consumption

7.3.4.1 Environmental factors

7.3.4.1.1 Affordability/ Price per quantity of fruit and vegetable

The price per quantity of FV or they being affordable was the most reported motivation to FV consumption among emerging adults. Majority of participants believed that FV were expensive on campus and thought that reducing price per quantity would motivate them to consume more FV.

> "I'll also look at affordability, at least. I'm not saying there should be like a specific number of say onions, maybe five onions for GH¢1.00. That will be cool. But in terms of the number of items, the price should be the same with the ones we get outside campus. That way we wouldn't feel the need to travel all the way to those places to get them. 'cause once we know maybe three onions go for GH¢1.00 here, same happens there. But then, we're not getting the same." (R1, FGD 2).

For many students, since they had to spend more money to consume relatively more FV in order to achieve the full-filling effect offered by "carbohydrates", reduced prices for FV would encourage most students to consume FV. That way, they would not have to spend too much money to get the "satisfaction" needed.

> "The thing with plant protein that I realised is, I'll have to consume extra more. Like you don't get full…you have to increase, if its soya, you have to eat more. You have to consume more…" (R4, FGD 5).

For other students, although they did like fruits, they had to be free or cheap to motivate them to make it an integral part of their diet. Due to the perceived high cost they would otherwise eat fruits occasionally.

> "Mmm...as I said, so the first on my list is cost or price. So, I'll look at the cost of the fruit first. My favourite fruit is actually apple, which is quite expensive. So unless is free, then fine. I'm willing to include it but if it is costly then perhaps maybe once in a blue moon..." (R3, FGD 6).

Other young people thought that reducing price would not be sustainable as the price of food, like other products, would always increase with time. According to such young people, they would rather "get more money" and be able to afford FV.

7.3.4.1.2 Proximity/ location of fruit and veg. outlets

The closeness of FV outlets to students was reported as key to encouraging students to consume more FV during term time. Some emerging adults reported that student in halls of residence closer to the few outlets that offered FV were more encouraged to buy FV. This was because such students were more likely to see the FV since they plied those routes daily.

> "Yeah and also for Night Market I think a lot of people around Diaspora purchase from Night Market because those who walk past there see so you just buy when you are going. So, the location too helps." (R1, BFPI 1).

Knowing the importance of FV, some students expressed feelings of being let down by the food environment. Even during times when they craved for FV, they had to settle for foods high in carbohydrates, as FV options were not within easy reach. Many students therefore reported that FV should be sold close to halls of residence

> "Also I think that the most essential kind of food that human beings needed like fruits and vegetable should be something that should be close to us. Because most of us don't take these fruits and vegetable because its far from our hall. I think it will help us to eat at least a balanced diet. Sometimes you crave for vegetables but since they're not available, you have to just buy these heavy foods, this carbo. carbo. thing." (R3, FGD 2).

Almost all halls and hostels had some sort of convenience store in-house that did not offer FV. In a similar vein, young people reported the absence of food outlets in some academic departments. Of departments that had food outlets, some did not offer FV options. Some students therefore reported that siting FV outlets at or closer to departments would make it easier for them to develop the habit of FV consumption.

> "Yes, like when I have people at the entrance of my hall selling fruits, I will be moved to buy fruits anytime I get to my hall. Yes. Or around my department selling fruits, I will be moved to buy fruits anytime." (R2, BFPI 5).

For some young people, FV should not only be closer to them. They should also be positioned in a way that always ensures visibility. This way, students reported they "would be more encouraged to buy".

> "Me I would say... yeah I would say like if it's more available or it's close by; it's somewhere you always see it, then I would be more encouraged to buy it." (R2, FGD 1).

7.3.4.1.3 Advertising and visual prompts

Closely related to the proximity factor, some students thought that in addition to increasing the number of FV vendors on campus, visual prompts and advertising would improve visibility for FV on campus. For such students, they would be prompted or reminded to buy FV.

> "There's no advertising…Yeah. So its off your head. But I think if there are joints or…you walk here and you see fruit there, that one will prompt you to buy them. But if you don't see them at all, me it will not even come in my mind." (R2, BFPI 3).

7.3.4.1.4 Choice/ Variety

Students valued variety and choice. Students expressed improved ability to vary their diets to include FV where there was variety.

> "Its a strategy for variety. So is not always that I'm supposed to be depending on meat. So maybe today I'll eat meat, tomorrow I'll eat beans and you know plants [plant protein], plantain and then an egg..." (R1, BFPI 7).

Food vendors that offered variety of vegetable salads was reported as an encouragement for students to consume vegetables. According to some students, vendors who allowed students to make a choice according to their vegetable preference enabled them to eat vegetables whenever they purchased food from them.

> "I don't like cabbage, 'kokonte'; a lot of things. So I like to buy waakye from my department. Because other places when you ask for salad there's a lot of cabbage inside; mostly their salad is just cabbage. But over there they've done one with cabbage and one without cabbage, so I get to choose the one I want." (R2, BFPI 1).

7.3.4.2 Societal factors

7.3.4.2.1 The home environment and significant others

Most emerging adults reported the "home" as a more congenial environment that encouraged FV consumption compared to the University campus. According to some respondents, FV were more readily available at home and free compared to when they were in school. Some emerging adults reported this was because they had FV farms or gardens at home. This meant that it was easier for them to consume FV when at home than when in school.

> "For me, I take more protein and more fruits when I'm at home. The reason being that I farm. Yes, I own an animal farm; some chicken and sheep. I grow pawpaw, mango,

> and oranges…So when I'm at home, I take more protein food and more fruits because I also grow some fruits." (R4, FGD 4).

For many emerging adults, their parents or guardians influenced them to consume FV when they were at home. In some instances, some emerging adults reported being "forced" by parents to "eat FV everyday".

> "Me if it's at home, they'll probably 'force' me to eat fruits everyday though. We grow some of the fruits at home…And my dad and my mum will probably force me to eat fruits every day." (R1, BFPI 1).

Most emerging adults reported that their parents or guardian brought FV to the house regularly to ensure availability of FV at home. According to emerging adults, this made it easier for them to eat FV as the refrigerator at home was always stocked with some fruits.

> "… in the house I normally take FVs. Because that one when my mother goes out and she's coming she buys them and put them in the fridge. So when I open the fridge, I see it, I will just take it. Ha! Ha! Ha!" (R2, BFPI 4).

> "… But in the house its my cousin he likes fruits so always there are fruits in the fridge so when I open the fridge and feel like taking it then I just take." (R2, BFPI 3).

Other young people were also influenced by their parents' dietary choices to consume FV when at home. From the account of some emerging adults, whether their parents ate FV frequently or not influenced their FV consumption.

> "But when I'm at home I eat a lot of vegetables though 'cause we cook for the family and there's always vegetables. Because my parents are old. So they're trying to be healthy and now we all have to be healthy. Ha! Ha! Ha!" (R2, BFPI 1).

This was because most young people ate from the same pot with their parents as a household, young people usually had to follow the same diet as their parents when they were at home.

7.3.4.2.2 Peer influence

Some emerging adults reported that their friends or roommates influenced them to consume FV. For most of such students, the only times when they consumed FV on campus was when a friend invited them to do so. According to respondent account, such emerging adults would not buy FV on their own initiative for their own consumption.

> "…Dorcas is part of my [food] environment. She would buy fruits almost all the time. That is when I will eat. When I'm walking with her, 'Respondent 2, let's buy fruits'. Then that's when I'll buy." (R2, FGD3).

Emerging adults indicated that they would walk with their friends to buy FV upon their friends' invite. They thought that this would motivate them to take FV.

> "...I think friends too count. If my friend is eating pineapple, I'll definitely take the toothpick and then, you know, choose some pineapple and eat it. I think I get to eat fruit when my friends are eating it... So, I personally, like Respondent 2 said, wouldn't have in mind that I'm going to buy fruit. When I'm coming to school and I'm doing my list, even though I go to the market, there are tonnes of fruits at the market, I'm blinded. I don't see it. I get the provisions and those things that I need. So probably maybe when friends are eating it, I know that one for sure. Or maybe friends buy some. You guys, so where did you buy this? Then I'll go and get some. But like personally going to buy fruit, nothing motivates me." (R1, FGD 3).

This was corroborated by other young people who did not take FV altogether or reported very low FV intake. They suggested that if they had a support network of friends and/or roommates that consumed FV daily, they would also be "nudged" to develop some likeness for or habit of frequent FV consumption.

> "Ok, let's say the people around us. Maybe if you're with your friends or your roommates and there is someone among them who likes fruits, like you will be moved by the person. Yeah. But then it's like all of us we are in the same shoes." (R1, BFPI 6).

While some young people did not have such network of friends, others had friends that consumed fruits frequently but had yet to be motivated by their fruit consumption habit. According to such students, if their friends invited them to buy fruits together that is when they would be encouraged to buy fruit for their own consumption. Respondent 2 (BFPI 5) gives an example of this in their submission.

7.3.4.3 Intrapersonal factors

7.3.4.3.1 Health or Nutrition knowledge and education

According to some young people, their nutrition knowledge motivated them to consume FV. Most students expressed awareness of the health and nutrition benefits of FV. For some students, this knowledge base motivated them to eat FV during the few occasions they did.

> "You have to eat fruits. It's good. Last time I was going to buy bread and egg. And a hunch was telling me that so you're going to buy sickness whilst there's

> pineapple...my conscience was worrying me: this thing you'll be sick and you'll get this [health condition], you'll get that. When I got down there I was like this is the right way. This is the wrong way. Know for yourself that bread and egg daily is not good. I was like ok today you won, and I took the fruits and I left. Sometimes your conscience will let you buy because you know that is good…" (R2, FGD 7).

Although majority of young people perceived FV as expensive and a luxury to be taken occasionally, some were informed and thought differently. Growing up, some emerging adults had been enlightened to think of fruit or vegetable not as a luxury good but essentials for health. For such emerging adults, they are motivated to consume increased portions of FV.

> "I don't really think its a luxury as I think its something normal. Its still the same. Because I was told that when I was very little, I liked bananas and growing up too I like them. And I think growing up to come and learn about fruits, it has motivated me to take it more because of its health benefits." (R1, FGD 4).

Some emerging adults reported that such nutrition education or conscientization would support them to develop the habit to consume FV. Their accounts also suggested the need for such education to come from trustworthy sources in order to be effective.

> "I think what will motivate me is to put the idea in my mind that I have to take the fruits. Its essential for me. Then I will take it. Because I always accept what is good for my body...I was actually told some time ago by the doctor not to eat pineapple again. And that is what made me develop the habit for mango and watermelon. So if the World Health Organisation is saying fruit is essential for me, then I will eat. I think that is what will motivate me." (R3, FGD 2).

This was confirmed by some emerging adults who felt empowered after their participation in this research. For such young people, the information they gleaned from the interview and discussion sessions had inspired them to make conscious efforts to consume FV.

> "After today, what we've done here... Ha! Ha! Ha! It'll motivate me because we've been saying fruits and vegetables, now I'm thinking about…orange, I'm thinking about pawpaw. So the next time we go out I would buy us some." (R1, BFPI 8).

It is worth noting, however, that majority of respondents did not consume FV often even though they demonstrated some knowledge of the health and nutritional benefits of FV intake. From the account of most students, there was a mismatch between the nutrition knowledge and the dietary behaviour of emerging adults.

> "Oh, if you're eating healthy you should have like groundnut, there should be all of them: like there should be fruits, vegetables. And you should have everything in its right proportion. But my ideal… like when I eat and I feel that

> oh today I’ve eaten well is…just having the carbohydrate and protein. That’s it. Ha! Nothing extra.” (R1, BFPI 8).

> “…when I'm getting lunch, I know the things I'm supposed to eat; balanced diet. But I don't really take it. I don't really practice it...” (R6, FGD 1).

This appears to suggest that knowledge of the importance of FV did not necessarily translate into dietary behaviour or dietary behaviour change among all emerging adults. For some young people, it appeared it would take more than just nutrition education to cause behaviour change towards FV consumption. For example, one emerging adult stated: “Wotua me ka koraa mennyɛ” [Even if you pay me, I won’t do it] (R3, FGD 3) during discussions around the intake of plant protein.

7.3.4.3.2 ‘When I’m sick’

One of the commonest facilitators to FV consumption reported by emerging adults was when one fell sick or had a health condition. For most participants, the only period when they consistently consumed fruit or vegetable was during a health condition.

> “…I would say I prefer vegetables to fruits. Like if I’m cooking something like Indomie, I would have to have plenty onions. I’m bound to have like vegetables in there...But with fruits, I don’t buy fruits. Most of the time if I want to buy fruits, its because maybe I’ve gotten sore throat...” (R1, BFPI 8).

In many cases, such emerging adults did not continue their intake of fruit or vegetable once the health condition was no longer there. They discontinued fruit or vegetable intake until they fell sick again. As have been indicated previously and made apparent from respondents’ accounts in this subheading, most students were aware of the health benefits of FV but waited until they were either diagnosed of or showed symptoms of a health problem. A good case in point was when one respondent who had received a diagnosis a day before attending the research interview expressed their resolve to increase their FV intake, in which they demonstrated in-depth nutrition knowledge.

> “…Yesterday like this, before I went to class I had to draw some plan but is like right now, I was diagnosed anaemic and so its like right now I'm trying to back up. So I'll be taking more of that and then more of the iron rich fruits and vegetable. I'll be considering citrus fruits and banana, is rich in iron...” (R1, BFPI 7).

Despite having some depth of nutrition knowledge, from respondent accounts, the most effective reminder about FV consumption to emerging adults was "sickness." According to students, the go-to remedy at the onset of sickness was the consumption of fruit or vegetable.

> "Basically, I have that mindset that when you eat more fruits, you become healthy and immune to diseases. So even when I fall sick right now, the first thing that comes to my mind is: 'you don't eat fruits, like you don't eat the right amount.' I'll get rash and after taking fruits for three days continuously, I'm ok. It does that magic. It works for me, so I don't even think twice when I'm sick." (R3, FGD 7).

However, for a few respondents, they would only take vegetable or plant protein consistently "if the dietitian tells" them. Either than that they "will definitely for the usual." On the contrary, a couple of students prioritised their personal health and reported that as the reason they consumed some FV at least once in a week.

> "So my health is very important that at least once in a week, some fruits should go in there. So if... even if the price is still the same or everything is still the same, I'll... my health should motivate me to eat more fruits." (R1, FGD 1).

For such young people, the perceived high cost of fruits on campus did not dissuade them from consuming fruit.

7.3.4.3.3 Body image

Participants' body image dissatisfaction was one of the reasons they consumed fruit or vegetable. Some emerging adults expressed displeasure about their physique and thought frequent consumption of FV would support them to achieve their desired body weight. Many of such cases were young people who wanted to lose weight.

> "Yes, so currently I'm trying to channel my meat money to vegetable money. That's what I want to come out [up with] because I feel like I'm... putting on weight. It usually happens when I'm in the house. Especially when I go for holidays. I take in so much protein and put on before I go to school. So when I get to school, I try to... although it doesn't work most of the time but then its something I'm beginning to do." (R2, FGD 5).

In some few instances, some young people who thought they were too skinny and needed to put on some weight reported that taking FV would enable them to reach their goal. A typical example was when a respondent made fun of their friend they were in the interview with:

> "…'cause I've realised that I've lost weight, as she [best friend/interview partner] was laughing at me. So me taking that it will help me to build up." (R2, BFPI 7).

7.3.4.4 Barriers and facilitators to ultra-processed foods consumption

Two broad themes specific to ultra-processed foods consumption (all being facilitators to consumption) emerged from the analysis of data from FGDs and dyadic interviews with best friend pairs: (1) convenience and time factor and (2) availability, campus lifestyle, and campus norms. These themes are described in more detail in the following sections.

7.3.4.4.1 Convenience and the time factor

Time and convenience were the most recurrent motivation for emerging adults to consume ultra-processed foods during term time. The demand on time from academic work generally made ready-to-eat or quick-fix meals and other UPFs the important and preferred food options for most participants. However, the issue of time and the consumption of UPFs triggered interesting discussions and arguments that highlighted the context dependency of 'time' as a motivation to consume UPFs. In that, many students presented cooking as a stressful and time-consuming endeavour to combine with "early morning lectures" and 'life after' a long day roving between lecture halls. Convenience was thus portrayed as an important facilitator making UPFs the popular food category among these emerging adults during term time. Time and convenience were more prominent drivers of UPF consumption during weekdays and even more important during examination period.

> "…eating different types of food is hard to make. And you see when you're in school you want something that can make you easy going... during weekdays I tend to snack more. 'cause if I don't eat and I'm hungry…I'll buy pastries. Then to me I've eaten." (R1, BFPI 8).
>
> "Respondent 2: And during the day, if I have time, I will cook but if not, I'll just munch on something. Most of the time I always buy spring rolls and a drink. That's what I eat most of the time.
>
> Interviewer: Ok, what sort of drinks?
>
> Respondent 2: The...fizzy ones.
>
> Interviewer: Ok. Like?
>
> Respondent 2: Fanta, coke, yes, those ones." (R2, BFPI 2).

However, other participants argued that making time for cooking was a "matter of planning or time management" and setting individual priorities. Participants expressing this view positioned their argument on the consequences of consuming unhealthy diets, including the possibility of being 'bedridden' or "sleep[ing] away the whole time" one sought to save by prioritising convenience over health.

> "…she [roommate she partners in cooking] likes cooking at night because that's the time she's free…It depends on how you manage the time and how you carry yourself, else you will not even take any proper food. You'll keep drinks or snacks by you and just go with it. So, I think its just about time management...cooking doesn't waste your time." (R2, FGD 3).

Although some participants who initially had a different view subsequently agreed to the "time management" argument, other students maintained that even time management would not work, as the "course controls you". They also felt that the salience of time management is context [academic load] dependent. In the following excerpts for example, a participant who shared this view thought that time management would only work for students with smaller academic load.

> ...I've compared our course work with other course works...with other courses or programmes and is not the same, whether you have time management or not. Because the course controls you. You don't control it...so it depends really on what their academic work is. (R1 FGD 3).

7.3.4.4.2 Availability, campus lifestyle, and campus norms

The proliferation of UPFs within the University foodscape was also mentioned many times as a motivation for frequent UPF consumption. Participant narratives portrayed UPFs as being ubiquitous in the University foodscape, which according to many students influenced them to consume UPFs more frequently. SSBs and carbonated drinks, ice cream, biscuits, pastries and French fries were the most recurring UPFs, with Coca-cola, Fanta and malt drinks being the most popular SSBs. Indeed, there was widespread feeling that it "is what is available, that's what we eat. We have no choice."

> "…when one is craving you know exactly the only options that are there….its either you're going for cake…going for ice cream…or you're going for a junk. Junk could be chicken and chips…" (R1, BFPI 4).

> "…I want to stop taking carbonated drinks...but here it doesn't look like they're happy with that. Haha. 'cause everywhere you go there's a carbonated drink somewhere." (R2, BFPI 4).

In the above excerpts, participants' narratives indicated that the prominence of UPFs in the food environment impacted their UPF consumption behaviours. The ubiquity of fizzy drinks in the campus foodscape was constructed as a 'stumbling block' to UPF consumption behaviour change efforts. Respondent 2 in BFPI 4 for example, expressed the difficulty they experience in efforts to cut on UPF consumption "…'cause everywhere you go [on campus] there's a carbonated drink somewhere." This omnipresence contributed to making UPFs a more convenient food option that appeared to support the formation of other habits, especially late-night eating, which in turn further fueled UPF consumption.

> "... initially when I came, like level 100 there, I decided not to cook. So normally I go [out] to get food... So I don't actually wake up early. I watch movie in the night. Yes, so I keep a lot of snacks: like drinks, biscuits, and all that, because around 1, 2am thereabout I'm watching movies, so I have to take something..." (R3, FGD 1).

Late-night studies and 'night life fun' in general, which are common and often integral to university lifestyle, were also recurring factors that appeared to encourage UPF consumption among participants. Participants observed that apart from UPFs being "always available", university lifestyle (specifically late-night studies and night-time fun) appeared to make UPFs more appropriate and acceptable. SSBs and biscuits were constructed/recounted as the most appropriate and preferred foods to eat at night or when students "feel it's too late" to eat "heavy foods". UPFs also served purposes other than food and nutrition in the University campus lifeways, including as 'non-sleeping pills', 'treats', as social class symbols, apart from being used as 'appetisers and accompaniment food'.

> "…most of the time I have like snacks and like biscuit or a drink…that I take before I eat.
>
> Interviewer: What type of drink?
>
> Respondent 2: Oh Coke. Yeah. I also take it especially during the night because it kind of helps me stay awake. I like to study in that time so I have snacks and biscuit…when I'm studying 'cause I like to chew things else I'll sleep…" (R2, FGD 2).
>
> "…If its not Royal Apple, it's Tampico. Those are the two drinks I take...I take my drinks mostly in the evenings. When I feel it's late and I'm learning, and I don't wanna eat much, then I go and get a drink. There are vendors…some of them have drinks around…" (R2, FGD 3).

In some instances, students described the consumption of certain UPFs as a befitting way to "pamper" themselves. They would even travel to or bear delivery costs to order such UPFs from eating venues outside the immediate University food environment. Other students believed that taking such UPFs, including SSBs conferred on them a superior social class status and so used them as a "show off".

> "Respondent 2: …once in a while you have to pamper yourself, go outside like something different…like KFC.
>
> Respondent 1: You like the KFC!
>
> Respondent 2: No, I like their Krushers. Ha! Ha! So yes, that's the only thing I think. And then other ice cream flavours. Yes. 'cause on campus its like the same [flavours]." (R2, BFPI 2).
>
> "Yes. I learnt that when we're eating, sometimes you know, you want to show off. So you eat alongside ehm...juice and fizzy drinks. But I learnt that is not that healthy, so we're supposed to take more water…" (R1, BFPI 7).

Indeed, some students felt more attracted to UPFs than other food types available in the University food environment.

> "There are rice dishes there. There is banku and those things but I don't…I've never bought…I don't like those things. I'm not attracted to like that. Just the normal drinks and pie..." (R1, BFPI 8).

The student in the above excerpt, for example, did not patronise hot meals during term time except SSBs and pastries.

7.4 Discussion

7.4.1 Summary of key findings

This qualitative study set out to identify factors that inhibit or facilitate UPFs, fruit and/or vegetable consumption behaviours in emerging adults in a Ghanaian university community. We found that factors operating at the three levels of the socio-ecological model (SEM) of health behaviour—personal, interpersonal, or societal, and environmental—were perceived to inhibit or encourage/influence adequate FV consumption among young adults. Personal nutrition knowledge, value satiety, societal norms, parental influence, cost of FV within the University foodscape, and retailers' opening hours were the key issues reported as perceived barriers to FV consumption. Most of the perceived barriers inhibiting FV consumption were intrapersonal/individual level factors. Being sick, the availability and proximity of FV, the home environment, and peer support were important enablers of FV consumption. The findings on barriers and facilitators are discussed through the lens of the three dimensions of the SEM of health behaviour.

7.4.2 Environmental level barriers and facilitators

The cost of food is undoubtedly a primary determinant of food choice. In this study and consistent with previous findings, the perceived high cost of FV within the University foodscape was the most prominent perceived barrier to most emerging adults meeting FV consumption guidelines. A growing body of evidence suggest that the nexus between optimum diets and low-income is mediated by the cost of healthy food (Miller et al., 2016). Reputed as core components of healthy diets, FV have also been repeatedly found to account for a large part of the cost of a healthy diet (Kern et al., 2017; Miller et al., 2016b; Rao et al., 2013). In low-income populations in the USA, Australia, and UK, the retail price of FV has been reported as a perceived prohibitive factor to adequate FV consumption in systematic reviews (Darmon & Drewnowski, 2015), quantitative studies (Livingstone et al., 2020), other qualitative studies (De Leon et al., 2020; Tamrakar et al., 2020; Thwaite et al., 2020). Consistent with this rationale, in a pooled analysis of national dietary surveys in 12 European countries, diets in poorer EU countries were poorer relative to diets in richer EU economies (Rippin et al., 2020). Reporting similar findings, a recent systematic review and meta-regression analysis of meat and FV consumption in 24 sub-Saharan African countries, FV consumption was comparatively higher in richer SSA countries (Mensah et al., 2020). Specific to students, college students in the USA in Dhillion et al.'s (2019) study also perceived the high cost of FV as a barrier to meeting FV intake recommendations. Indeed, other research has suggested that the perceived cost of a food product leads to an inversely proportional frequency of consumption of that food item (Tanawattanacharoen et al., 2020).

Limited availability of FV vendors in this campus was a key barrier to FV consumption. The issue of availability was also mirrored in other perceived barriers in this inquiry, including the opening hours of food outlets. Even when emerging adults craved FV, they had to suppress it and resort to "carbo" foods due to spatial inaccessibility of FV or because it was outside FV outlets' business hours. But the minority that had FV outlets in close proximity to their halls of residence reported proximity to FV retailers as a facilitator/motivation to consume some FV. While this may imply that siting FV joints near students, may encourage FV consumption, a systematic review of evidence from HICs has also suggested that availability measures (e.g.

count, which improves variety/choice) may be more effective at influencing dietary changes compared to accessibility measures (e.g. proximity) depending on the food outlet type and dietary outcome of interest (Bivoltsis et al., 2018). It is therefore an essential precondition that future research explores the effectiveness or otherwise of proximity and/or accessibility measures, among other interventions, at improving FV consumption specifically or dietary behaviour in general in the SSA university setting.

Availability was also an important facilitator to UPFs consumption in this emerging adult group. The ubiquity of UPFs in the university foodscape made it easier and more convenient for participants to consume UPFs more frequently but made behaviour change towards lesser UPFs consumption a nearly impossible endeavour during term time. Neighbourhood availability of UPFs (Leite et al., 2018) and higher variety of SSBs in the neighbourhood (Duran et al., 2016) has been associated with increased UPFs consumption in Brazilian children (Leite et al., 2018) and 15% increase in frequent SSB consumption among Brazilian adults (Duran et al., 2016). Among older Netherland adults, availability and proximity to supermarkets and restaurants have been associated with lower consumption of UPFs (Pinho et al., 2020).

Academic demands on time at university also highlighted the role of time limitations in making UPFs the popular food type among participants in this study. Time constraints from academic demands appeared to interact with the proliferation of UPFs within the University foodscape and UPFs being available nearly around the clock contributed to making UPFs a convenient food option for most students. Time and convenience therefore played an important role in students' everyday negotiations/navigation of the foodscape to make UPF consumption decisions. Perceived time pressure has been reported as an important determinant of health behaviours including physical activity and food practices, especially among employed women (Welch et al., 2009) and households with children (Sato et al., 2020). For instance, time constraints have been reported among Brazilian mothers as a major reason for their consumption of UPFs and for feeding their children with UPFs in a qualitative study (Sato et al., 2020). According to a cross-sectional study, Norwegian parents with higher time constraints were more likely to eat more ultra-processed dinner foods, snacks and sweetened beverages (Djupegot et al., 2017). Specific to students, American university students following 4-year programmes have reported time pressure as constraints to balancing busy schedules with eating healthy meals, with those in the lower socioeconomic status reporting more perceived time constraints (Pelletier & Laska, 2012). In the school setting, Korean high-school students with higher academic stress levels had greater intakes of total sugar from SSBs, confectionery and fast food (Kim et al., 2013). Despite the reported time constraints in this emerging adult sample, many students believed that by managing their time properly, they could make time to prepare healthy meals at home (student accommodation) during term time. This would reduce their reliance on UPFs.

However, there was also the impression that operationalising this belief into a regular routine would be possible for only a few. These contrasting views raise two questions: (1) is it the case that students who reported time constraints as obstacle to preparing meals have extremely busy schedules or (2) that they consciously or unconsciously prioritise a variety of demands on their time above their own nutrition and health? Prior qualitative studies have found that students in four-year courses may have difficulty structuring their time (Strong et al., 2008) which could result in perceptions of time scarcity for activities deemed less important (Cluskey & Grobe, 2009; Deliens et al., 2014). Similar to findings from previous literature (Hilger et al., 2017), many students in this study lacked the self-efficacy (including cooking skills and the motivation to forgo UPFs) or the equipment/facilities that discourage making time for cooking. The high cost of fresh healthy foodstuff and the huge presence of the often-affordable UPFs in this University's foodscape may also compound the constraints of this emerging adult group.

In light of previous literature indicating that lives get busier with age when individuals transition from school into the world of work, underscores the importance to intervene and support emerging adults to develop healthy lifestyle including healthy food behaviours and practices despite time constraints. This would equip young people with self-efficacy that prepares them to be able to balance demands from work and family life with healthy dietary practices. Indeed, balancing work life and family responsibilities have been associated with perceived time constraints to practice healthy dietary behaviours (Pelletier & Laska, 2012). Other researchers have therefore suggested the need for interventions addressing time burden among young adults to promote healthy eating. It is suggested that further research explore the subjective perceptions of time scarcity among this emerging adult university students or how they construct time to better understand the nexus between time use/pressure and UPFs (or convenience foods and ready-meals) consumption. Intervention studies on the feasibility of practical strategies like meal and time planning aimed at improving self-efficacy in this young adult group towards time managing time pressures are also essential.

7.4.3 Societal or interpersonal level barriers and facilitators

Beyond the food environment influences, students' insight suggests that their food socialisation imbued in them norms, beliefs, and a food culture that favour food options that are satiating and/or are social status symbols rather than FV which they considered as 'auxiliary'. Although consumer food socialisation is largely a lifelong process, the formative years (childhood and adolescence) are critical. As the foremost point of contact, the family is widely believed to be the most influential socialisation agent (Moore, 2018). The home, including parents/carers and significant others, was pivotal in shaping young people's beliefs and perceptions about FV in this study, corroborating previous findings on the potential influence of parents in modelling healthy behaviour (Jalali et al., 2016; Moore, 2018). Food parenting practices including ensuring FV availability at home, coercive control, parental modelling, and encouragement and negotiation were reported as features of the home food environment that facilitated FV consumption at home. In this sense, participants' insights characterised the home 'as a two-way street', acting both as a barrier and a facilitator to the nurturing of optimum FV consumption behaviour, depending usually on family-related characteristics and the values of the most influential figures in the home. Previous evidence suggests that during formative years, familial factors including parenting and resources (availability of healthy/unhealthy food options at home) define health behaviours which shape lifestyle in later years (Mollborn & Lawrence, 2018) even though consumer socialisation theory argues that parental grip or influence decreases with age, with friends taking over in adolescence (Hota & Bartsch, 2019; John, 1999). However, in Denmark, parents (versus friends) were found to be the main influencers of 16- to 19-year-olds' FV consumption with what parents do being more important than what they say (Pedersen et al., 2015). This sheds light on young people's predisposition to emulate parental eating behaviours or actual food choices (what they do—descriptive norms) rather than what they 'instruct' or say (injunctive norms) (Fleary & Ettienne, 2019; Pedersen et al., 2015) especially during independent/unsupervised eating occasions (Reicks et al., 2015).

It has been suggested that perceived inconsistencies between parental food rules and actual parental dietary behaviours ("do as I say, not as I do" principle) are likely to result in adolescent non-compliance with norms (injunctive) from the home (Fleary & Ettienne, 2019). In both theoretical and empirical evidence, forcing young people to eat FV has been counterproductive (Jordan et al., 2020) and implicated in poor food behaviours, as it makes the experience aversive (Bergmeier et al., 2020; Mitchell et al., 2013; Zimmer-Gembeck et al., 2019). Indeed, according to retrospective studies, food aversion in adults can be traced back to childhood experiences of coercive feeding (Ellis et al., 2016; Roberts et al., 2020). While the influence of the foregoing parental practices is yet to be researched/investigated (which we recommend) in our study population or similar, they may partly explain why some emerging adults in this inquiry ate FV at home but hardly consumed FV in school.

Normative beliefs learned from the home, which were intricately linked to the wider societal norms, interacted with campus food norms and peer influence ('the need to belong') to shape emerging adults' attitudes towards FV, and how they negotiate their food-related decisions or interact with their foodscape in general. Insights from participants' narratives suggested an internal conflict between wider negative societal beliefs towards FV consumption and their knowledge of the benefits of FV consumption. Gadegbeku et al. (2013) for example, found food taboos prohibiting the consumption of fruit like banana, guava and coconut among Ghanaians living in Accra. Such food beliefs are even more pronounced/extensive during pregnancy, lactation, and weaning when the consumption of more FV are prohibited (Armar-Klemesu et al., 2018; Otoo et al., 2009)(e.g. avocado, pumpkin, taro, pineapple, cabbage, okro, etc.). These habits may persist post-partum, lead to maternal and infant malnourishment or even mortality (Ahmad et al., 2019; Gebremariam & Gebremariam, 2017), and adversely affect the diets and dietary behaviours of their children and/or partner. Similar food beliefs have been confirmed in Nigeria (Ekwochi et al., 2016; Ugwa, 2016), Ethiopia (Tsegaye & Ayalew, 2020), Kenya (Kariuki et al., 2017; Riang'a et al., 2017), South-Africa (Chakona & Shackleton, 2019), and other LMICs (Diana et al., 2018; Iradukunda, 2020; Köhler et al., 2018). This in part may explain why some emerging adults in this study thought that FV are not "really engraved" in Ghanaian dietary habits.

Although the food norms in this campus did not appear to favour FV consumption, a few students, for example, reported being motivated by friends to eat FV. In many such cases, this was the only time such students took any FV when on campus. Many young people in this sample believed that having a network of FV-eating/loving friends would be an effective way of encouraging FV consumption on campus. Dhillon et al. (2019) have reported similar findings in college students in a food desert campus in the USA. Experimental studies of social norm interventions have also reported significant reduction in high calorie snack consumption in UK adults (after seeing information on others' junk food eating habits) (Robinson et al., 2013) and induced healthy (FV) (Kim et al., 2019) and unhealthy choices (sugar-sweetened beverage) (Kim et al., 2020) among children in Singapore after seeing other children's food choices. These findings reiterate the importance of peer influence/support in food-related behaviour change, especially in young people, and how it challenges parental grip on behaviour during transition into adulthood.

On the other hand, in terms of UPF consumption, participant narratives suggested that this campus' food norms support/encourage UPF consumption, a norm that appeared to be facilitated by the ubiquity of UFs within the university foodscape. Some students thus constructed the university foodscape as a congenial environment for the formation of habits that favored frequent UPFs consumption. This is consistent with recent findings from a cross-sectional study associating social norms with increased UPFs consumption among Brazilian adults during the Covid-19 pandemic (Ruíz-Roso et al., 2020). In a qualitative study in the USA, household and family norms were identified as key determinants of UPF consumption in households with children (Moran et al., 2019). In another qualitative e enquiry, the sociocultural environment in the Brazilian Amazon was key to defining the meanings assigned to various food types among adult mothers (Sato et al., 2020). Ultra-processed foods were categorised as the most frequent of "special meals." These meanings influenced participants' consumption of UPFs. Ultra-processed foods were the most frequent of "special meals" which were foods consumed on weekends and on special occasions (Sato et al., 2020). These meals usually included pizza, burgers, hot dogs, pasta and barbecued meat accompanied by carbonated drinks (Sato et al., 2020). In Stok et al.'s (2016) systematic review of experimental and correlational studies, 32 out of the 33 studies included in the review found that social norms influenced the types of food young people consumed in the presence of their friends. Descriptive norms were positively associated with the consumption of SSBs, unhealthy snacks and fast food (Stok et al., 2016). Participants in this study viewed UPFs consumption as 'special' and befitting for "pampering" themselves, especially on special occasions. UPFs consumption was used for purposes other than nutrition and feeding, including being used by some students to display social class status.

7.4.4 Intrapersonal level barriers and facilitators

Most of the dominant themes reported as perceived barriers and facilitators by emerging adults were individual level factors including perceived lack of knowledge, value satiety, mistrust for vegetable sources, 'out of sight out of mind', sensory aversion, and misconceptions about FV as barriers to FV consumption. Sickness was presented as a facilitator to FV consumption.

Dietary knowledge or the lack of it, and body image preferences were both facilitators and barriers to FV consumption among emerging adult university students. These barriers and facilitators are discussed in detail below.

Dietary knowledge and the lack of it were important influences, both as a barrier and enabler for FV consumption. Despite widespread knowledge of the health and nutrition benefits of FV consumption among emerging adults in this enquiry, the lack of knowledge of the levels of consumption required (as recommended by the WHO) to achieve the protective effect of FV was the most recurrently reported perceived barrier to FV consumption. This may shed light on why many emerging adults perceived FV largely as food for ‘intervention’ to be consumed when the need arises rather than on a daily basis for the nutritional value. Pineapple, for example, was valued for its potency as remedy for occasional indigestion, sore throat or cold. Similar perceptions and behaviours towards FV as barriers to FV consumption have been reported among caregivers of children aged 6 to 23 months in northern and central Ghana (Armar-Klemesu et al., 2018). Sickness was reported as a facilitator to FV consumption in this emerging adult sample. Other qualitative studies have found that being diagnosed with a disease is often the only reason why adults in the USA and UK are likely to make modifications to their dietary behaviours (McGee et al., 2008; Puddephatt et al., 2020). Longitudinal studies have also reported that Canadian and English adults increased their FV intakes only after they were diagnosed with a disease (Hackett et al., 2018; Newsom et al., 2015). Risk perception in general has also been found to trigger changes to health-related behaviours (Barry et al., 2018). The absence of a national nutrition guideline and nutrition agenda for the study country at the time of this study, appeared to contribute to significant nutrition education gaps on the need to frequently consume FV. For other participants (mostly female) in this study, body image preference was a motivation to consume FV. Awareness of being overweight or underweight encouraged some students to eat FV to achieve “summer body.” In Cuban (Careaga & Armas, 2019) and Brazilian (Ribeiro-Silva et al., 2018; Tebar et al., 2020) adolescents, desired body image was associated with higher vegetable or FV consumption. Similar findings have also been reported among single women in the UK (Donkin et al., 1998). Emerging adults’ awareness of the healthiness of FV may be harnessed to encourage frequent consumption at the recommended levels.

In addition to expanding on the nutrition knowledge of this group, interventions effective at consistently reminding, prompting, or nudging them to eat FV at optimum levels on a daily basis should be investigated. Indeed, some participants felt motivated (by discussions during the FGDs and BFPIs) to make conscious efforts to frequently consume more FV when prompted about the WHO recommendations for FV intake. Moreover, a few participants in this study were motivated by their nutrition knowledge to consume FV relatively more frequently. Mobile phone based interventions including self-monitoring, audio and textual health applications improved fruit and/or vegetable consumption among adults in longitudinal studies (Hendrie et al., 2020), randomised-controlled (Chung et al., 2021; Elbert et al., 2016; Mummah et al., 2017), and systematic reviews (Mandracchia et al., 2019). Interventions to improve FV consumption in this emerging adult group should take into account the deep-seated preference for satiety and the various misconceptions about FV and FV consumption. Similar misconceptions as barriers to FV consumption have been observed among rural Indian (Kehoe et al., 2019) and Sudanese (A.kheiri et al., 2017) women of reproductive age.

Sensory aversion was also a barrier to consumption in a small proportion of the study sample. This is consistent with previous quantitative findings associating mouthfeel (tactile sensitivity) with picky eating in Dutch undergraduates (Nederkoorn et al., 2019) and sensory sensitivity with picky eating in US undergraduates and children (Zickgraf & Elkins, 2018). Specific to FV, a cross-country study among European adolescents also found that highly disliked vegetables were characterised by disliked sensory features like bitter taste (Dinnella et al., 2016). In a South Korean student sample where vegetable was the most disliked food (by 74.7% of participants), previous negative experiences including forced feeding were cited (by 46%) as the reason for food or vegetable dislike (Kim & Lee, 2020). The sensory dislike to FV observed in this study's emerging adult sample may be explained by negative historical experiences of FV as reported in other studies (Kim & Lee, 2020). However, the current study did not capture this. Further research to ascertain the underlying causes of the observed sensory aversion to FV in this young adult sample are required to enhance understanding and inform interventions.

This study is the first to use the ecological model to explore the barriers and facilitators to emerging adults' consumption of UPFs, fruit, and vegetable during term time in a sub-Saharan African university setting. The combination of FGDs and dyadic interviews with best friend pairs to gather students' views is also novel and another important strength of this explorative study. Compared to one-to-one interview, both dyadic interviews with best friend pairs and FGDs creates a more 'naturalistic' environment (closer to everyday conversation) and conducive atmosphere for participants to share their thoughts freely. This enabled us to get a more realistic picture of the complexity of factors this university student group navigate/negotiate in their day-to-day food choice decisions during term time. On the contrary, some participant narratives may have been influenced by social desirability bias, especially in FGDs. For the same reason, some participants may also have made less submissions than other students during FGDs.

Another possible limitation of this study could be the use of self-selected participants. These may have been students who were interested in the research topic. It is possible that this may have introduced selection bias and may have influenced the findings. Participant characteristics in this study however show a good mix and sufficient variety in year and programme of study, BMI status, and gender, although some characteristics were under- or over-represented. This allowed the combination of homogeneity and/with sufficient variation among participants within groups (in FGDs) to ensure the ease of sharing ideas and allow for contrasting opinions to mitigate against the limitations associated with single-gender or homogenous groups that may be inclined towards a singular or similar opinions. Indeed it has been suggested that focus groups consisting of mixed student participants (in terms of gender, year and programme of study) generate discussions between genders from varied study disciplines, backgrounds (Deliens et al., 2014) and varied levels of experience with the university food environment.

A third limitation relates to the conduct of this study on one university campus. This university has another campus outside the main/central campus where the study was conducted. Due to contextual differences among university environments, (including size, structure, foodscape features, features of surrounding environment, campus norms, etc.) the generalisability of this study's findings to other/wider student populations may be limited, but not in the case of other student populations studying or living on campuses with similar characteristics. Researchers have questioned the possible applicability of qualitative research to the wider population given its cultural- and context-specificity (Schwandt, 1997). (Tracy, 2010). However, (Silverman, 2014) has argued that drawing generalisations from qualitative research is based on recurring social processes but not about sampling and sample size. Therefore a more fitting/apt goal would be transferability and resonance of the socio-cultural processes to other contexts and similar populations (Guenther & Falk, 2019; Tracy, 2010). The interpretation and application of this study's finds should be caried out in the appropriate context.

Lastly, despite the study's strength of including a novel food category, ultra-processed foods, only two main question themes were used apart from follow-up questions to participant responses that pointed to/included UPFs. This may have limited the amount and variation in participants' responses on UPFs consumption as compared to the data and responses relating to FV consumption. However, participant responses were probe for more detailed answers as possible. Another limitation related to data collection has to do with the size of some focus groups not meeting the ideal number. This may have reduced the effectiveness of FGDs in creating lively, co-constructed data (when group size was too low) or resulting in the over-dominance of a few participants (when the size was too large). Some FGD participants arrived later when discussions had already commenced, disrupting group discussions and possibly reducing the richness of the data obtained in those FGDs where there were such occurrences.

CHAPTER EIGHT

WE'RE MEAT, SO WE NEED TO EAT MEAT TO BE WHO WE ARE—MOTIVATIONS TO INCREASE/ REDUCE MEAT CONSUMPTION AMONG EMERGING ADULTS IN THE UNIVERSITY OF GHANA FOOD ENVIRONMENT.

8.1 Chapter summary

Background: The increasing presence of meat and other ASFs in the diets of SSA populations as observed in Chapter 3 have dire consequences for human and planetary health in the subregion. Dietary shifts/modifications that favour FV will offer dual health and environmental benefits. But are emerging adults in the Ghana (or the SSA setting) who are both important targets and potentially key drivers of dietary change willing to modify their diets or dietary behaviours for health and ecological benefits?

Objectives & Method: This qualitative study component explores motivations and willingness of emerging adult university students to adopt healthy and sustainable diets. The study used the same methods adopted in Chapter 6.

Results: Various motivations to increase or reduce meat consumption are highlighted by the results, some of which they deemed more relevant than others. Health concerns; animal welfare; and environmental sustainability were not important to this age group, and they did not consider changing their behaviour on the basis of these drivers. Body weight and shape; meat as identity, pleasure, and joy; meat eating as part of socialisation; religion and cultural practices were more frequent drivers of behaviour. Generally, bodyweight and shape concerns drove increased preference for meat consumption as did meat as identity, pleasure and joy, and meat eating as part of socialisation, whereas religious and cultural practices were generally cited as a reason to limit meat intake.

Conclusion: Given the complexity of factors driving meat-eating behaviour in these emerging adults and the deep-seated role meat plays in the diets of the cultures represented in this study, a multi-level and multidisciplinary approach may be successful at changing dietary behaviour. However, this may take time and require further research.

8.2 Introduction

Findings in Chapter 3 shows meat consumption in SSA has been on an upward trajectory over the last 30 years, with consumption increasing with age, trends which the WHO projects will persist as SSA economies get richer and the middle-class population expands. Meat consumption being a leading risk factor for major NCDs (including cancers, stroke, hypertension and cardiovascular disease, and all-cause mortality) which are projected to be the leading cause of death and morbidity in SSA in the absence of planned and directed dietary modifications. This part of the qualitative research component explores the underlying motivations and barriers to the adoption of healthy and sustainable diets. It also sought to examine awareness of environmental sustainability and to gauge emerging adults' willingness to adopt healthy and sustainable diets. This part of the qualitative study also used data from the same methods described in Chapter 6.

8.3 Results

8.3.1 Characteristics of participants

In total, 46 emerging adult university students participated in eight BFPIs (or dyadic interviews with best friend pairs) and seven FGDs, lasting 60-75 minutes respectively. The full demographic details of participants are presented in Chapter 6 and Table 6.1.

8.3.2 Emergent themes

Participants were categorised as self-declared medium, high meat-eaters or aspiring meat-reducers based on their responses to questions around the frequency of meat consumption. The majority of emerging adults identified themselves as high meat-eaters (HMEs) with only a few medium meat-eaters (MMEs) or aspiring meat-reducers.

Emerging adults drew on an array of explanations in narrating the basis for their intention/decision to reduce or increase the amount of meat they eat. Eight dominant themes, mostly individual level motivations, were identified through the analysis, were recounted principally in connection with health/nutrition, body weight and body image concerns, and animal welfare, meat identity, environmental sustainability, religion, and socialisation concerns. These are reported below with example quotes from participants. Appendix 8.1 also presents additional example quotations.

8.3.2.1 ‘Everything can be bad for your health’: Contesting meat-related health concerns.

Motivations to consume more meat were recounted in relation to health/nutrition concerns. Many emerging adults downplayed health risks associated with excessive meat consumption. They deployed various strategies that rendered meat-related health risks as exaggerated, a ploy that sought to rationalise and uphold high meat consumption and to psychologically ‘immunise themselves’ from concerns about illness and/or mortality associated with excess meat consumption. Several participants for example used various descriptions (including “stuff”; “it’s a lie”; “I don’t really care”) that ‘reduced’ meat-related health risks to ‘health scares’ which many of them—particularly female participants—demonstrated in their narratives would not succeed in making them eat less meat. Young people also cited other practices involving risk such as cigarette smoking and drinking SSBs, and even life itself as being inundated with risk:

> “…I’ll rather increase it. There's this thing: smoking can kill, it can give you cancer [on cigarette pack]...they can see rotten lungs whatever, they still take it…” (R3, FGD 3. Female).

> “Yes. I believe your death will come when its time for you to die. There are a lot of things in the world that can. And then everything has disadvantages and advantages. If its not meat, its water or carbonated drink, too many constraints and stuff. If you’ll die, you'll die by all means. When its time to die you'll die anyway” (R6, FGD 1. Male).

Although there was some recognition of risk, the link between excessive meat consumption and NCDs or a healthy life in general was undermined. Excessive meat consumption was thus construed as nothing unique/peculiar—just one of the possible contributory factors to ill-health or death—and not worthy of disproportionate attention. Thus, emerging adults’ narratives generalised the notion of risk and sought to demonstrate that every lifestyle option carries risk, not just high meat consumption. In that, young people recounted that every living being bears risk, notwithstanding their lifestyle choice. Apart from downplaying the health risks associated with excessive meat intake, health risks were deferred to an ‘imagined’ distant future of later adult life. Many participants thus expressed a difficulty grasping the idea of going through known meat-related health conditions while still young. Thus, known (meat-related) disease was ‘allocated’/ ‘consigned’ to older age.

At other times, there was a demonstration of defiance towards excessive meat consumption and the possible health risks and implications, which again reinforces the dismissal of risk. Some HME expressed such defiance to include cases where they are advised on medical grounds to reduce meat consumption, which some participants disagreed to and challenged, and described as sheer "youthful exuberance" which stance they remarked will change once reality dawns. That is, when a health condition 'visits' them. In defence, one HME invoked an example from her family grounded in the 'it happened to them doesn't mean it'll happen to me' argument:

> "Interviewer: Interesting. Respondent 3, what do you think about reducing your meat intake?
>
> Respondent 3: No, please. I'm sorry.
>
> Respondent 2: Its gonna affect your health.
>
> Respondent 3: 'ɛneɛ ɛn-affɛkte ɛ.' [then it should affect me] 'cause me, in my family most people get diabetes. Yet I take sugar like crazy. I don't really care. The fact that they got it doesn't mean I'll get it. My grandpa; my daddy's dad, he died of diabetes. My daddy doesn't take sugar and stuff though he's not diabetic." (R3, FGD 3. Female).

Another participant (a student nurse) speaking from his experience with hospital patients corroborated that many people do not adhere to behavioural change advice when they are sick, although such recommendations are based on medical grounds.

> "Oh there are many people who do not. I'm not a food type nurse but I've worked with patients, and I've also worked like clinicals and those things expose me to patients and all that. Many people will not cut it." (R1, FGD3. Male).

Other participants brushed off the possibility of being advised by a medical or nutrition professional on the premise that they were not consuming "too much meat" in the first place. However, in another breadth most of such respondents could not recount or expressed uncertainty about how much meat they ate on average, using words or phrases like "this is difficult", "its not something I monitor", "how do you calculate that?" "maybe".

> "Interviewer: How much meat would you say you take in a week?
>
> Respondent 2: Hmm...this is difficult but maybe I'll say half, half a kilo of chicken or probably...I don't really take a lot 'cause its expensive around here. (R2, FGD 2. Female).
>
> Respondent 2: And one important thing…Maybe if I have a health condition and the doctor should advise that, then I have no option than to reduce the intake. But I feel I'm not taking much anyway. So there's no way doctor will say don't take.

> Respondent 2: If they should say I shouldn't take. Oh, he has killed me.
>
> Respondent 3: I know right.
>
> Respondent 2: I don't even imagine myself being a vegetarian. Like, no! No, no.
>
> Respondent 3: It will be very harsh.
>
> Respondent 2: Even with the Eid, people will be chewing meat even though they're vegetarian.
>
> Respondent 3: Especially when you go for weddings or some social events. When you cannot eat the meat. You can't resist...” (FGD 2).

In this excerpt, some “meat lovers” however observed that medical advice due to the onset of a medical condition associated with high meat consumption would be the only motivation to make downward adjustments to their intake. Young people who shared this view felt that they would ‘struggle’ but for their “own good” they would “have no option” although it would not be done “whole-heartedly”. For some passionate meat lovers, any such medical advice must be accompanied by clear and explicit evidence to elicit their compliance.

> “And even if the doctor tells me to stop, I'll want to know the main reason why he's saying that. If its health wise or for my own benefit, and there's nothing I can do about it, yes, then I'll follow. But then if he just gives me an excuse that it could help you, I take the 'could' away but then I'll still take the meat. I don't see it to be something I can do without.” (R3, FGD 2. Female).”

Most of the few participants who had already reduced their meat intake and identified as medium meat eaters had only done so on personal health grounds. They viewed it as an act for their ‘own good’—a responsibility owed to themselves which none other would bear but themselves—and a personal contribution to promoting the longevity of their own lives. Explanations for their decision were based on medical advice from health or nutrition professionals and on personal knowledge of the adverse health effects of consuming excess fat from meat. In relation to this, knowledge of the digestion duration for meat was also cited as a key reason underpinning the motivation to eat less meat.

> “…I heard meat takes some days to digest in the body. So intake of too much meat is unhealthy…so I think we should concentrate on eating more vegetable instead of meat which also has fats. Or other protein like beans, other plant protein” (R2, BFPI 3. Male).

Meat-related epidemic outbreaks like the Bird Flu and Ebola were also cited as examples of the only circumstances that would lead to the curtailment of meat consumption. This is a position expressed by some HMEs who "did not see anything that would make them not eat meat." Even in such circumstances, participants who shared this view observed that they would abstain from only the affected meat types, reinforcing their unwillingness to adjust their meat consumption behaviours.

> "Like something serious like Ebola that has infected the animals that's not making it possible to eat meat, then we know that meat type is a no-go area..." (R1, BFPI 3. Female).

In the above excerpts, infectious diseases are constructed as more salient health conditions compared to NCDs. It appeared the salience of infectious diseases appeared to contribute to influencing behaviour change towards meat consumption.

8.3.2.2 'Our body is meat and needs meat': Meat as a tool for growth and weight control.

Emerging adults' body image goals was also recounted as a motivation for high meat consumption. Body image goals as motivation to consume meat was closely tied to health and/or nutrition. Emerging adults observed that their bodies were still developing as young people and therefore required more meat protein to facilitate this growth. In some cases, this was premised on the perception that "our body is like meat" and therefore "needed to eat more meat to be what we are." Meat consumption was very often presented as a 'tool' for weight gain. Emerging adults who wanted to put on weight therefore 'set out to intentionally' consume more meat and other animal protein to actualise their desired body image. Participants (except for a few) appeared to prioritise their individual body image ideals 'above all else'—including their personal health, animal welfare and the environmental sustainability (discussed below).

> "And now that I'm growing, I'm not done. My body, my cells haven't expanded fully so I'll eat." (R2, FGD 3. Female).
>
> "Respondent 4: Yeah, I want to gain so I try taking a lot of meat protein. Yes
>
> Interviewer: Ok. How about you, Respondent 3?
>
> Respondent 3: I think really I'll love to gain weight too." (R3 & R4, FGD 5).

A consensus among emerging adults on meat as a tool for weight gain is reinforced when body image ideals was again presented as motivation to curtail meat consumption. While the aim here was to lose weight, the underlying motivation was the same as those expressed by participants who ate meat to gain weight. That is, to "look nice." For a few meat lovers, their body image goals were the only reasons they would consider reducing or ending their intake of meat. Although one female participant who shared this opinion did not view/consider same as a strong motivation, it emphasised the importance female participants placed on body size ideals.

> "…the only thing that will motivate me is summer body. That's the only thing that'll motivate me to stop eating meat." (R1, BFPI 2).
>
> "Maybe too, if I want a flat tummy that's all part. Even that one, its not a strong point" (R2, BFPI 2).

8.3.2.3 Willingness to stop or reduce meat consumption because of animal welfare.

There was widespread disregard for the welfare of animals in decisions related to the consumption of meat. Animals were constructed/viewed as 'food' and a nutrient source for humans. The language used by participants expressed utter absence of sympathy or empathy for animals. Participants employed words and phrases like "I don't care", "I don't give a hoot", and they are "delicious". Compromising the nutrients and sensory pleasure derived from meat for the welfare of the animal was thus something that "doesn't cross their mind."

> And then animal welfare. Again, not that I don't care about animals, but I like meat. Ha! Ha! Ha! I don't really ask about how the animal was killed. I'm not very happy when they are killed in a very cruel way. So, I wouldn't want to ask. (R1, FGD 2).
>
> "Hm! It doesn't cross my mind...it really doesn't, honestly. I tried being a vegetarian like for two months, but I was like 13, I think, yes. It didn't go on so well." (R2, BFPI 2).

In isolated cases some emerging adults demonstrated some level of concern about the welfare of animals including handling practices and slaughter conditions. These animal welfare concerns were positioned in the context of sustainable development, religious beliefs and emotions related to domesticated animals-human attachment. Observations in relation to both sustainable development and religious beliefs did not condemn the "killing" or eating of animals per se, but the scale and manner in which it was done. The 'SDG persons' advocated minimal killings or replacements for every slaughter and replenishing food used as feed and fodder. In the religion argument, the Islamic tenet admonishing the humane slaughtering of animals was evoked to highlight the concept of Khalifah, which highlights man's duty to look after Allah's creation. Respondent 2's (FGD 2) contribution, for example, stresses that enshrined in the principle of Khalifah is a ritual slaughtering procedure (called 'Zabihah') prescribed by the Qur'an and Hadeeth to ensure the minimisation of distress for the animal. To bring the argument home, R2 climaxed her point with an illustration stressing that like humans, animals equally feel physical discomfort.

> "…I've not really thought about animal welfare in that sense, because the cow is also an animal eat. The hen, I eat it. But I'm looking at it in terms of Islam. You don't just kill animals anyhow and you consume them. You have to ensure their welfare…when you're about to kill the fowl you make it drink water…And you kill it in the name of Allah…'sɛ woreku no a' [when slaughtering it], you cut it at once…like see how sometimes when you cut things and you'll be cutting it like [using a carpenter's saw]…You, you're human, imagine if you're about to be killed and you're being killed like this. You just cut it once and for all to ease the pain." (R2, FGD2).

> "Yes. I don't care about the animal. Ha! Ha! So far as its delicious I'm taking it. But then…I don't go for certain animals that I know that they are too close to human beings like dog, cat, rabbit…its some way to me..." (R3, FGD 2).

In the excerpt from R3 (in FGD 2) above, attachment to domesticated animals was another dimension of empathy for animals expressed. For such animals, participants recounted the experience of horrific and strange feelings even at the thought of other people eating them. However, based on the foregoing three-part list of concerns (sustainable development, animal welfare, religious faith), only two participants occasionally stayed away from eating meat. The language used by the remaining participants who identified with these views displayed an absence of a commitment to the animal welfare campaign strong enough to lead to adjustments or curtailment of their consumption of meat.

> "…I take that [animal welfare] into consideration... sometimes I take like some small [meat] for example, like maybe I'll even eat without meat and take soya beans. Its not every time 'cause I like meat. I like milk, I like cheese. So occasionally." (R4, FGD5).

Two female friends in a best friend pair interview openly expressed dislike for animals. For such young people, curtailing meat consumption on the grounds of animal welfare was out of the question. In their view, there is a growing animal population that should be controlled by consuming more meat.

> "Animal welfare: I don't really give a hoot about them because I'll eat it. There are too many of them and me I don't like animals, so I wish they'll just find a place and go." (R1, BFPI 4).

> "And if people don't take the meat, there'll be too many animals running around. I don't like that. They should be eating the meat so the animals will reduce. There are too many animals." (R2, BFPI 4).

8.3.2.4 'I'm young and a meat person': Meat as a seal of youthful identity, a source of pleasure and joy.

For HMEs, motivations to consume more meat were explained in the context of being "meat lovers" and the widespread belief of being too young to be meat-reducers or meat-excluders. Students construed emerging adulthood as the 'best period' to consume or enjoy meat and portrayed it as a 'window of opportunity' not to be missed. High meat consumption was constructed as key part of a 'seal of identity' for being young. The emphasis was placed on the 'pleasure' and not denying oneself of the gratification derived from eating meat while they can— 'enjoying the moment' sort of—even if it meant a shorter life span. More female than male participants identified with this notion as well as identifying as "meat lovers". For most emerging adults who identified as "meat lovers" further exploration uncovered a range of sensory properties—including taste, aroma (usually referred to as 'scent' by participants), and texture—of various meat options as underlying/primary drivers for decisions to consume more meat. Many students recounted how these sensory properties contributed to 'high meat-eating' habit formation that they "don't see anything that will make them stop eating meat". The sensory properties of meat were also recounted as key to defining/determining which meat type emerging adults preferred over another. Most participants identified as chicken lovers, followed by beef and then pork lovers. In addition to these meat types, other animal protein and meat products like eggs and sausages were frequently mentioned favourites because they were thought to be/viewed as relatively affordable and the "always available" options apart from their sensory properties.

> "…Well I've seen so much stuff about that. I don't really care. I'm a meat person…" (R3, FGD3, Female).

> "And then animal welfare. Again, not that I don't care about animals, but I like meat. Ha! Ha! Ha!" (R1, FGD2, Female).

> "…So I think the scent is something is inside that makes me want goat so very much. If I smell the aroma somewhere, I'll follow it till I get to the source." (R3, FGD 2, Female).

For other students who identified as meat reducers, sensory properties of meat were a 'put-off' for them. Visual appearance properties of meat such as marbling, and the in-mouth texture were constructed as essential parameters for consumer perception of the tenderness of meat.

> "Ok, so my first point is I'll look at the digestion. That's, is the meat able to digest early or not? Like 'wele', I don't like it. Because I feel like it doesn't digest early.

> But if you come to KFC, their meat is somehow soft so, I consider those kinds of meats." (R1, FGD 1).
>
> "You see, I don't know, if you realise, if you take meat, you can put it in a longitudinal way. Chicken too goes longitudinal. So is goat meat. Those lines lines things, I don't like it. You're gonna chew, chew, chew. They're never gonna mix or digest. But fish is ah! Its soft, easy to swallow." (R1, BFPI 4).

The marbling of meat for example was associated with 'hardness' and subsequently with dyspepsia or digestion difficulty. Some emerging adults contrasted the hardness of red meat and cowhide (referred to as "wele") with the tenderness of fish and KFC chicken nuggets and expressed preference for fish and "KFC meat" due to their perceived softness. For such respondents they subscribed to the consumption of less red meat due to the discomfort associated with masticating/chewing and digesting red meat.

8.3.2.5 Knowledge and awareness of the environmental impacts of meat production and consumption.

One of the recurring themes was the lack of understanding of the concepts of environmental sustainability. The majority of emerging adults did not understand the concept of environmental sustainability and most of them were hearing it for the first time during the interview or FGD session. Prior to the interviewer's (and sometimes some participants') explanation, environmental sustainability was usually misinterpreted/ misconstrued to mean environmental sanitation or sanitary conditions in the area surrounding a food outlet. In an isolated case, it was misinterpreted to mean an epidemic outbreak.

> "…'cause I don't even understand what animal welfare is…or environmental sustainability..." (R1, BFPI 8).
>
> **"**Ok so environmental sustainability, mostly I try to look at the conditions under which the food has been prepared. Then maybe when we're going to buy the food you look at the surrounding as well…" (R1, BFPI 6).
>
> "Environmental sustainability, I was thinking of where the place is situated. That's what I was thinking...first when I saw it then I was a bit confused because I didn't know what to think…" (R1, FGD 7).
>
> "… As in like environment. Can it be like if there's an epidemic?" (R2, BFPI 2).

The link between meat consumption (and diets in general) and climate change or environmental sustainability was thus a difficult concept for many participants to grasp. There was mixed response when this was explained by the interviewer and in some cases, by some participants who had knowledge about it. Although some emerging adults agreed to the possibility of their meat intake adversely affecting the environment, in most cases it was a controversial topic that sparked discussions. Young people who agreed were inclined to associate meat consumption with methane emissions into the atmosphere and fodder-related deforestation. Other participants who agreed cited the inextricable interrelationship between human activities and/or lifestyle and the environment. Those who disagreed expressed doubts about how their meat "eating would affect the environment."

> "Yes, to me yes. Meat produces a lot of methane. Yes, so sometimes I tend to cut down meat because of methane being one of the major sources of greenhouse gases in the atmosphere..." (R5, FGD 1).

> "…And then the environmental sustainability, I don't know how my eating would affect, honestly speaking, the environment at large…" (R1, BFPI 8).

Although participants underestimated the possibility of their meat intake affecting the environment, they expressed genuine interest in understanding the connection between the environment and meat production and consumption.

> "Please I want to understand that is it that when we eat meat, we give off methane or is the meat that's giving off methane if we kill it" (R1, FGD 1).

8.3.2.6 Willingness to stop or reduce meat consumption because of environmental reasons.

When asked if participants would reduce their meat consumption for the sake of environmental sustainability, the majority of emerging adults expressed unwillingness to reduce or curtail the consumption of meat for ecological reasons. Participants who advanced this narrative evoked several arguments as justification, including, the notion that their individual meat intake alone cannot destroy the environment or "make any difference". Other "meat lovers" presented personal goals such as gaining weight by eating more meat as more paramount compared to cutting meat consumption for environmental reasons. In other arguments, meat consumption was presented as just one small part of a myriad of actions—including tree-felling and illegal mining—affecting climate change and thus required a lot of people to subscribe to eating less or no meat, to make any significant contribution to the cause of sustainable develop. Emerging adults cast doubts on the acceptability of meat reduction or exclusion to the general population just as they were unwilling to.

> “Respondent 2: And I have to agree with Ama that Kofi’s meat intake alone wouldn’t make a difference. I mean you do need a lot of people to make a difference. One person can’t…
>
> Respondent 1: It starts from one person.
>
> Respondent 2: Well, it starts, but how many people are interested… and I mean is not only the meat. It has to be more things, talk about the trees. And once we all shift our attention to fish, fish too is going to reduce”. (BFPI 4).
>
> “And in relation to the environment, me I believe that everybody has a part they play. If we all say we will not do it because it is not significant to the environment, then who will change. So if he’s doing it because the environment, he should go ahead ‘cause the sun…the place is becoming too hot.” (R1, BFPI 1).
>
> “We form part of the environment so any effect you pose on the environment indirectly it comes back to us.” (R1, BFPI 6).

However, a minority of participants, during FGDs and in a BPFI on one occasion, expressed disagreement and recounted that ‘every little’ reduction in meat consumption is essential towards climate change mitigation. Young people who advanced this view expressed willingness to reduce their meat consumption for ecological reasons or were already doing so, at least, occasionally. This included students who identified as “SDG person” or student of Sustainable Development. Explanations for the willingness to reduce meat consumption was premised on the fact that humans are an integral part of the ecosystem and that damaging it equates ‘a self-infliction of pain’. Further exploration uncovered the risks associated with climate change, including extreme hot weather conditions, as a primary driver. Emerging adults felt that their continuous consumption of certain meat types would equate an endorsement of environmentally hostile activities in the meat supply chain, including the burning of car tyres as fuel for roasting animal carcasses.

> “And then seventh [point] is environmental sustainability. Sometimes I don’t want to take certain foods because I just consider that I will encourage them by buying their food, because this food for example…‘wele’. ‘Wele’, for instance, how they make it…They have to burn it with car tyres. And I’ve seen them doing it before and the amount of smoke that goes in the atmosphere. So sometimes I’m like no, I’m not going to take this food to encourage them to do it.” (R3, FGD 2).

Participants’ narratives, including ‘SDG persons’ and ‘meat persons’ demonstrated a universal admission of genuine difficulty with eliminating meat completely from their diets for the sake of the environment. There was a display of an internal conflict among ‘SDG persons’ as one part of them supported the concept of meat exclusion, yet they couldn't completely sacrifice the gratification derived from eating meat on the altar of environmental sustainability. Most meat lovers on the other hand, again, were defiant and did not see any reason to reduce their consumption, not to talk of eliminating meat consumption from their diets.

> "Respondent 4: I'll think about that [the environment] when I gain weight.
>
> Interviewer: When you gain weight?
>
> Respondent 4: Yeah, I want to gain so like I try taking a lot of meat protein. Yes." (R4, FGD 5).
>
> "…me I don't see anything that will make me stop eating meat or something like sake of environmental... No! For me so far as I have the means to take my meat, I don't care whether its 70 grams, 1000 grams, whatever, I'm eating it..." (R2, FGD 4).

Swapping meat portions with plant-protein portions appeared to be most appealing alternative to participants. This was presented as a plausible and easier adjustment they may manage to make to their diets in relation to meat. Emerging adults thought that this could be part of a gradual process towards achieving reduced meat consumption, including some "meat lovers" in isolated cases. Here again, meat socialisation from infancy is deployed to emphasise the need for a shift to a meat protein and plant protein balance in their diets to be a gradual process. Emerging adults used this to convey the implicit contradiction in how they are socialised from childhood to develop taste buds for meat but are later "told" it is only "good up to a point." The theme of contradiction is presented in the following excerpt from FGD 2.

> Respondent 3: I might consider maybe balancing them, plant protein, animal protein. But not totally not taking it. 'cause…I like meat more before I got to know about protein and the carbohydrates and the percentage [quantity]...which is good for my body. So please for me, it's God.
>
> Respondent 1: Ha! Ha! Ha!
>
> Interviewer: Ha! Ha! How about you, Respondent 1?
>
> Respondent 1: Same thing...I'll either find a way to balance them or not eat them at all. I'm talking about the plant protein because as she said, we started eating meat like when we were younger before we got into and they told us, ok, this is meat. It contains protein what, what, what. Then later I got to find out ok, this is good up to a point.
>
> Respondent 3: Even before our forefathers knew there's something called protein, they were taking it, the meat plus the plant protein. And they lived.
>
> Respondent 2: And we will live.

> Respondent 1: Ha! Ha! (FGD 2).

In a similar vein, Respondent 3 in FGD 3, another meat lover, expresses willingness to, at best, replace only cow milk (but not meat) with soya milk (plant protein), which demonstrates a subsequent admission of a need to make some dietary adjustments to favour the environment but only a ‘soft’ willingness to do same. Inherent within Respondent 3’s (of FGD 3) contribution is an expression of some ‘attachment’ to meat, a strategy deployed to justify her indifference towards overconsumption of meat, as they would not reduce their meat intake or swap portions with plant-protein even when paid to do so. In another isolated case, one SDG advocate expressed a personal difficulty or near impossibility in eliminating meat from her diet based on a previous experience of failing at an attempt at becoming vegetarian.

> “I can replace [cow] milk with soya [milk]... like the animals don't produce soya milk. That's the only thing I could but I can't [do that with meat] tsk tsk tsk. ‘Wotua me ka koraa mennyɛ’ [Even if you pay me, I won’t do it]….” (R3, FGD 3).
>
> “Ok, it will be very difficult to reduce. Ha! Ha! Yeah, like very very difficult but I think maybe with me, trying to reduce I will start gradually.
>
> Respondent 2: Mmm…an immediate effect ‘deɛ’ I don’t think it will work.
>
> Interviewer: How about doing it because of the environment or sustainable development?
>
> Respondent 2: Ok, yeah, that I think I will do wholeheartedly. Yes.
>
> Interviewer: You will do it for the environment?
>
> Respondent 2: Yes.
>
> Respondent 1: We form part of the environment so any effect you pose on the environment indirectly it comes back to us” (BFPI 1).

In the foregoing excerpt from FGD 2 for example, other meat lovers who expressed unwillingness to reduce their meat consumption or swap portions with plant-protein for ecological reasons suggested a meat-for-meat substitution instead. For some people, this was even dependent on whether any meat they were originally eating were contributing to climate change or were from animals in extinction or from animals being endangered.

8.3.2.7 ‘Forbidden fruits’: Meat and religion

Religious belief was a strong motivation for some emerging adults to reduce their overall meat intake or stay away from certain meat types. Participants expressed religious beliefs that prohibited/forbid them from eating various meat types. This was presented as an indirect means by which meat consumption is limited when a catalogue of meat types is considered and believed to be forbidden. Apart from one participant who identified as Christian, most participants who associated with this view were Muslims, with views based on the Islamic principles of “Halal” and “Haram” as prescribed by the Qur'an and Hadeeth. Participants cited meat from animals such as the pig and dogs among others as “forbidden” or “Haram” although some participants demonstrated uncertainty about the full list of animals considered “Haram”. This belief was reported to be grounded in the context that such meats are unclean based on historical antecedents in the Qur’an, at the commandment of the Prophet Muhammed (peace be upon him), being from animals not slaughtered in an Islamic manner (called 'Zabihah') or in the name of any other person or creation other than “in the name of Allah”. The only Christian participant whose religious faith motivated them to stay away from certain meat types identified with the latter. They were not to eat any meat slaughtered in the name of a deity. In this religious faith, consuming any such meats and any ‘Haram’ meat, in Islam, was construed as being sinful.

> “Yeah, so I’m a Muslim. Yeah. And I don’t eat pork. Or anything that is made from pork fat. Yeah, halal. So, most products, you will see them eh… with the halal certified. Which means is certified to eat as a Muslim.” (R2, BFPI 3).

> “Yes, the first is the religion and faith…there are certain things that are prohibited. In my religion we don’t eat some of them. So, in my religion we don’t eat pork, we don’t eat dog. Ok, dog is it ehm…? You could eat it. Like is not really forbidden. People eat it and so the main focus is like pork and or any substance made from pork...” (R1, BFPI 3).

Meat from animals outside of the ‘prohibition list’ and slaughtered in accordance with ‘Zabihah’ was considered “Halal” or lawful meat to eat. Indeed, other Muslim participants observed that these ‘Halal-Haram’ principles in the wisdom of Allah and the forebears of the Islamic faith “are for our own health benefit.” To support this, a mundane trope relating to pork being worm-infested was cited to highlight the healthiness of the “Haram” prescriptions. Tied to this trope was the perception or misconception that pigs contain toxic as “they do not sweat”.

> “…‘cause Islam says we shouldn’t eat pork. And it’s for our own health benefit. ‘cause it’s not good for us…Even with the pork when you squeeze the pork

> sometimes there are worms. They come out of the meat. And then they don't sweat too. Yes, based on my readings. So, its like all the sweat, the poisonous stuff, it's…'ɛhyɛ nam ne mu' [in the meat]..." (R4, FGD 3).

Nested in R2's FGD 2 submission in the above excerpt is the expression of a sense of displeasure at the sight of 'forbidden meat' and prejudice towards people with dissenting dispositions about the consumption of meat forbidden by Islam. There was a universal expression of scepticism among Muslim participants about the content of out-of-home prepared foods and the difficulty faced in verifying that food bought from campus eateries was not made with any "haram". While some participants had to ask food vendors and rely on information given them regarding the content of "haram," others reported buying from "trusted" vendors, especially those they knew shared their religious faith.

In a similar vein, other young people expressed certain religious identities that did not bar them from the consumption of certain meat types as some religious faiths did. Participant narratives indicated that these religious identities—Protestant, Charismatic, and Pentecostal Christians—influenced the type and amount of meat they ate.

> "And moreover, my religion doesn't restrict me from eating certain things" (R1, BFPI 7).

> "Religion or faith: well fortunately for me I don't belong to a religious body where, for example, we say eating of pigs isn't healthy. So it's the last [thing I would consider] 'cause we don't have any limitation on it. You can eat a crocodile if you want to." (R2, BFPI 4).

8.3.2.8 The 'Meat socialisation'

Social aspects of meat consumption were also recounted as motivations for high meat consumption. Emerging adults recounted that they were socialised into a culture of meat-eating where meat is central to many dishes/delicacies. Meat was presented as the most preferred and enjoyable part of the diet, a perspective which participants reported they learned from the home and at social gatherings. In the home, the biggest portion of meat was therefore allocated to the breadwinner. Here again, the association of meat consumption with age is presented as another normative belief integral to meat socialisation. This theme is expressed in the following contribution from R2 FGD3. R2 (FGD3) recounts how "our grandmothers have in due time" voluntarily cut their meat consumption as the exigencies of age such as tooth loss dawned on them. She continues to cite other mundane and popular practices in the home like the father giving her his red meat from his lot at dinner, a strategy by which he cuts down his consumption of red meat due to age. Other narratives (for example from R3 in FGD 2) highlight the cultural specificity of meat socialisation. Nested in R3's (FGD2) narrative below is the cultural differences in meat socialisation, emphasising that different cultures and/or families are socialised into liking or disliking certain meat types.

> "Respondent 1: There are many alternatives.
>
> Respondent 3: Yeah
>
> Respondent 1: So just find a different meat that is not causing harm to the environment.
>
> Respondent 3: Snake, they're increasing and entering people's rooms...
>
> Respondent 1: Oh!
>
> Respondent 3: Yes! Snakes, ants are not animals that we really crave to eat because that's not what we're socialised into. But in other societies, even here in Ghana, people take snake meat, which is so nice to them.
>
> Respondent 1: I can never take snake.
>
> Respondent 3: So, their place if a snake is killed…Like a snake has entered somebody's house, all the guys in the village go over there to take the snake and then they roast it. They grill it.
>
> Respondent 2: Yoo [I see].
>
> Respondent 3: Yes
>
> Respondent 1: I can never take it." (FGD 2).
>
> "And me I feel at a point in time I may reduce my intake of meat. Because as at that time you don't need the protein. Our grandmothers have been in due time. Even it will get to the time you'll not even feel like eating meat again. Sometimes my daddy [asks me], if you want meat, come and take the meat from my food [plate]. He'll take fish…so now I know it will get to a point in time I will be told to stop eating meat..." (R2, FGD 3).
>
> "I don't like goat. Ok, I like it but occasionally. I take the 'aponkye nkrakra' [goat light soup] and 'fufu'. But not something I want all the time. 'cause we don't even do red meat at home so cow meat, pork, goat, whatever. But they're things you could eat once in a while…somewhere occasionally. I mean like once a year or twice a year, I can't remember...but egg and sausage comes in. Chicken, I think I'm giving up on it slowly. Fish, I love it, but I'm scared to try it outside. But at home its all fish." (R1, BFPI 4).

Meat consumption practices at home were also cited as motivations for eating less meat. Two participants [(R2, BFPI 2), (R1, BFPI 4)] reported family dietary restrictions at the home which created a support environment for dietary compliance relating to the exclusion of red meat and pork from diets prepared from home. The only instances when emerging adults from such homes ate any red meats or pork happened at venues outside of the home, particularly at social gatherings.

Social gatherings were constructed as ‘havens’ for freely available meat which usually was presented as the central ingredient to popular dishes served at social gatherings. At such gatherings, young people recounted that they are ‘irresistibly invited’ to “eat a lot of meat.” In some cases, social gatherings were not only determinants of how much meat young people ate at social occasions, but which meat types were eaten—including meat options they were not used to.

> “…So, yeah. And then maybe we're at an occasion, like a party, there's a lot of khebab so I'll eat a lot of meat.” (R1, BFPI 2).
>
> “And the religion and the faith, my best friend is a Muslim and last time we were going to buy food… I like pork. [But my friend was reminding me] ‘Respondent 2, I don't eat pork. I don't like sausage.’ Because she has this perception that most of the sausages are pork sausage, and she wouldn't eat it at all. So when I'm going to buy food for both of us to eat, I wouldn't buy sausage, I wouldn't buy pork...” (R2, FGD 3).
>
> “In my house, like my mother doesn't eat pork so growing up there wasn't pork in the house. I started eating pork when I came to university. My friends used to say pork is so nice. ‘Why haven't you?’ so I tried it and I realised that I like it. So, I went for this party with my mother, and they were serving pork and I went for it. She's like when did I start eating pork?...And she was so surprised because she didn't train us...like cook pork for us so she was really surprised.” (R2, BFPI 2).

Participant narratives also suggested that the values, beliefs and preferences of their eating companions and friends influenced their meat-eating and procurement attitudes. They were presented as motivations for both increased and less meat consumption. In her contribution above, Respondent 2 in FGD 3 for example excluded some meat types from her diet during food procurement or eating occasions with her friend whose religious faith barred her from eating certain meat types. Indeed, the above excerpts suggest that meat socialisation from the home appeared to ‘give in’ to peer pressure to adopt contrary meat attitudes out-of-home. Some students recounted how they were influenced by friends to ‘learn’ to eat meat types they were never ‘allowed’ to eat at home, reinforcing the enormity of friends’ views in shaping meat-eating attitudes among university students.

8.4 Discussion

8.4.1 Summary of findings

This study set out to provide insights into emerging adults' mindset and motivation to eating more or less meat to support the initiation of strategies to promote low meat diets. The results highlight a number of varying motivations among emerging adults to increase or reduce meat consumption some of which they considered more relevant than others. Health concerns; animal welfare; and environmental sustainability were not important to this age group, and they did not consider changing their behaviour on the basis of these drivers. Body weight and shape; meat as identity, pleasure, and joy; meat eating as part of socialisation; religion and cultural practices were more frequent drivers of behaviour. Generally, bodyweight and shape concerns drove increased preference for meat consumption as did meat as identity, pleasure and joy, and meat eating as part of socialisation, whereas religious and cultural practices were generally cited as a reason to limit meat intake. These findings contribute to the literature in many ways and are discussed in more detail below with recommendations for future research and activities to promote a shift/adjustment towards a low meat diet.

The study demonstrates body image and weight concerns/dissatisfaction as both a driver of increased preference for more meat (more dominant) and conversely, a motive for intentions to reduce meat consumption. This finding was linked to young age and growth or muscle building. Previous research findings provide convincing evidence linking meat consumption with weight gain (Dabbagh-Moghadam et al., 2017; Kim et al., 2017) and lean muscle mass growth and muscle strength in young men (Moore et al., 2009; Witard et al., 2014) and older adults (Sahni et al., 2015; Yang et al., 2012). Similarly, cross-sectional studies have found that body image perceptions influence nutrient intake (Waswa, 2011) and inspire dieting (Jaworowska & Bazylak, 2009) among female university students in Kenya and Poland, respectively. In the Polish study, a significant proportion of students had misconceived their body weight classification, despite being the basis of their dieting decisions. Over 66% of underweight (by objective measurements) females perceived themselves as normal weight, while 25% of normal weight perceived themselves as overweight or obese (p=0.0001). About 54% and 18% of overweight (by objective measurement) males, respectively, perceived themselves as normal weight and underweight (Jaworowska & Bazylak, 2009). Similar weight misconceptions have been observed in over 50% of urban Nigerian adults (Akindele et al., 2017). Like in several other studies (Grossbard et al., 2011; Kelly et al., 2015; Veldhuis et al., 2017) including systematic reviews (Rounsefell et al., 2020), young females have reported preference for thinner body shapes while males have expressed preference for heavier bodies or larger BMIs. In this study, preference for heavier bodies in males was reported as a motivation to eat more meat while female participants were divided between the motivation to consume more meat for heavier-looking bodies and to consume less for thinner bodies. These perceptions have been attributed to widespread gendered stereotyping of body weight and shape especially in 'Western' cultures (Thomas & Kleyman, 2020; Veldhuis et al., 2017). The ideal male body shape is portrayed as muscular and firm with broad shoulders, and slender figures for the female. Young males in this study may therefore be pursuing weight gain in the form of muscle. The division over preference for heavier and slender body shapes in this study's female sample (as meat consumption drivers) is likely a materialised reflection of the coming together of the 'Western' female body image ideals (Jaworowska & Bazylak, 2009) and the longstanding Ghanaian cultural preference for 'larger' female bodies or buxomness (Toselli et al., 2016). Considering that young people may be consuming more or less meat based on misconceived weight status resulting perhaps from 'conflicting' societal pressures to look 'good', urgent action, including further research aimed at effective nutrition education and weight management interventions for young people are important first steps.

The scepticism and defiance demonstrated by young people towards known health risks related to excess meat consumption is consistent with findings from Sweden (Bohm, 2016) and defiance towards health promotion for other lifestyle issues like smoking (Bethea et al., 2015; Choi & Banwell, 2017; Gough et al., 2009; Hardcastle et al., 2016; Triandafilidis et al., 2017). Participants' questioning of meat-related advice was based on lay understandings informed by personal observation and the desire to consume meat but not on expert advice or personal experience of any adverse health impact related to excess meat consumption. To young people in this university campus, meat consumption behaviour change was warranted only within the context of a diagnosed condition in later life. Vizcaino et al. (2021) found similar attitudes among students in a US university who were seventeen times more likely (than non-adherents) to adhere to a plant-based diet "to manage or treat a medical condition". However, 94% of the students were less likely to follow less-meat diets "to maintain and/or improve my health" (Vizcaino et al., 2021). However, life-course studies have consistently shown that early life behavioural factors (including eating/food behaviour) are important risk factors for the onset and gradual development of NCDs (Mink et al., 2020; Pudrovska & Anikputa, 2011), obesity (McMullen, 2014; Newton et al., 2017) and general wellbeing (Clark & Lee, 2021) in later life, which most participants in our sample were unaware of. A Canadian study has suggested that university students intend to eat healthily but lack knowledge of dietary guidelines and self-efficacy to do so (Matthews et al., 2016). Actions towards interventions for this study population should consider health promotion that emphasises the importance of pre-adulthood dietary behaviour towards morbidity and mortality in middle-age. This ties in with the need for education on the recommended levels of meat consumption, of which this study population expressed extremely limited knowledge. Similar findings of limited nutrition knowledge has been reported in Australian military personnel (Kullen et al., 2016), Head Start Teachers in Texas (Sharma et al., 2013), Swiss adults in a longitudinal study (Hagmann et al., 2019), and a systematic review covering both high- and LICs (Barbosa et al., 2016). Specific to students, university students with knowledge of dietary guidelines or improved nutrition knowledge followed healthier diets than students lacking nutrition knowledge (Jerome et al., 2018; Kolodinsky et al., 2007), although Perlstein et al. (2017) reported contrary findings in Australian medical students. Considering that students' scepticism (in the present study) was borne out of limited information, increased awareness of links between dietary behaviours in early life and health status in later life, together with encouragement may lead to meat consumption behaviour changes in this student sample.

The study also revealed widespread lack of awareness of the concept of environmental sustainability or climate change and more so, of its association with meat consumption among university students. When the concepts were explained, majority of participants were sceptical (about the association between their meat consumption and climate change) and not convinced to modify their meat-eating habits for ecological reasons. Previous studies including systematic reviews (Hartmann & Siegrist, 2017; Sanchez-Sabate & Sabaté, 2019) have reported similar findings of limited awareness and scepticism towards the connection between meat consumption and environmental sustainability in Scottish adults (Macdiarmid et al., 2016), Norway (Austgulen et al., 2018), Netherlands (de Boer et al., 2013), and the Chatham House multi-country survey[32] (Bailey et al., 2014). For example, in a recent systematic review, only 18 to 38% of participants from HICs linked meat consumption with adverse environmental factors (Hartmann & Siegrist, 2017). A postal survey in UK also reported that only 18.4% of adults believed that reducing their meat consumption would be beneficial to climate change mitigation (Clonan et al., 2015). Among students, 29% of undergraduates in a US university

[32] Involved an online survey conducted in Brazil, China, France, Germany, India, Italy, Japan, Poland, Russia, South Africa, the UK and the US, with a minimum of 1,000 participants in each country.

agreed that reducing their meat intake will yield environmental benefits (Campbell-Arvai, 2015). In other surveys among US college and Belgian university students, only <10% and <5% of them, respectively, linked meat with climate change (Truelove & Parks, 2012) or had "very much" knowledge about it (De Groeve & Bleys, 2017).

In the Chatham House multi-country study, consumers with limited awareness of meat's contribution to GHG emissions were less likely to express willingness to modify meat-eating behaviour for environmental reasons. Participants from emerging economies indicated higher consideration of climate change in their meat and dairy choice decisions and also demonstrated greater willingness to change consumption behaviour (Bailey et al., 2014). For participants in this study, climate change was not an important driver of behaviour, likely due to the observed low consumer knowledge. However, upon explanation, environmental sustainability seemed to have potential as an issue that interested these emerging adults and could motivate them to reduce meat consumption. This is promising, given that emerging economies like Ghana are projected to be the major demand drivers for future meat and ASFs (OECD/FAO, 2020) as they urbanise and incomes rise above poverty levels according to the Bennett's law. The Ghanaian policy community should take advantage of lessons from historical trends of meat consumption in advanced countries to inform policy actions to ensure that consumption trends does not follow the same/similar curve as have occurred in HICs with increasing incomes. Insights from sociodemographic trends also suggest that meat-eaters who are younger, more educated, and open-minded are more likely to reduce their meat intake in Swiss, Dutch and Germans (Dhont & Hodson, 2014; Pfeiler & Egloff, 2018a, 2018b; Wozniak et al., 2020). Although bridging the awareness gap could increase willingness to act, that alone may not be effective at changing meat-eating behaviours. However, it appears to be an essential prerequisite for behaviour change. In this study, the few emerging adults who knew about the meat-climate change nexus prior to attending this study occasionally did not eat meat for climate objectives, but still faced the dilemma of doing or not doing so consistently. Previous research illustrates a meat paradox—the widespread public acknowledgement of responsibility for and concern (especially in HICs) about animal welfare, climate change and personal health but demonstrating no intention to modify meat-eating behaviours (Graça et al., 2015; Oleschuk et al., 2019). This has been attributed to a psycho-protective mechanism known as 'directed or intentional forgetting' employed to downplay any upsetting memories consciously or unconsciously (Font-i-Furnols & Guerrero, 2014; MacLeod, 2013), during decision making to eat/buy or not to eat/ buy.

In this emerging adult sample, animal welfare was also a new concept. Even when explained, unlike the concept of environmental sustainability, this student population was not persuaded to modify their meat consumption based on animal welfare concerns and experienced no guilt about their meat consumption decisions. Animals were generally/largely viewed as a nice/tasty food source and necessary for nutrients. Similar findings have been reported in environmentally informed students from the Department of Environmental studies in two large Czech Republic universities (Šedová et al., 2016). Killing animals for food was not considered an ethical issue among meat-eating students of environmental studies (Šedová et al., 2016). These findings are consistent with recent theorisations of the reasons for rationalising meat consumption—the 3Ns (Joy, 2010) and the 4Ns of justification (Piazza et al., 2015). That is, the belief that meat consumption is natural, normal, necessary, and nice. These captured 83 to 91% of justifications used by Australian university students to rationalise meat consumption (Piazza et al., 2015).

Although the issue of 'ethically incorrect' animal products was largely not an important driver of meat-eating behaviour in this study, the strongest animal welfare concerns regarding meat consumption were expressed within the religious belief context. Muslim participants in our sample (although a small minority), abstained from meat and meat products derived from 'unclean' animals like pigs and from animals not slaughtered according to Islamic principle (called 'Zabihah'). 'Zabihah', among other things, admonishes that animals feel pain just like humans and must be slaughtered in a manner that minimises pain, including offering them drinking water before slaughter. Filippini & Srinivasan (2019) found that Hindu households in India belonging to a religious group were more likely to be vegetarian compared to members of non-religious groups. Interestingly, Hindu households that used the print or electronic media were more likely than those that did not to eat meat. Religion has been reported as the least prevalent motivation for not consuming meat frequently in both native Dutch and Chinese-Dutch samples (de Boer et al., 2017). However, previous evidence suggests that meat-related behaviours based on ethical convictions (as in Islamic religion) may be enduring (Hoffman et al., 2013). A few other (non-muslim) students in our sample also found the consumption of domesticated animals like dogs and cats to be upsetting/off-putting. Similarly, Piazza and colleagues found that consumers who endorsed the 4Ns as justification for their meat consumption included fewer animals in their circle of moral concern (Piazza et al., 2015).

The observed general unwillingness to modify meat consumption in this sample is not surprising considering how meat is viewed and the role assigned to meat in the diet in many cultures. In the study country, there is a longstanding perception of meat and dairy consumption as a marker of social class/wealth and 'living well' (Agyei-Mensah & Aikins, 2010). Eating meat regularly is seen to confer a superior social status. There is also a dimension of 'masculinity' which manifests in how meat is shared in the home/household. The lion's share is served to 'the man of the house' who is usually the breadwinner. However, female students in this study demonstrated relatively higher dedication to meat consumption and a stronger resistance to reducing meat consumption than males. Also, meat and dairy are sometimes used as rewards for children in the Ghanaian home. In the Ghanaian, like many other African cultures, meat and dairy are thus deep-seated desirable status symbols (Bundala et al., 2020) imbibed through infancy into adulthood. In this study, emerging adults were socialised into developing taste buds for meat from childhood and into liking/disliking some meat types over others, with the home, friends and social gatherings being key socialisation agents. Just as some students in this study identified as "pork lovers" some tribes in Ghana for example consider dogs, cats, and snakes as delicacies while many others dislike them. Consistent with findings from many advanced countries, meat-eating has been the predominant lifestyle compared to vegetarianism (Corrin & Papadopoulos, 2017; Macdiarmid et al., 2016). For example, more than 80% of the UK population are meat-eaters compared to nearly 3% vegans (Johnson, 2021). Although veganism in the UK has recently reached an all-time high, analysis of vegan-related discourses in UK national newspapers in 2007 revealed that about 74% of them portrayed veganism negatively and variously stereotyped it (Cole & Morgan, 2011). In the early 21st century Australian non-meat eaters and vegetarian diets were negatively stereotyped and viewed as 'strange' (Lea & Worsley, 2003). More recently they have been ridiculed in Slovenia (Crnic, 2013) and discriminated against in Turkey (Bagci & Olgun, 2019). Given that meat consumption is a deep-rooted cultural norm in Ghana, behaviour change in this emerging adult group may therefore take time and may require multi-level interventions to gradually alter/shift cultural perceptions about meat and dairy consumption. Behaviour change around meat consumption in SSA may also be challenged with multiple nutrition dilemmas including the increasing dual-malnutrition burden. While meat consumption behaviour change in this group may offer large absolute environmental benefits, it has been suggested that dietary behaviour change in Africa should be carefully planned and implemented in a manner that reduces undernutrition and micronutrient deficiencies without worsening obesity and NCD prevalence (Mensah et al., 2020).

Students in this study viewed emerging adulthood as the best period to enjoy meat and thus were unwilling to sacrifice the pleasure derived from eating meat for ethical (environmental or animal welfare) or personal health objectives. However, substituting portions of their meat with plant protein appeared to appeal to this student sample. The flexitarian dietary regime which is a growing trend in the UK and Europe has been recommended as an easier way to make dietary modifications that offer dual health and environmental benefits without completely cutting out meat. The flexitarian diet may therefore appeal to this study's sample as it allows them to continue to 'enjoy' some meat and at the same time contribute to climate change action. A large population-based survey in Switzerland found that flexitarians were more likely to be low income earners (Wozniak et al., 2020) which maps to the economic status of participants in this study despite the cultural differences. The acceptability and feasibility of the flexitarian and other plant-based dietary regimes should be explored in these emerging adults who are educated, classified as low income, and expressed interest in contributing to environmental sustainability whilst 'enjoying their meat'.

This is the first study to employ qualitative methods to explore the factors that motivate young, educated urbanites to reduce and/or increase their meat consumption in a SSA university setting. Another strength of the study is the application of the University's collegiate system during recruitment to reduce selection bias which allowed the inclusion of participants with little/no involvement to high involvement with nutrition/health, environmental sustainability, and animal welfare issues. The study encouraged genuine discussions and responses/submissions during focus group discussions and best friend pair interviews, however, it may be possible that responses were affected by social desirability bias, especially in the focus group discussions, where some participants may have given face-saving and socially acceptable answers. In addition, due to the qualitative approach and the limited number of participants, the findings reported here should be interpreted with circumspection. They should not be interpreted to be representative of all university students or a wider population.

8.5 Conclusion

This study shows evidence that health concerns, animal welfare, and environmental sustainability does not frequently drive meat consumption behaviour, likely due partly to the observed lack of awareness about the association between meat consumption and environmental sustainability or animal welfare in young university students. Further, many participants viewed their consumption as low, although all participants lacked knowledge about recommended intakes and reference standards. The observed scepticism and downplaying of the adverse health implications of excessive meat consumption is also an important behaviour change barrier. Whiles education and awareness creation are likely an important pre-requisite, it would be ignorant to suggest that these can solely lead to meat-eating behaviour change in these emerging adults. As have been discussed, personal and socio-cultural values and beliefs—body image ideals; meat as identity, pleasure, and joy; meat eating as part of socialisation; religion and cultural practices—are more frequent drivers of meat-eating behaviour in this group. Individual level behaviour change may be impossible/unattainable if these personal, cultural, and religious values and beliefs are not addressed. It is suggested that alongside objective ecological and health goals, these values and beliefs must be incorporated into discussions and debates around meat consumption in order for culturally acceptable sustainable diets to emerge. Given the complexity of factors driving meat-eating behaviour in these emerging adults and the deep-seated role meat plays in the diets of the cultures represented in this study, a multi-level and multidisciplinary approach may be successful at changing dietary behaviour. However, this may take time.

CHAPTER NINE

DISCUSSION AND CONCLUSIONS

9.1 Introduction

In this final chapter, a summary of the key findings from each research component of this thesis are presented in relation to the research questions, and how these findings fill gaps identified in the literature. The chapter also highlights the strengths and limitations of the research as well as the implications of the findings for policy and further research. The chapter concludes with a list of the scientific outputs from the study to date and the events through which these outputs have been disseminated.

9.2 Key findings

The literature review in Chapter 1 outlined a set of research questions and highlighted some gaps in the existing literature. This mixed methods research has attempted to address the research questions and to fill these gaps, as detailed below and brought together in Figure 9.1.

9.2.1 Addressing research questions and gaps in the literature

9.2.1.1 The trend of meat, fruit, vegetable and UPFs consumption in SSA

To answer research questions 1 and 2, a systematic review and meta-regression analyses was conducted to identify the trend of meat, fruit, and vegetable (MFV) consumption in sub-Saharan Africa (SSA), and to ascertain variations in consumption between rural and urban populations and other population subgroups (i.e., adults, children, income classification, male, and female). The systematic review and meta-regression analyses, the first to focus on SSA, showed upward trends in MFV consumption in SSA populations over the 30- to 38-year period between 1977 and 2015, including Ghana. Although FV consumption had increased over the years (ß=4.43, p=0.00), daily per capita consumption in both food items were still significantly below WHO recommended intakes with daily per capita meat consumption growing above recommended levels. Vegetable consumption was higher in rural than urban residents (ß=-25.48, p=0.00). FV consumption appeared to decrease with age (ß=219.8, p=0.03; ß=80.32, p=0.08). Finally, no clear differences in consumption were observed between sexes.

A second systematic review was conducted to identify the trend of ultra-processed foods (UPFs) consumption in SSA and any differences in consumption between population subgroups. The systematic review found limited research focusing on the assessment of UPFs consumption, either in portion size or frequency of consumption in SSA populations based on data collected between 1989 and 2018. No conclusive trends were therefore identified. However, the studies that exist appear to show increasing UPFs consumption. Typical examples included findings from longitudinal studies from Seychelles (Cardoso et al., 2012) and South Africa examining data from the late 1990s to 2012. It also appears that urban populations and richer economies consume more UPFs. UPFs consumption appears to increase with age and females seem to be consuming slightly more than males, although some between-country variations in this gender gradient were observed.

9.2.1.2 The features of the current food retail environment in a case study urban university community

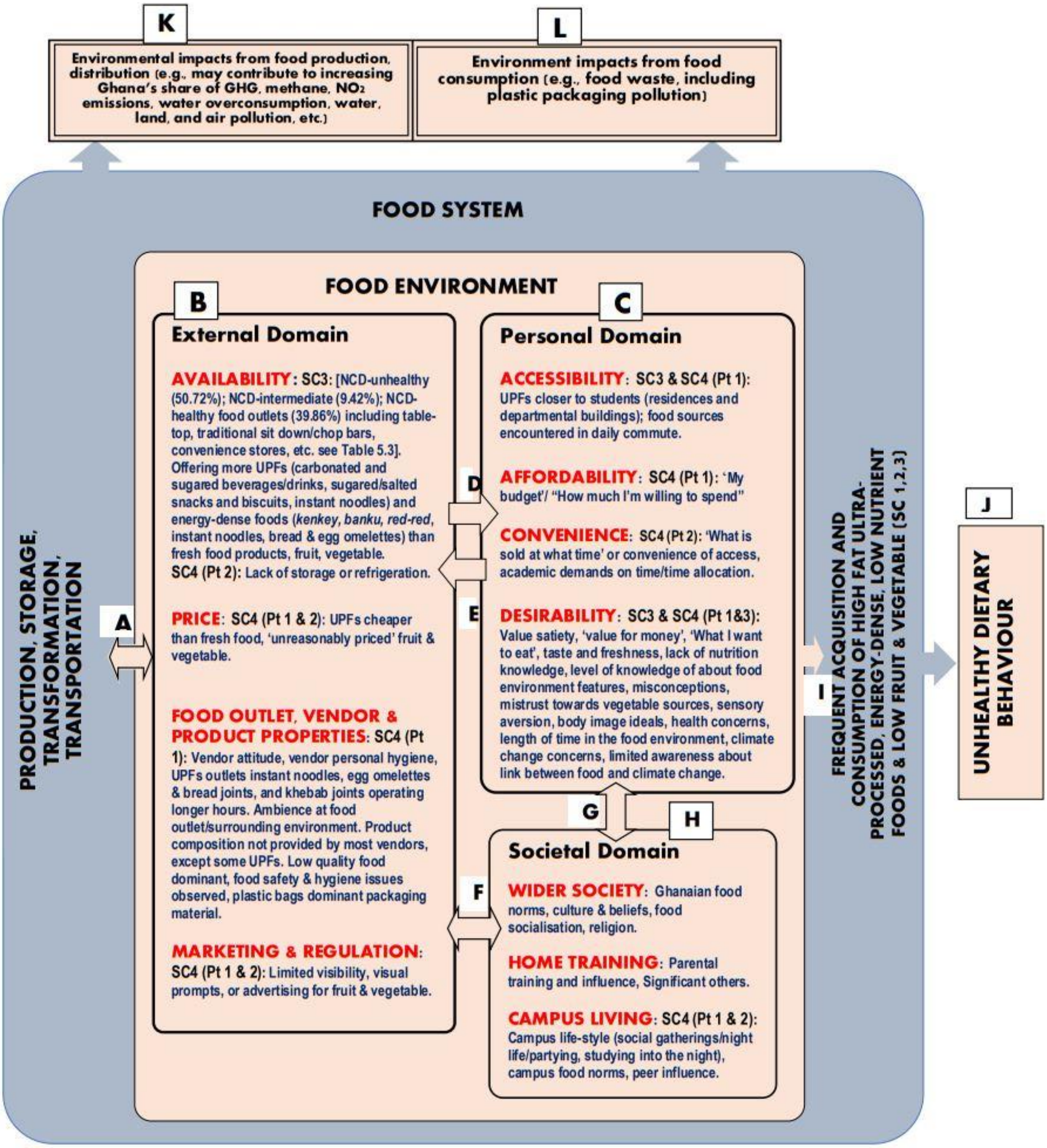
The components of the food retail environment were mapped and examined for healthiness in this research component. Open-source tools were used to identify and map food outlets within the campus foodscape. Geographical Information System (GIS) spatial analysis techniques in QGIS version 3.10.0 were then used to examine food outlets distribution, density, and proximity to residential and departmental buildings. A classification system was also developed to assess the healthiness of food-outlets within the university foodscape based on food items on offer. These were aimed at answering research question 3 and related research gaps.

Food outlets were found to be unevenly distributed over the university food environment, which was dominated by food outlets classified as NCD-unhealthy. This encompassed food outlets that sold no fruit and/or vegetable choices, but offered ultra-processed foods (UPFs), other high-fat, and energy-dense food choices that encourage excess calorie intake. Some of the most predominant outlets were those selling carbonated and sugared beverages/drinks, sugared/salted snacks and biscuits, instant noodles (cooked/uncooked), and sausages (cooked/uncooked) (see Figure 9.1B). The spatial analyses showed that disproportionately higher number of NCD-unhealthy than NCD-healthy and NCD-intermediate food outlets clustered closer to residential buildings (see Figure 9.1B). These characteristics of the food environment in this urban community are suggestive of an obesogenic food environment.

The spatial analyses also identified limited availability of food outlets closer to departmental buildings. Many of the food outlets around departments were informal in nature and mostly temporary table-top structures offering snacks, biscuits and pastries, other confectionery and SSBs (see Figure 9.1B). This may encourage frequent ultra-processed foods intake (see Figure 9.1I) and certain dietary habit formation over time (such as meal skipping), given that students spend most of their weekday time at the department (see Figure 9.1J).

Food service places was the dominant food outlet type in the campus food environment, constituting nearly two-fifths of all outlets identified. This is suggestive of high eating-out among young people in this community. That is, the prevailing characteristics of the University foodscape may be a materialised reflection of students' longstanding preferences (see Figure 9.1E & 9.1F).

Figure 9.1: Integration of key findings from the four study components



Source: Adapted from Turner et al., 2018

9.2.1.3 How individuals interact with the food environment and the role various food environment dimensions play in shaping food acquisition and dietary patterns/food choice.

In the most recent and closest study, Dake et al. (2018) used objective measures to examine the influence of the built environment (including measures of the food environment) on obesity. Having focused on deprived urban poor population, this study lacked diversity in its findings and did not examine the influence of the built environment on dietary patterns/behaviour. Existing literature suggests an early-stage nutrition transition in SSA among high income and middle-class urban population. Most importantly, Dake et al. (2018) did not examine how individuals interact with their food environment. Apart from addressing research question 4 and 5, this component of the research also addresses this gap.

Drawing on the socio-ecological models (SEM) of behaviour, the study also explored the influences of the food environment features along with social and personal level factors in shaping emerging adults' food outlet choice and food choice decisions in the first and second parts of a three-part qualitative research component (Study component 4) among emerging adults living in this student (elite urban) community. Drawing on SEM, the study identified that students negotiated a complex interplay of factors in interacting with their food environment. As rational consumers who seek to maximise satisfaction, students' outlet choice decisions were largely the product of rational decision-making process shaped partly by their level of knowledge of their campus food environment (Figure 9.1C). Students complemented their often-limited personal knowledge and past experience of the campus foodscape with their information environment (their social network, phone-based apps) and exposure to the foodscape in their daily routines (Figure 9.1B & 9.1C). The study also found that students' outlet choice decisions were sometimes not out of rational decision making but induced by 'what they crave' or other food cues which often constituted irresistible temptation. Environmental food cues, especially the limited number of FV vendors and advertising materials for healthy foods in the campus foodscape (Figure 9.1B) were perceived to inhibit healthy food outlet use, demonstrating how food environment exposure influences individuals to form intentions to eat (Figure 9.1I & 9.1J). Young people recurrently indicated that they "forgot" to consume FV because they hardly saw any in their daily trajectories or commute, which links to the individual level barrier "out of sight, out of mind."

However, the price per quantity of food, proximity of food outlets, individual purchasing power, value satiety, peer influence, and social modelling and facilitation were usually presented as the deciding factors for many young people to patronising a particular food outlet.

More importantly, emerging adults adapted their food outlet and food choice decisions to their financial constraints. They matched cost of food at the various food outlets with their individual budgets. According to students' narratives, the mismatch between their budgets and food prices influenced them to focus on the need for volume and satiety, thereby preferring outlets offering more calories per price. Price per quantity of food and value satiety were usually constructed as pivotal and more important determinants of food outlet choice decisions (see Figure 9.1C), given the low-income status of students who are usually unemployed and depend on remittances. Young people were thus inclined to patronising outlets offering cheaper and high calorie food options they perceived to offer full-feeling effect aimed at deferring another expenditure on food (see Figure 9.1I). High calorie food options such as *banku*, *kenkey*, *fufu*, and *red-red* or *gari* with beans and food outlets offering such dishes were therefore poplar among students in this study (see Figure 9.1B) as they were usually perceived to be satiating and offered 'value for money' (price per quantity) (see Figure 9.1C & 9.1I), leading to repetitive use of particular outlets which in turn may result in habit formation over time. With regards to cheaper food options, UPFs such as coca-cola, fanta, malt drinks, other SSBs, sweetened/salted snacks and instant noodles were also very popular in this campus (see Figure 9.1B & 9.1I), especially among female students (see Figure 9.1B & 9.1I). These explain the disproportionately high density of NCD-unhealthy food outlets than NCD-healthy or NCD-intermediate food outlets observed in this university community's food environment (in the geo-mapping component) (see Figure 9.1E 9.1F). Indeed, participants in this qualitative component did mention relatively limited availability of food outlets around departmental buildings as a key factor determining what students ate during the day's work/lectures around departments, if they ate at all. The issue of availability was also mirrored in other perceived barriers in this inquiry, including the opening hours of food outlets. Even when emerging adults craved FV, they had to suppress it and resort to "carbo" foods due to spatial inaccessibility of FV or because it was outside FV outlets' business hours. It was also reported that healthy foods including FV were 'unreasonably' priced in this food environment. The perceived high price of healthy foods was thus reported as an important reason for inadequate FV intake in this emerging adult group, supporting findings of low FV consumption in urban SSA populations observed in the systematic review (in study component 1) (see Figure 9.1I). Given the hot and humid conditions in the study location, refrigeration arrangements in student accommodation facilities also compounded students' situation. Indeed, students felt that the characteristics of the food environment significantly shaped their dietary behaviours and practices as it "is what is available, that's what [they] we eat. [They] We have no choice" (see Figure 9.1I). In addition, based on the concept of location-allocation in the siting of a food outlet, which prioritises/attends to the availability of a sizeable demand/customer base to ensure economic viability for the outlet, food vendors or food outlet operators in this community's food environment may be responding to residents' preferences and demand learned overtime, thereby supplying more UPFs, cheap, energy-dense foods and other NCD-unhealthy food products to ensure business sustenance. This demand-supply interaction may have contributed to shaping this food environment over time (see Figure 9.1E & 9.1F), which in turn plays a key role in shaping food choice decisions in this young adult group. It is therefore not surprising that the ubiquity of UPFs in this university community was described as an important driver of UPFs consumption behaviour among students. Although some participants priotitised affordability or craving over proximity to a food outlet, most students settled on food products offered by most proximal food outlets to save time (see Figure 9.1C). This also favoured UPFs given their proliferation over the foodscape (see Figure 9.1B).

Wider societal norms and campus food norms also shaped food choice decisions. Campus lifestyle appeared to favour certain food products because of perceptions of being convenient or being social status symbols (see Figure 9.1H). SSBs, sugared/salted snacks, biscuits, other pastries and other ready-to-eat UPFs appeared to support students' preference for convenience (and "easy going" food options) due to academic demands on time (see Figure 9.1C). Being nicely packaged, such food products fit the 'elitist' lifestyle on this campus, apart from fitting easily and securely in young people's backpacks. Frequently consuming SSBs and other 'Western-style' fast foods was perceived to confer a favourable social class on an individual. Students therefore ate such foods or drunk SSBs to "show off" or as a befitting way to "pamper yourself" (Figure 9.1H), not discounting the fact that some students did not perceive them as such.

Overall, the findings suggest that although the food environment characteristics play a key role in shaping young people's food behaviours (see Figure 9.1J), the food environment characteristics, solely, do not determine food practices and dietary patterns in this emerging adult group, but how much the food environment characteristics accommodate emerging adults' social and individual needs/goals, constraints, and preferences in a specific situation (Figure 9.1D, E, F).

9.2.1.4 The perceptions and attitudes of educated urban residents towards dietary change in relation to health and environmental sustainability (meat, FV and UPF).

Finally, emerging adults' perceptions and attitudes about modifying dietary behaviours were explored in the third and final part of the qualitative study. Participants were asked whether they would modify their diets for the sake of environmental sustainability and their personal health using meat, FV and ultra-processed foods as proxies given their associations with health/disease and environmental impacts.

The results highlight a number of varying motivations among emerging adults to increase or reduce meat consumption, some of which they considered more relevant than others. Health concerns; animal welfare; and environmental sustainability were not important to this age group, and they did not consider changing their behaviour on the basis of these drivers, although being sick was an important driver of FV behaviour. Body weight and shape; meat and UPFs as identity, pleasure, and joy; meat eating as part of socialisation; religion and cultural practices were more important drivers of behaviour (Figure 9.1H). Generally, bodyweight and shape concerns showed potential in inspiring FV intake, reduced UPFs consumption, and drove increased preference for meat consumption as did meat as identity, pleasure and joy, and meat eating as part of socialisation, whereas religious and cultural practices were generally cited as a reason to limit meat intake. FV not being part of food socialisation based on perceptions of FV not being integrated properly into the Ghanaian food culture, beliefs, and misconceptions about FV, limited availability and high cost of FV were important barriers to improving FV consumption behaviour (see Figure 9.1I).

There was widespread lack of understanding of the concept of environmental sustainability, with most emerging adults hearing the term for the first time during the interview session. The connection between meat consumption (or diets in general) and climate change or environmental sustainability was not only a difficult concept for most young people to grasp, but also a controversial subject that drove diverging opinions. Although some students believed the link between the two phenomena, many students expressed scepticism about how their diets or meat "eating would affect the environment", a posturing that will support dietary behaviours with adverse environmental impacts (Figure 9.1K, 9.1L). Similar findings of limited awareness about the diets-climate change nexus have been reported in Brazil, China, France, Germany, India, Italy, Japan, Poland, Russia, South Africa, the UK and the US in the Chatham House multi-country study (Bailey et al., 2014). In the Chatham House study, participants with limited awareness of this connection were less likely to demonstrate willingness to make dietary modifications for ecological reasons. Despite the expression of scepticism about the potency of their food consumption to affect the environment, emerging adults in the current study demonstrated genuine interest in understanding the connection, and environmental sustainability concerns appeared to hold potential to influencing dietary modifications in this young adult group. But previous evidence suggest that dietary-related knowledge alone does not necessarily translate into behaviour change (Figure 9.1J).

When asked whether they would modify their diets for the sake of environmental sustainability, most young people were unwilling to do so. Emerging adults who advanced this view, evoked a number of justifications. Paramount among them is the belief that their meat intake alone cannot “make any difference” or destroy the climate, although this was challenged by other participants who believed that that ‘every little’ reduction counts. Also modifying diets to include less UPFs and meat but more FV was generally viewed as not necessary (age-wise) or possible (financially/economically) now and thus deferred into the future when they were gainfully employed or when ill-health during later adulthood necessitated dietary modifications based on medical advice. This may partly explain the increased consumption of meat and UPFs in SSA over the years and higher intakes in urban SSA populations observed in the systematic review components of this study (Chapters 3 and 4) compared to FV intakes that fall short significantly of the WHO guidelines (Figure 9.1I), which may contribute to increasing the sub-region’s contribution to climate change (Figure 9.1K, 9.1L). Emerging adulthood was perceived as a window of opportunity to explore and enjoy 'good and tasty' food, a venture that would not be possible later in life, offering some insights into why FV consumption appeared to decrease with age (from childhood to adulthood) in Study Component 1 (Mensah et al., 2020) (Figure 9.1J).

Just as participants in this study demonstrated widespread unwillingness to make dietary modifications based on ecological considerations, they expressed doubts regarding the acceptability of the call to dietary behaviour modifications (especially in relation to meat reduction or exclusion) in the general population. However, some young people who identified as SDG advocates or students of Sustainable Development (SD) demonstrated willingness to modify their diets or were already doing so, at least, occasionally, by not eating meat sometimes. Such students constructed any human-induced damage to the ecosystem (including food-related ones) as ‘a self-inflicted injury’. Extreme weather and climatic conditions being experienced across the world were cited as typical examples of the dire consequences of damaging the environment. To such young people, continuous consumption of meat, for example, meant sanctioning the environmentally damaging activities in the meat supply chain.

However, the cultural-embeddedness of food and dietary behaviour, and as observed in this study, societal constructions, and portrayal of ‘Western-style’ diets including fast foods, SSBs and other UPFs, and meat as social status symbols may significantly impede behaviour modification in the short term. Indeed, there was a universal admission of difficulty (including SD persons) modifying diets, especially to consistently include less meat in favour of more FV (Figure 9.1I). But swapping meat portions with plant-protein portions appeared to be the most appealing alternative dietary regime to this young adult group, including some participants who identified as ‘meat lovers’ or ‘meat people’. Any such adjustments were however only possible if it follows a gradual or staggered approach. The implications of these findings for policy interventions and further research are presented subsequently in the light of the study’s limitations and strengths.

9.3 Strengths and limitations of this project

The combination of GIS mapping and analytical tools with meta-regression analysis, FGDs, and BFPIs in this study represents a robust and effective means to studying how characteristics of the built environment interact with socio-cultural and individual level factors to influence lifestyle behaviours as suggested in previous research (Dake et al., 2016; Kirby & Inchley, 2009, 2013). GIS tools enable “objective measurement of the environment, linking geographical and epidemiological information through spatially locating socio-demographic, behavioural and environmental data” (Smith et al. 2010:2). Adopting a similar mixed methods approach in this study helped in mitigating and making up for the limitations of the individual research methods, some of which are discussed below. In addition, the use of GIS tools together with qualitative research techniques in this study helped to create a good picture of how characteristics of the built environment interact with socio-cultural and individual level factors to influence emerging adults’ food behaviours.

The use of FGDs can also be considered a strength of this study. FGDs do not only support the creation of shared understandings. They are credited with a greater ability for collecting “well-grounded, rich descriptions and explanations of processes in identifiable local contexts. With such qualitative data one can preserve chronological flow, see precisely which events lead to which consequences, and derive fruitful explanations.” (Miles & Huberman, 2009). FGDs are thus particularly useful in research aimed at understanding how the food environment influences food behaviours or how young adults interact with their food environment to make food choice decisions.

In addition, offering participants an option between FGDs and BFPI increased opportunities for greater participation which allowed the collection of a wider range of views. Individuals who would be uncomfortable in the presence of 'strangers' had the option to participate with their best friend. However, quotes reported as representing emerging themes are researcher-selected and may introduce some researcher bias. To minimise this first supervisor checked coding framework and a random 10% of transcripts for quality and consistency. More importantly, participants were invited (along with reports on findings) to comment on whether findings represented the views shared during interview and FGD sessions.

Another limitation could be that participants consisted only of emerging adult students of one university in Ghana. Findings may therefore not be applicable to the general population. However, the focus on emerging adults in this study was necessitated by the research gaps in the literature and the need for research to inform tailored interventions. It was also expected that university/tertiary students would appreciate issues around environmental sustainability compared to other population groups given the low rate of literacy in Ghana.

Finally, sample size adequacy may have been limited due to the sampling approach adopted. Certain subgroups (e.g., foreign/international students, students of certain ethnic backgrounds) may not have been adequately represented in the sample, although the sampling approach aimed for a diverse sample including students from all disciplines, the various levels of study, and halls of residence. Challenges during fieldwork affected timeframe for fieldwork which may also have affected sampling and sample size. This includes delays resulting from challenges encountered in the process of obtaining local ethical clearance and disruptions from semester breaks. Recruitment was finally truncated by the outbreak of Covid-19 and subsequent close of universities. However, a good diversity of participants was reached as observed from participant characteristics reported in the results.

9.4 Implications for policy

The findings of this study are expected to be valuable in health policy formulation in Ghana aimed at tackling obesity and other nutrition-related health conditions among young adults through sustainable diets. The findings highlight the importance of context-specific policy interventions. In addition to limited interventions, another gap in the literature was the use of knowledge on context- and local population-specific characteristics in the design of interventions including interventions that recognize the importance of environmental and contextual factors to intervention effectiveness. In their systematic synthesis of evidence on the effectiveness of tailored/contextual health interventions, Liu et al. (2012: 149) propose that "decisions on adaptation need to be based on a detailed understanding of the target community". The application of existing health promotion strategies to specific population sub-groups, including emerging adult university students, in SSA is not well studied, with most health interventions taking a general population approach. However, as reported in this study, there are challenges that are unique to some population groups (university students in this case). This may mean that a generic approach may mean less effective interventions in certain sub-groups. Considering the context-specificity, social-embeddedness, age disparities in dietary behaviours, obesity and other diet-related health conditions, a tailored approach may therefore lead to intervention effectiveness and prevent counterproductive interventions.

Indeed Nastasi and Hitchcock (2016) observe that interventions address culture and context in their design through rigorous research that systematically examine factors culturally relevant to the setting. Alkin et al. (2016: 4-5) also contends that attending to culture and context in the design, implementation and even evaluation of an intervention improves its "acceptability, social and ecological validity, integrity, outcomes and sustainability". Nastasi and Hitchcock (2016:15) suggest that mixed methods research (MMR) can offer "the most informative, complete, balanced and useful research results" which can be the basis for such adaptation of intervention.

The MMR approach adapted in this study offers the relatively detailed understanding and "evidence-based cultural grounding" which can provide the basis for some interventions. Based on this study's findings, a number of suggestions for policy interventions across all levels of influence are made as follows:

Table 9.1: Suggestions for interventions based on findings from this study

Level of influence	Example recommended interventions
Upstream/Policy level (Including national/local government, University authority/management)	• **Food tax policy**: Both GIS mapping and qualitative analyses showed disproportionately higher density of unhealthy food outlets within the University foodscape. Emerging adults also confirmed that this influenced their food choice behaviours and that they 'had no option than to eat what was made available to them'. At the policy/macro level, regulating(restriction) the importation of ultra-processed foods (especially, carbonated/SSBs) and the implementation of taxation policies on such unhealthy food products as have been successfully implemented in Brazil, Chile (Caro et al., 2018), Mexico (Colchero et al., 2016) and other Latin American countries and recently, South Africa's sugar tax (Wrottesley et al., 2021). Such an upstream tax intervention contributes to modifying the food environment and usually has a wider national impact (including university campuses and other education institutions) by indirectly influencing consumption behaviours at the individual level. Given that taxes make such foods more expensive, it is likely to be effective at reducing consumption in this emerging adult group most of whom reported living on low incomes. In Barbados (Alvarado et al., 2019) and Mexico (Colchero et al., 2016), observational studies have shown that up to 20% SSB tax policies have been successful in shifting consumption to healthier drinks and water from SSBs. • **Subsidies for FV/healthy foods on campus**: Systematic reviews and experimental studies suggest that unhealthy food taxes are more effective at improving healthy dietary behaviours when implemented together with healthy food subsidies (Eyles et al., 2012; Niebylski et al., 2015; Thow et al., 2014). Emerging adults in this study believed that regulating food prices to make healthy foods cheaper is one of the effective ways to support them to improve their FV consumption behaviours. Subsidising healthy foods, especially FV, to make them cheaper on campus will modify the food environment and may motivate students to make more healthy food choices during term time. Indeed, reducing FV prices on campus was the most frequently suggested intervention and most appealing to emerging adults which they believed would motivate them to increase their intake of FV. In South Africa, for example, a cash rebate program increased FV intakes by 21% and significantly reduced

	unhealthy food consumption (An & Sturm, 2017) and improved children's diet in Burkina Faso (Tonguet-Papucci et al., 2017). However, reduced FV prices or increased disposable income per se may solely not translate into increased FV intakes although it increases the variety of foods one may potentially choose from (Bele et al., 2019). It has been argued that multicomponent dietary interventions are more effective relative to single component interventions (Kelly et al., 2016; Roy et al., 2015; Whatnall et al., 2018) like monetary incentives only. Subsidies may need to be complemented with other interventions suggested and will require research, as indicated previously. While this could be a government (population-wide) policy, university authorities can take advantage of their semi-autonomous nature and take the initiative to implement subsidies for FV, which would benefit from being tailored/context-specific. Subsidies can contribute to increasing the availability of healthy food options in the food environment and improve both physical and fiscal access (Bennett et al., 2020; Gittelsohn et al., 2017). • **Campus nutrition standards:** The University can develop and implement nutrition standards in consultation with students and relevant stakeholders for its food environment to support regulation. Such standards can among other things define and restrict the kinds of food and number of unhealthy food options an outlet can offer. Nutrition standards can also incorporate standards or guidance on hygiene for food vendors which can improve hygiene regulation. An office charged with these responsibilities should be customer-facing and/or have friendly reporting and feedback channels accessible to all students. Students should be made aware of the existence of such a system and be encouraged to use it. While this is the responsibility of university authorities, student leadership can champion advocacy for the uptake of such policies. • It is important to include regulations for all student accommodation to provide recommended communal kitchen/cooking facilities.

	• Making small funding amounts available to promote student-led health promotion activities aimed at improving healthy dietary behaviours among students. E.g., student competitions, funding to providing free FV (instead of SSBs) at social events on campus, FV voucher incentives, etc.
Physical (campus) food environment	• **Promotion of healthy foods**: Design of relevant marketing activities and materials (e.g., messages and images) for motivating healthy dietary behaviours (including FV consumption improvement). These could benefit from the inclusion of point-of-purchase advertising (i.e., posters and labels) to improve visibility of FV and other healthy food options on campus. Counter-marketing activities to decrease student exposure to on-campus marketing of energy dense foods and drinks, including point-of-purchase advertising posters. These can be done together with food outlet operators. Other healthy food promotion activities could include competitions or award schemes for most healthy food outlets in the university food environment. • Initiatives to increase spatial access to FV and other healthy food options on campus. For example, local farm to campus programmes to increase access to fresh and affordable FV and other healthy foods. • **Fruit/veg on-the-go**: The limited availability of FV in the campus foodscape highlighted in this study includes the non-availability of the pre-prepared nicely packaged (or ready-to-eat) fruit or vegetable salad options which students could grab and eat on-the-go. It is anticipated that such options will be expensive. But the implementation of FV subsidies (suggested above) can make such ready-to-eat FV options affordable apart from being attractive to students.
Social environment	• **Peer support**: Friends and roommates were portrayed as important agents of food behaviour change in this study. Using carefully designed commensal activities and events organised around FV and other healthy foods only on campus would be an effective way to promote FV consumption behaviours among students. Using existing social networks like campus peer support groups (e.g., student religious groups, academic/sporting clubs and societies, cultural and ethnic associations, etc.) offer unique opportunities for such interventions to succeed at promoting healthy eating among students.

	• **Healthy food giveaways**: Periodic giveaways of FV and other healthy food options on campus may also support this emerging adult group to improve their FV consumption and healthy eating behaviours. Under such a programme, student groups could be supported with small funding amounts to providing free FV and other healthy foods at social events on campus. • Design fun and attractive activities aimed at motivating FV consumption and other healthy behaviours, including those based on opportunities to socialise or make friends.
Individual (student) level	• **Awareness campaign on healthy/sustainable diets**: The study highlighted limited nutrition knowledge among students. Public education campaigns and other activities to inform emerging adults and increase awareness about healthy food behaviours and dietary guidelines or recommendations in this emerging adult group. Awareness campaigns should include activities that address misconceptions and beliefs about FV, meat, SSBs and other ultra-processed foods as have been highlighted by this study. A typical example is the perception that FV are less satiable when many FV options offer the feeling of fullness and satiety. Awareness campaigns may also benefit from highlighting the importance of plant-based diets to climate change/environmental sustainability as most students in this study expressed willingness to modify their diets for the sake of the environment. It is similarly important for such interventions to aim to improve awareness of the health risks of excessive meat consumption among this emerging adult group. • Design and implement activities aimed at equipping this emerging adult group with skills for the preparation of healthy, quick, easy, and low-cost meals at the student accommodation. • University-based programmes should include suggestions on how young adults can implement simple healthy eating behaviours in the home to influence the rest of the family. • **Access to credible nutrition information**: Creating awareness about credible avenues (e.g., government websites, offices, etc.) where emerging adults can access reliable nutrition information.

Although some of the interventions suggested here have been successfully implemented in other jurisdictions and achieved results, it is recommended that the design and implementation attend to the culture and context of the target community through rigorous and systematic research where this study has not provided enough basis.

It is acknowledged that upstream interventions have the greatest likelihood to succeed and make wider/far-reaching impact on dietary behaviours compared to individual level interventions that do not address the range of factors that influence food behaviours in an individual's social, physical and policy environment (Adams et al., 2016; Holdsworth & Landais, 2019; Story et al., 2008). Interventions proposed here therefore cut across the various levels of influence to ensure effectiveness and a wider reach given the individual variability in dietary behaviours. Such cross-sectoral approach to policy design and adaptation will require interdisciplinary collaboration and engagement among a wide range of stakeholders, key amongst them being students and student leadership.

9.5 Implications for research

The findings from this research provide essential/initial exploratory results but also identified a number of gaps that represent opportunities for further research.

First, the systematic review highlighted a lack of evidence investigating ultra-processed food consumption in SSA populations at the country level, and the extent to which consumption differ between population subgroups. The Covid-19 outbreak and the shutdown of university campuses in Ghana did not permit quantitative survey intended for a similar analysis as part of this study. Large nationally representative surveys with standardised, valid nutritional tools, and robust methods should make use of disaggregated population groupings to quantify how much UPFs people are consuming and the differentials between population sub-groups. There is also a general lack of literature exploring how UPFs consumption has changed over the years in Ghana and other SSA populations. Retrospective time series analysis/studies could be employed to understand how UPFs consumption has changed in SSA populations (including young adults and other subpopulations) the last few decades. The systematic review highlights the need for further research assessing the drivers of UPFs consumption in a large representative sample in a university setting and the general population. Such surveys may benefit from incorporating the assessment of campus norms and other socio-cultural factors that may be driving UPFs consumption among university students or young people and across heterogenous SSA populations. The cross-sectional nature of existing quantitative studies (Osei-Kwasi et al., 2020) may not properly capture the influence of food environment exposure on dietary behaviours. Due to the timeframe allowed for this research and Covid-related challenges, the use of a longitudinal design was not possible. In the next stages of this study, quantitative research assessing/investigating the effects/association of exposure to the characteristics of the campus food environment would benefit from a longitudinal design which could include linking of year of entry/matriculation data and subsequent year or final year data on dietary behaviours of students. This could highlight the disparities in dietary behaviours pre- and post-exposure to campus food environment characteristics to consolidate findings in the current study and enhance understanding of environmental influences on food behaviours in this emerging adult group.

The qualitative analyses identified the need for further studies testing students' attitudes and perceptions about dietary changes towards sustainable diets in a large representative survey. Such surveys should include the assessment of the prevalence of dietary practices (i.e., vegan, vegetarian, almost vegetarian (eating meat or fish only occasionally), part-time vegetarian (a few times a week), pesco-vegetarian or omnivore) among students or the general population. In addition to assessing the willingness to make dietary modifications, the survey should also aim at highlighting motivations that can be used for encouraging less meat diets that favour of plant-based food and nutrient sources among young adults and the general population. The survey should include measures of environmental sustainability, animal welfare, culture, religion, and other social factors that may encourage dietary modifications.

The result from the current study highlights the relative densities of healthy and unhealthy food outlets over the university foodscape, with disproportionately limited availability of healthy food outlets located around departmental buildings. While the study findings suggest that this relatively higher density of unhealthy food outlets is partially a result of student preferences over time, the current study did not collect the views of food outlet operators/vendors in the food environment. One of the next steps of this research will be to speak to food vendors in this university campus using both qualitative and quantitative research methods to examine the factors that influence their decisions to sell one food type but not the other. These studies would benefit from including an assessment of what the primary deciding factor(s) is, and whether this includes demand for the food product.

The qualitative component of this study also identified limited nutrition knowledge in this emerging adult group, including dietary requirements, misconceptions and skills for gauging food serving size. Further research aimed at informing self-efficacy interventions should investigate nutrition information seeking behaviours and pathways to nutrition information among emerging adults and university students in Ghana and other parts of SSA in qualitative studies. Further studies should also examine current dietary education practices in Ghana to identity and examine the nutrition messages being delivered to the public. This would enhance understanding of the direction of nutrition education interventions.

In close relation to the above, the study also highlights a lack of self-efficacy for gauging the quantity (serving or portion size) of food they consume. This meant that even with knowledge of dietary guidelines, this emerging adult group may have difficulty with compliance given inability to gauge food quantities. Further studies should investigate effective and reliable methods by which young people can estimate food quantities. Such studies may benefit from considering cultural appropriateness and local applicability of such measuring methods.

Finally, the study highlights intervention suggestions (both by students in this study and the researcher based on study findings) for improving the University food environment. Participants also gave an indication of the kind of interventions that would support them to consume FV during term time and facilitate the development of FV consumption behaviours. As an initial step of a phased approach towards intervention development, this research can be considered a formative study. Further studies should test the acceptability and feasibility of participant recommendations for interventions (to improve the University food environment and to support students develop healthy food behaviours) in representative surveys among students in the study area and qualitative studies with staff, relevant university authorities and other relevant stakeholders. The findings and recommendations made by the researcher should also inform the design and uptake of interventions with contextual and cultural relevance for improving food behaviours in this emerging adult group. However, as indicated above, pilot studies should be conducted to test the efficacy of these tailored interventions at improving the food environment and ultimately, the dietary behaviours of young adults, and how they compare to any existing generic interventions.

9.6 Conclusions

This study makes important contributions to the literature around the influences of the urban food environment on diets, health, and the environment in SSA populations. First, through an initial systematic review and meta-regression, this study is the first to conduct a comprehensive systematic evidence synthesis to understand the secular trends of MFV consumption in SSA over a 38-year period and subpopulation variations in average daily consumption. Through a second systematic review, this study is also the first to synthesise research evidence on UPFs consumption trends in SSA. In particular, the second evidence synthesis mostly served to underscore the lack of research that focus on quantifying how much UPFs is being consumed in SSA populations. However, the existing studies appear to suggest increased consumption of UPFs in urban SSA.

This study also used GIS mapping and analytical tools to characterise the physical food environment in SSA using an elite urban community in Ghana as a case study. Although a previous study (Dake et al., 2016) has used GIS methods to characterise the urban food environment in Ghana, this study is the first to classify food outlets based on a NCD healthiness scale using an adapted outlet classification tool and to explore how residents interact with the food environment. Using GIS analytical tools, the study created a clear picture of the University foodscape, including how food outlets were distributed and densities of various food outlet types within the local food environment. Through GIS analyses, the study also highlighted the healthiness of the food outlets in the foodscape and the relative densities of healthy and unhealthy food outlets around residential and departmental buildings.

Through qualitative methods this study provides interesting culturally specific insights into how young adults interact with their food environment and the factors that drive their food outlet choice decisions and dietary patterns. The findings suggested that environmental factors were more prominent drivers of food outlet choice decisions than social and individual level factors. However, the findings also suggested that environmental level characteristics alone did not drive emerging adults' decision to patronise an outlet, but how much the food outlet characteristics accommodated emerging adults' social and individual needs and goals, constraints, and preferences in a particular choice situation.

The study also identified a complex interplay of influences driving emerging adults' fruit, vegetable and UPFs consumption behaviours in the university foodscape during term time. Perceived high cost of FV in the foodscape, 'what is sold at what time', proximity, perceived lack of storage, perceived Ghanaian food norms and food socialisation, limited nutrition knowledge, value satiety, sensory aversion, and misconceptions about FV discouraged FV consumption behaviours at different magnitudes. However, living near FV outlets, having health and nutrition knowledge, being sick, body image ideals, family and peer support were important facilitators to FV consumption behaviours. Interestingly, no barrier to UPFs consumption was observed. Academic demands on time, proliferation of UPFs in the food environment, campus lifestyle, and campus norms incentivised UPFs consumption and made UPFs or convenience foods a preferred food option during term time. Young people believed that improving availability and proximity of FV, making them cheaper on campus or giving them away for free would motivate them to eat more FV.

A final contribution is a provision of important insights into culturally specific attitudes and perceptions towards environmentally sustainable diets, and motivations to increase or reduce meat consumption, some of which were considered more relevant than others. Health concerns; animal welfare; and environmental sustainability were not important to this age group, and they did not consider changing their dietary behaviour on the basis of these drivers. Social and individual level factors including body weight and shape; meat as identity, pleasure, and joy; meat eating as part of socialisation drove increased preference for meat consumption, whereas religion and cultural practices were constructed as a reason to limit meat intake. Interestingly, the study found widespread limited knowledge about environmental sustainability and the link between environmental sustainability and diets among emerging adults, who were also skeptical about the link between excessive meat consumption and health. These demonstrate an urgent need for culturally tailored interventions to increase awareness around sustainable diets, improve the food environment and dietary behaviours, a series of which are suggested based on findings from this study.

9.7 Scientific outputs and conference/seminar presentations

1. Mensah, D. O., Nunes, A. R., Bockarie, T., Lillywhite, R., & Oyebode, O. (2020). Meat, fruit, and vegetable consumption in sub-Saharan Africa: a systematic review and meta-regression analysis. *Nutrition Reviews*. *https://doi.org/10.1093/nutrit/nuaa032*
2. Mensah, D. O., Mintah, F., Oteng, S., Aryeetey, R., Lillywhite, R., Nunes, A. R., & Oyebode, O. (2020). P30 Emerging adults' attitudes and perceptions towards ultra-processed foods, meat, fruit, and vegetables consumption in a university foodscape.

Submitted to: SSM Annual Scientific Meeting 2020, University of Cambridge, Cambridge, United Kingdom, September 09-11, 2020.

3. Mensah, D. O., Nunes, A. R., Bockarie, T., Lillywhite, R., & Oyebode, O. (2019). P39 Meat, fruit and vegetable consumption in sub-saharan africa: a systematic review and meta-regression. Society for Social Medicine and Population Health & International Epidemiology Association Joint Scientific Meeting 2019, Universit College Cork, Ireland, September 04-06, 2019.

4. Mensah, D. O., Nunes, A. R., Bockarie, T., Lillywhite, R., & Oyebode, O. (2019). P22 Meat, fruit and vegetable consumption in sub-saharan africa: a systematic review and meta-regression. Livestock, Environment and People (LEAP) Conference, Said Business School, Park End Street, Oxford, United Kingdom, December 10, 2019.

5. Mensah, D. O., Nunes, A. R., Bockarie, T., Lillywhite, R., & Oyebode, O. (2019). P39 Meat, fruit and vegetable consumption in sub-saharan africa: a systematic review and meta-regression. Warwick RSSP Research Harambee: A celebratory day of student research at Warwick. Ramphal Building, University of Warwick, June 19, 2019.

6. Mensah, D. O., Nunes, A. R., Bockarie, T., Lillywhite, R., & Oyebode, O. (2019). P39 Meat, fruit and vegetable consumption in sub-saharan africa: a systematic review and meta-regression (preliminary findings). Plant and Crop joint seminars, Wellesbourne Campus, School of Life Sciences, Uniersity of Warwick, January 24, 2019.

9.8 Other scientific outputs and presentation unrelated to thesis

1. Murphy, M., **Mensah, D**., Mylona, E., & Oyebode, O. (2021). Acceptability and feasibility of strategies to promote healthy dietary choices in UK secondary school canteens: a qualitative study. *BMC Research Notes*, *14*(365). https://doi.org/10.21203/rs.3.rs-551209/v1

2. Westbury S, Ghosh I, Jones H, **Mensah DO**, Folake S, Irache A, Azhar N, Iqbal R, Oyebode O. The influence of the urban food environment on diet, nutrition, and health outcomes in low-and middle-income countries: A systematic review. BMJ Global Health. Accepted for publication on September 17, 2021.

3. **Mensah DO**, Aryeetey R, & Oyebode O. Evidence on physical activity and sedentary behaviour in Ghana: A rapid scoping review. AJFAND (manuscript under review) 2021.

4. Anjorin S, **Mensah DO**, Ayorinde A, Oyebode O. Uthman O. Equity of national publicly funded health insurance scheme under universal health coverage agenda: a systematic review of studies published in Africa. Journal of Public Health 2021.
5. Mensah, D. O., Helena T. (2021). Oral presentation. Eating Alone or Together: Exploring social aspects of students' eating practices (EATEx study). British

Sociological Association (BSA) Food Studies Group Conference (virtual). BSA Conference Committee & Events, Durham, U.K, June 22-23, 2021.

6. Mensah, D. O., Helena T. (2021). Eating Alone or Together: Exploring social aspects of students' eating practices (EATEx study) during Covid-19 pandemic. Draft manuscript prepared.

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Appendices

Appendix 3.1: Conversion methods for standardizing data

Conversion	Estimation Method	Explanation	Source
Median to mean	$(q1 + m + q3)/3$	Where q1=the first quartile, q3=the third quartile, m=median	after Wan et al., 2014
IQR to SD	$\frac{q3 - q1}{1.35}$	Where q1=the first quartile, q3=the third quartile	after Higgins et al., 2008 (Cochrane Handbook)
SE to SD	$SD = SE \times \sqrt{N}$	SE=Standard Error, N=Sample size	after Higgins et al., 2008 (Cochrane Handbook)
CI to SD	$SD = \sqrt{N} \times (\text{upper limit} - \text{lower limit})/3.92$	For 90% confidence intervals 3.92 should be replaced by 3.29, and for 99% confidence intervals it should be replaced by 5.15	after Higgins et al., 2008 (Cochrane Handbook)
Ounze (meat, fish) to gram	1Oz= 28.35g*	Reported number of ounze multiplied by 28.35g	*
Kilogram to gram	1kg= 1000g	Consumption reported in kg is multiplied by 1000 to achieve gram values	
Portion/Serving of fruit/veg. to gram	1 portion/serving= 80g**	Reported number of portions/servings multiplied by 80g	**
Cup of fruit juice to gram	1 cup= 250ml=250g	Reported number of cups multiplied by 250g	*
Cup of orange vegetable (e.g. carrot, pumpkin) to gram	1 cup= 150g	Reported number of cups multiplied by 150g	*
Cup of raw leafy vegetable (leafy) to gram	1 cup= 40g	Reported number of cups multiplied by 40g	*
Portion/Serving of meat (cooked) to gram	1 portion/serving= 100g	Reported number of portions/servings multiplied by 100g	*
Portion/Serving of poultry (cooked) to gram	1 portion/serving= 80g	Reported number of portions/servings multiplied by 80g	*
Portion/Serving of fish (cooked) to gram	1 portion/serving= 100g	Reported number of portions/servings multiplied by 100g	*
Per week to day	1 week= 7 days	Consumption reported as g/week is divided by 7 to achieve g/day values.	
Per month to day	1 month= 30 days	Consumption reported as g/month is divided by 30 to achieve g/day values	
Per year to day	1 year= 365 days	Consumption reported as g/month is divided by 30 to achieve g/day values	

**WHO recommendation *after Saxelby 2009

Appendix 3.2: Quality appraisal of studies included in the MFV review

	Domain	Statement of study objective/aim	Clarity of study population definition	Sampling method	Response rate	Reliability and accuracy of measurement technique	Reporting of data		Total Score	Class Score Calc (%)
	Question	1. Was the research objective clearly stated (to measure meat/fruits/vegetables consumption)?	2. Was the study population clearly defined?	3. Was the sampling method one that achieves a sample representative of the intended study population?	4. Was a response rate mentioned in the study?	5. Was the measuring technique accurate and reliable?	**6.a.** Missing data-Were missing data and strategies for addressing missing data reported?	6.b. Presentation of data—Were data clearly and accurately reported	**(E)**	**E/19 x100**
Author(s)		0—Not stated, 1—Not clearly stated and 2—Explicitly stated.	0—Not stated 1—Not clearly defined 2—Explicitly defined * Clear definition of population/sample should be beyond country of study to include exact location, age cohort gender and other socio-demographic details.	Not Reported—0 Category A—1 Category B—2	Not reported—0 Reported (below 60%)—1 Reported (60% plus)—2 *Response Rate is reported if authors reported a precise rate or drop-outs & cancellation of interviews were reported. Compute Response Rate where enough information is reported but precise rate not reported.	D1—Single Dietary recall (e.g. 24-hour recall) D2—Food Frequency Questionnaire D3—Repeated/Multiple dietary recalls (e.g. food records, multiple pass recall, etc.)	Not reported—0 Reported only—1 Reported and addressed—2 **Apart from being explicitly stated, Missing data is reported if exclusions based on incompleteness of responses are reported	Not reported—0 Reported with error—1 Reported accurately—2 **Data presentation is accurate if average consumption data (MEAN/MEDIAN) and measures of statistical dispersion (SD, Variance, Range/IQR) are all reported correctly, Score 2. Score 1 where there are anomalies in reported data or only consumption data is reported without any measure of dispersion or where consumption data is reported in a graph/figure only.		
Amo-Adjei & Kumi-Kyereme (2014)		2	2	2	0	0	0	2	**8**	53
Albrechtsen, Fa, Barry, & MacDonald (2006)		2	1	2	0	1	0	2	**8**	**53**
Amare et al. (2012)		2	2	2	2	2	2	2	**14**	**93**

Amoateng et al. (2017)	2	2	2	0	0	0	0	**6**	**40**
Anderson et al. (2010)	2	2	1	0	1	0	1	**7**	**47**
Asayehu, Lachat, Henauw, & Gebreyesus (2017)	2	1	2	0	3	0	2	**10**	**67**
Bourne, Langenhoven, Steyn, Jooste, Laubscher, et al. (1994)	2	2	2	0	1	0	2	**9**	**60**
Bourne, Langenhoven, Steyn, Jooste, Nesamvuni, et al. (1994)	2	2	2	0	2	0	2	**10**	**67**
Caswell et al. (2015)	2	2	2	0	1	0	2	**9**	**60**
Caswell et al. (2018)	2	2	2	0	3	0	2	**11**	**73**
Faber et al. (2011)	2	1	1	0	2	0	1	**7**	**47**
Faber et al. (2007)	2	2	1	0	3	0	1	**9**	**60**
Faber (1999)	2	2	0	0	1	0	2	**7**	**47**
Ferguson et al. (2015)	2	2	1	2	3	0	1	**11**	**73**
Foerster et al. (2012)	2	1	1	2	1	0	2	**9**	**60**

Galbete et al. (2017)	2	2	2	0	2	0	1	**9**	**60**
Gelibo et al. (2017)	2	2	2	0	0	0	2	**8**	**53**
Gewa et al. (2014)	2	2	1	1	3	0	2	**11**	**73**
Gomna & Rana (2007)	2	2	2	0	1	0	1	**8**	**53**
Huybregts, Roberfroid, Kolsteren, & Camp (2009)	2	2	1	2	1	0	2	**10**	**67**
Iannotti & Lesorogol (2014)	1	2	2	0	1	0	1	**7**	**47**
Jackson et al. (2012)	2	1	1	2	3	0	2	**11**	**73**
Jemmott-III et al. (2011)	2	2	1	2	2	2	2	**13**	**87**
Keding et al. (2017)	2	2	2	2	3	0	2	**13**	**87**
Langenhoven et al. (1988)	2	2	2	2	1	0	2	11	73
MacIntyre et al. (2002)	2	2	2	2	2	0	2	**12**	**80**
Macintyre et al. (2000)	2	1	0	0	2	0	2	**7**	**47**

Maruapula & Chapman-Novakofski (2007)	2	2	2	2	3	0	2	**13**	**87**
Matsinkou et al. (2016)	2	2	0	0	3	0	2	**9**	**60**
Mwaniki & Makokha (2013)	2	2	2	0	1	0	1	**8**	**53**
Nago et al. (2010)	2	2	2	2	3	1	1	**13**	**87**
Nel et al. (2013)	2	2	1	2	1	0	2	**10**	**67**
Nkondjock & Bizome (2010)	2	2	2	0	2	2	1	**11**	**73**
Oguntona & Kanye (1995)	2	1	2	0	3	2	1	**11**	**73**
O'Keefe, Rund, Marot, Symmonds, & Berger (1988)	2	2	1	0	2	0	2	9	60
Osei-Asare & Eghan (2014)	2	1	2	0	1	0	1	**7**	**47**
Parr et al. (2002)	2	2	1	2	2	2	2	**13**	**87**
Peltzer & Phaswana-mafuya (2012)	2	2	2	2	1	0	2	**11**	**73**
Premji et al. (2008)	2	1	0	0	0	0	1	**4**	**27**

Ronquest-Ross et al. (2015)	2	1	0	0	0	0	1	**4**	**27**
Sanusi & Olurin (2012)	2	2	2	0	1	0	2	**9**	**60**
Sodjinou, Agueh, Fayomi, & Delisle (2009)	2	2	2	0	3	0	1	**10**	**67**
Steyn, Abercrombie, & Labadarios (2001)	1	1	0	0	0	0	1	**3**	**20**
Steyn, Nel, & Casey (2003)	2	1	0	0	1	0	2	**6**	**40**
Steyn et al. (2016)	2	2	1	0	3	2	2	**12**	**80**
Steyn, Senekal, Brtis, & Dsc (2000)	2	2	1	1	2	1	2	**11**	**73**
Torheim et al. (2001)	2	2	1	2	2	0	2	**11**	**73**
Vähätalo et al. (2005)	2	2	1	2	1	0	2	**10**	**67**
O'Keefe, Ndaba, & Woodward (1985)	2	2	1	0	2	0	2	9	60

Appendix 4.1: Quality appraisal of studies reporting UPF portion sizes

	Statement of study objective/aim	Clarity of study population definition	Sampling method	Response rate	Reliability and accuracy of measurement technique	Reporting of data		Total Score	Class Score Calc (%)
	1. Was the research objective clearly stated (to measure UPF consumption)?	2. Was the study population clearly defined?	3. Was the sampling method one that achieves a sample representative of the intended study population?	4. Was a response rate mentioned in the study?	5. Was the dietary intake measuring technique accurate and reliable?	6.a. Missing data- Were missing data and strategies for addressing missing data reported?	6.b. Presentation of data—Were data clearly and accurately reported	**(E)**	**E/18*100**
Author(s)	0—Not stated, 1—Not clearly stated and 2—Explicitly stated.	0—Not stated 1—Not clearly defined 2—Explicitly defined	Not Reported—0 Category A—1 Category B—2 Category B—3 A--Nonprobability sampling methods (eg. Convenience sampling, etc.) B--Probability sampling techniques (eg. Random sampling methods, etc.) C--Probability sampling techniques with power calculation report.	Not reported—0 Reported (below 60%)—1 Reported (60% plus)—2	0—Not reported 1—Other Methods 2—Single Dietary recall (e.g. 24-hour recall) 3—Food Frequency Questionnaire 4—Repeated/Multiple dietary recalls (e.g. food records, multiple pass recall, FFQ plus 24-hour recalls, etc.)	Not reported—0 Reported only —1 Reported & addressed—2 Reported/ Addressed/ Method used—3	Not reported—0 Report incurate/ with error/ without measures of dispersion—1 Reported accurately (including portion sizes and measures of dispersion)—2		**0**
Amare et al 2012	2	2	3	0	4	0	2	**13**	**72**
Anderson, Bellamy, Figures, Zeigler-Johnson, et al 2010	2	1	1	2	2	0	2	**8**	**44**
Asayehu, Lachat, Henauw et al 2017	2	2	3	0	4	0	1	**12**	**67**

Bourne, Langenhoven, Steyn, Jooste, et al 1994	2	2	2	0	3	0	2	**11**	**61**
Charlton, Steyn, Levitt et al 2005	2	2	0	0	4	0	1	**9**	**50**
Charlton, Steyn, Levitt et al 2008	2	1	1	0	4	0	1	**9**	**50**
Frank, Kroger et al 2014	2	1	1	0	3	3	2	**12**	**67**
Galbete et al. 2017	2	2	2	0	1	2	1	**10**	**56**
Holmes, Dalal, Sewram et al 2018	2	1	2	2	3	2	1	**11**	**61**
Kyamuhangire et al. 2013	2	1	3	0	4	0	1	**11**	**61**
Maruapula & Chapman-Novakofski 2008	2	1	1	0	4	1	2	**11**	**61**
Mwaniki & Makokha 2013	2	2	2		2	0	1	**9**	**50**
Nago et al 2009	2	2	3	2	4	2	2	**15**	**83**
Nkondjock & Bizome 2010	2	2	1	2	3	2	1	**11**	**61**

Oldewage-Theron & Kruger 2011	2	1	2	0	3	0	1	**9**	**50**
Ronquest-Ross et al 2014	2	1	2	0	0	0	1	**6**	**33**
Smith et al 1981	2	1	2	0	1	0	1	**7**	**39**
Sodjinou et al 2009	2	2	2	0	4	0	2	**12**	**67**
Steyn, Maunder, Tygerberg et al 2006	2	2	2	0	2	0	2	**10**	**56**
Steyn, Nel and Casey 2003	2	1	2	0	2	0	2	**9**	**50**
(Theron et al., 2007)	2	2	1	2	3	0	2	**12**	**67**
Vahatalo, Mikkila, Rasanen 2005	2	2	1	2	2	0	2	**9**	**50**
(Wolmarans et al., 1989)	2	2	2	2	2	0	2	**12**	**67**
Zeba, Delisle, Renier 2014	2	2	3	2	2	0	2	**11**	**61**

Appendix 4.2: Quality appraisal of studies reporting UPF consumption frequency

	Statement of study objective/aim	**Clarity of study population definition**	**Sampling method**	**Response rate**	**Reliability and accuracy of measurement technique**	**Reporting of data**		**Total Score**	**Class Score Calc (%)**
	1. Was the research objective clearly stated (to measure UPF consumption)?	2. Was the study population clearly defined?	3. Was the sampling method one that achieves a sample representative of the intended study population?	4. Was a response rate mentioned in the study?	5. Was the dietary intake measuring technique accurate and reliable?	6.a. Missing data- Were missing data and strategies for addressing missing data reported?	6.b. Presentation of data—Were data clearly and accurately reported	**(E)**	**E/18*100**
Author(s)	0—Not stated, 1—Not clearly stated and 2—Explicitly stated.	2. Was the study population clearly defined?	Not Reported—0 Category A—1 Category B—2 Category B—3 A--Non probability sampling methods (eg. Convenience sampling, etc.) B--Probability sampling techniques (eg. Random sampling methods, etc.) C--Probability sampling techniques with power calculation report.	Not reported—0 Reported (below 60%)—1 Reported (60% plus)—2	0—Not reported 1—Other Methods 2—Single Dietary recall (e.g. 24-hour recall) 3—Food Frequency Questionnaire 4—Repeated/Multiple dietary recalls (e.g. food records, multiple pass recall, etc.)	Not reported—0 Reported only —1 Reported & addressed—2 Reported/ Addressed/ Method used—3	Not reported—0 Report incurate/ with error/ without measures of dispersion—1 Reported accurately (including portion sizes and measures of dispersion)—2		
Adamu et al 2012	2	2	1	0	3	0	1	**9**	**50**
Allain et al 1997	2	2	2	0	3	0	1	**10**	**56**
Anteneh et al 2015	2	2	2	2	0	0	1	**9**	**50**
Åstrøm & Masalu 2001	2	2	2	2	0	0	1	**9**	**50**

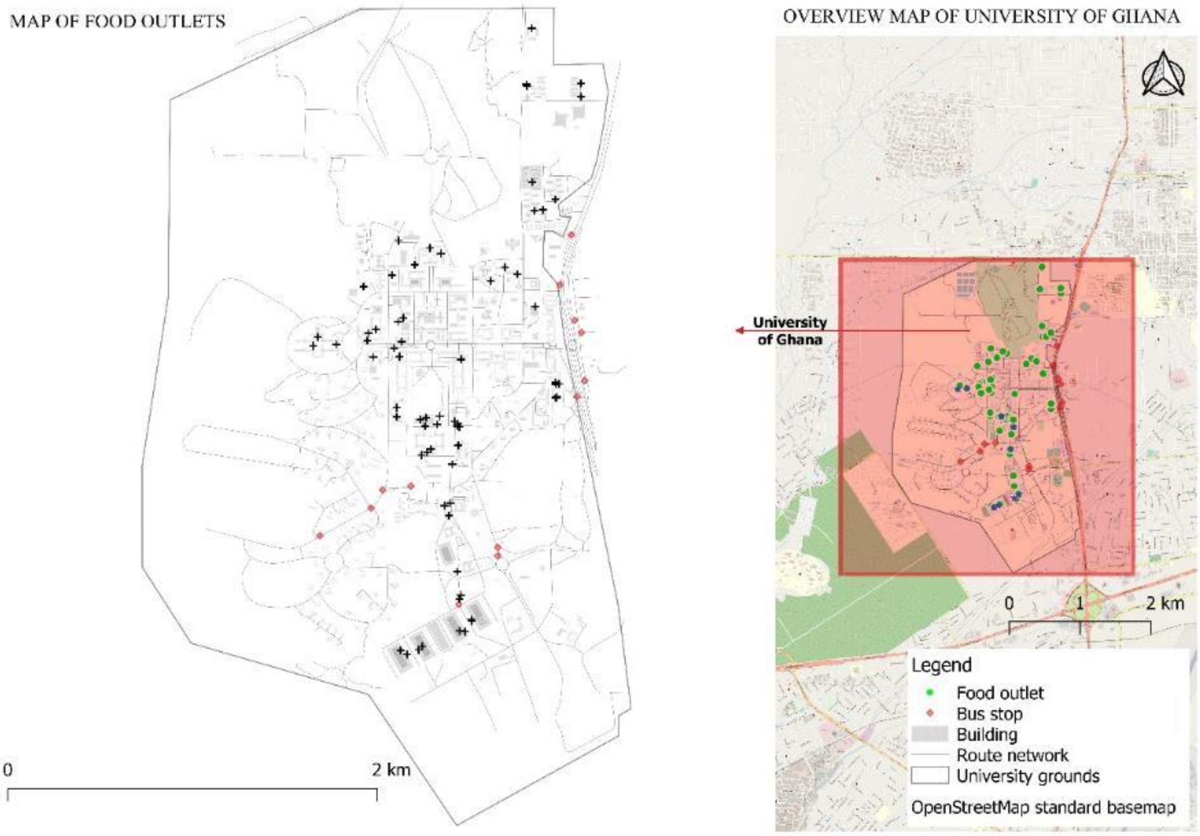
Cardoso, Bovet et al 2013	2	2	2	2	3	0	2	**13**	**72**
Caswell, Talegawkar, Brian, Siamusantu, Klemm, Palmer, Amanda 2015	2	2	2	2	2	0	2	**12**	**67**
Fadupin, Ogunkunle et al 2014	2	2	2	0	3	0	1	**10**	**56**
Feeley & Norris 2014	2	2	2	0	1	0	2	**9**	**50**
Feeley, Coly et al 2016	2	2	2	0	1	0	1	**8**	**44**
Feeley, Musenge et al 2012	2	2	2	0	1	0	1	**8**	**44**
Feeley, Musenge, Pettifor and Norris 2012a	2	2	2	0	3	0	1	**10**	**56**
Ferguson, Chege, Kimiywe et al 2016	2	2	2	2	4	0	1	**13**	**72**
Frank, Kroger et al 2014	2	1	1	0	3	3	2	**12**	**67**
Hallund, Hatloy, Benesi, Thilsted 2008	2	1	2	0	4	0	1	**10**	**56**
Kiwanuka, Astrøm, Trovik, 2006	2	2	2	2	3	0	2	**13**	**72**

Leyvraz, Mizéhoun-Adissoda et al 2018	2	2	1	0	3	0	1	**9**	**50**
Ogunkunle, Oludele et al 2013	2	2	2	0	4	0	1	**11**	**61**
Olatona, Onabanjo et al 2018	2	2	2	2	3	0	1	**12**	**67**
Pries, Huffman et al 2016	2	2	2	0	3	0	1	**10**	**56**
Steyn, Labadarios, Nel 2011	2	2	2	0	2	0	2	**10**	**56**
Van Zyl, Steyn & Marais 2010	2	1	1	2	1	0	1	**8**	**44**
Feeley, Musenge et al. 2016	2	2	2	0	1	0	1	**8**	**44**
Lateef et al	2	1	2	0	3	0	2	**10**	**56**
Becque, Savy et al 2010	2	2	2	0	3	0	2	**11**	**61**
Venter, Winterbach et al 2010	2	1	2	2	1	0	1	**9**	**50**

Appendix 5.1: Typology of food-outlets identified in the University foodscape

Food outlet type	Food store or service place	Description
Convenience store	Food store	Formal structure stocking packaged or ready-to-eat food options together with everyday/ general consumer goods. Usually small-sized and stock limited variety of items. Located closer/within residence of patrons. Open extended hours. One or two staff working at a time. (Maimaiati et al., 2019)
Grocery shop	Food store	Wooden/formal structure that specialised in stocking fresh and packaged food products, and non-food products. Usually stocked a relatively bigger variety.
Fruit store	Food store	Wooden/formal structure that specialises in stocking fresh fruits only.
Supermarket	Food store	Formal structure, specialised in stocking packaged foods, and non-food products. Relatively bigger than a grocery shop and stocks a wider variety. Usually has more than one point-of-sale device/point and a bigger staff size than convenience store.
Organic food shop	Food store	Usually grocery-shop style that specialised in selling only/mainly organic food products.
Traditional sit down	Food service place	Usually operates in wooden structure or open space. Shared wooden or metal benches and tables are usually used, creating an informal (atmosphere) and a local/old-style set up—commonly called the 'Chop-bar' style. Plastic tables and chairs are becoming more common. This encourages eating at the premises. Food was served in plastic and/or earthenware bowls. Usually served soupy dishes like fufu, banku, kokonte, TZ and occasionally some rice or yam dishes.
Standard sit-down restaurant	Food service place	Operated in formal structures with formal/ semi-formal set-up and seating with chefs and smartly dressed waiters. Table number system, receipt/invoicing system were used. Served a combination of select local and continental dishes using ceramic plates, cutlery sets. Offered take-away packing option at customers' request.
Take-out restaurant/fastfood	Food service place	Formal/semi-formal enclosed structure and/or counter, specialises in food prepared to be taken away for consumption elsewhere than at the premises.
khebab stand	Food service place	Kiosks, other wooden/metallic structure, stand-alone barbeque grill specialising in preparing khebab or other grilled meat. Usually operated extended hours.
Drinking bar	Food service place	Formal/semi-formal permanent enclosed structure that specialised in selling alcoholic and/or non-alcoholic (carbonated/sweetened) drinks with seating for drinking at the premises. Usually operated extended hours.
Fruit juice stand	Food service place	Temporary or permanent structure that prepared 100% natural fruit/vegetable juices or smoothies.
Snack bar/Ice-cream shop	Food service place	Permanent structure that specialised in selling ice creams and/or other (mostly frozen) snacks only.
Table-top	Both	Outlets operating from tables or table-like non-permanent structures mostly selling salted/sweetened snacks, carbonated/sugar-sweetened beverages/other confectionery, and bread with egg (omelette).
Food court	Both	Wet-market style food outlets having three or more different vendors with each offering different types of foods.

Appendix 5.2: Map of the university community food environment



Appendix 6.1: University of Warwick BSREC ethical approval

WARWICK
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Biomedical and Scientific Research Ethics Committee
Kirby Corner Road
Coventry
CV4 8UW

Monday, 02 September 2019

Mr Daniel Mensah
WMS
University of Warwick
Coventry
CV4 7AL

Dear Mr Mensah,

Ethical Application Reference: BSREC 115/18-19
Title: Emerging adults' Attitudes and Perceptions towards ultra-processed foods, meat, fruit and vegetable consumption in a university food environment

Thank you for submitting your revisions to the Biomedical and Scientific Research Ethics Committee (BSREC) for consideration. We are pleased to advise you that, under the authority delegated to us by the University of Warwick Research Governance and Ethics Committee, **full approval for your project is hereby granted.**

Before conducting your research it is strongly recommended that you complete the on-line Research Integrity training:
www.warwick.ac.uk/ritraining. Support is available from the BSREC Secretary.

In undertaking your study, you are required to comply with the University of Warwick's Research Code of Practice:
https://warwick.ac.uk/services/ris/research_integrity/code_of_practice_and_policies/research_code_of_practice/

You are also required to familiarise yourself with the University of Warwick's Code of Practice for the Investigation of Research Misconduct:
https://warwick.ac.uk/services/ris/research_integrity/research_misconduct/codeofpractice_researchmisconduct/

You must ensure that you are compliant with all necessary data protection regulations:
https://warwick.ac.uk/services/idc

Please ensure that evidence of all necessary local permissions is provided to BSREC prior to commencing your study.

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Please also be aware that BSREC grants **ethical approval** for studies. The seeking and obtaining of all other necessary approvals is the responsibility of the investigator.

Any substantial changes to any aspect of the project will require further review by the Committee and the PI is required to notify the Committee as early as possible should they wish to make any such changes. The BSREC Secretary should be notified of any minor amendments to the study.

May I take this opportunity to wish you the very best of luck with this study.

Yours sincerely

pp.

Dr David Ellard
Chair, Biomedical and Scientific Research Ethics Committee

www.warwick.ac.uk

Appendix 6.2: Local ethical approval from the EPRC

UNIVERSITY OF GHANA
COLLEGE OF HEALTH SCIENCES

ETHICAL AND PROTOCOL REVIEW COMMITTEE

Ref. No EPRC/NOV/2019............ November 20, 2019

Mr. Daniel Opoku Mensah
Division of Health Sciences Warwick
Medical School University of Warwick
CV4 7AL,
Coventry, UK.

ETHICAL CLEARANCE

Protocol Identification Number: ***CHS-Et/M2 – 4.12/2019-2020***

FWA: 000185779 **IORG: 0005170** **IRB: 00006220**

The College of Health Sciences Ethical and Protocol Review Committee (EPRC) at its 31 October, 2019 full board meeting reviewed and approved your research protocol.

Title of Protocol: "Emerging Adults' Attitudes and Perceptions towards Ultra-processed Foods, Meat, Fruits and vegetable Consumption in a University Food Environment"

Principal Investigator: **Mr. Daniel Opoku Mensah**

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

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

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

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

This ethical clearance is valid till November 21, 2021.

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

Signed: ....

Professor Andrew Anthony Adjei
Chair, Ethical and Protocol Review Committee

cc: Provost, CHS
Dean, Warwick
Head, Health Sciences Warwick

• P. O. Box KB 52, Korle Bu, Accra, Ghana. **Telephone:** +233 (0) 302 665103/4 • **Fax:** +233 (0) 302 660762
• **Email:** admin.chs@ug.edu.gh /provost.chs@ug.edu.gh • **Website:** www.chs.ug.edu.gh

Appendix 6.3: Advertising flyer for focus group discussions

Appendix 6.4: Recruitment advert for dyadic interviews

Appendix 6.5: Participant information leaflet and Consent form for focus groups

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Participant Information Sheet for Focus Groups with emerging adults

Study Title:	**Emerging adults' Attitudes and Perceptions towards Ultra-processed foods, Meat, Fruit and Vegetable consumption in a university food environment.**
Principal Investigator:	**Mr Daniel Mensah**, Health Sciences Division, Warwick Medical School, University of Warwick, CV4 7AL, Coventry, United Kingdom. E: *d.mensah.2@warwick.ac.uk* T: +233244709597.

General Information about the Research

Introduction

You are invited to take part in a research study. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take the time to read the following information carefully. Talk to others about the study if you wish.

Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Who is organising and funding the study?

I am conducting this study as part of my PhD research at the Health Sciences Division of the Warwick Medical School, University of Warwick, UK. This project is part funded by University of Warwick Chancellor's International Studentship.

What is the study about?

The types of food we decide to eat affect our personal health and impacts the environment. Recent analyses suggest that changing diets in sub-Saharan Africa and other developing countries will offer the largest absolute health and environmental benefits. The aim of this research is to gather information on how to improve the university food environment to support students make better decisions about food.

What would taking part involve?

1. We would like to ask you and other university students about food choice and the university food environment.

1

2. This will be achieved through group discussions with eight sets of university students on the university campus.
3. We anticipate the eight (8) groups of students will each comprise 6 to 8 students from the College of Health, College of Education, College of Basic & Applied Sciences, or College of Humanities.
4. You will be asked to provide written informed consent to participate and complete a one-page questionnaire on your personal details (age, gender, hall/hostel of residence, etc.). We will also measure your height and weight.
5. We will liaise with you regarding the date, time and venue for the group discussions, so this can be held at a time that is convenient for everyone.
6. The group discussions will last no more than 90 minutes and the discussion will be tape recorded. Notes will also be taken during the discussion.

Voluntary Participation

Do I have to take part?

It is entirely up to you to decide. Participation in this study is completely voluntary and choosing not to take part will not affect you in any way. Should you decide to participate, you can choose to withdraw your participation at any time, without giving a reason by contacting the researcher. Further details about withdrawing from the study are provided later on in this document.

Possible Risks and Benefits

What are the possible benefits of taking part in this study?

1. You might learn something new about healthy and sustainable food.
2. You'll learn more about health research.
3. You will have the chance to say what you think about the topic, and get to practice and develop your communication skills.
4. The study may inform the design of future interventions which would benefit you directly or indirectly.

What are the possible disadvantages, side effects or risks, of taking part in this study?
There are no physical harms associated with this study. You will have to take time out of your day to take part which could have been spent resting or on academic work.

Confidentiality

Will my taking part be kept confidential?

Yes. Your participation will remain strictly confidential. Your responses to the questionnaire will be typed into Excel spreadsheet and saved on a password protected computer, after which the paper forms will be destroyed. Group discussions will be held in safe spaces that ensure privacy and prevent non-participants from eavesdropping on any personal information. As part of ground rules for the group discussion, you and other participants will be cautioned not to disclose any personal and sensitive information discussed during the group discussion to anyone outside the group. We will audio record the discussion and also take notes during the discussion. We will transcribe the audio recording with the assistance of a third party transcription service. All names and any identifiable data will be removed from the transcriptions and replaced with unique ID numbers. This is called anonymised data. After this the audio recording will be deleted. Only the researcher, the third party transcription service and primary supervisor will have access to data including your name. Your name will not be used in any report or publication. All other individuals involved in the project, including other project supervisors at the University of Warwick in UK will have access to only anonymised data. Anonymised data will be kept securely for 10 years on University of Warwick server and may be shared with other trustworthy researchers who may request to use this data. All hard copies of data including signed consent forms will be stored securely in locked filing cabinets for 10 years, after which they will be destroyed.

Compensation

Refreshments will be provided for participants during the group discussions and participants will also be compensated with airtime vouchers and pens. Participants will also have the chance to win one of three £20 shopping vouchers or cash prizes.

Additional Cost

Expenses and payments: There will be no additional cost to you.

Right to leave the Research

What will happen if I don't want to carry on being part of the study?

You can decide to withdraw at any point of the study by informing the researcher. You would not have to give any reason and your decision to withdraw will not affect you in any way. If you decide to withdraw before the start of the focus groups, all data relating to you (provided through demographic questionnaire) will be destroyed.
If you want to withdraw during the discussion, simply inform the researcher and you are free to leave. You may contact the researcher on the contact details provided below if you wish to withdraw after the discussion. Your data will be deleted from the transcriptions should you withdraw during or after the discussion. If you decide to withdraw after the research has been published, we can only remove your data from the transcripts, so it is not used in any future research, but not from the published findings.

Please refer to the University of Warwick Research Privacy Notice which is available here: *https://warwick.ac.uk/services/idc/dataprotection/privacynotices/researchprivacynotice* or by contacting the Information and Data Compliance Team at *GDPR@warwick.ac.uk*.

What will happen to the results of the study?

The results and findings of the research along with recommendations will be put together in a technical report to constitute part of the researcher's PhD thesis. The key findings and recommendations will inform local interventions that may be replicated in other SSA countries. The results will also form the basis of the subsequent chapter of the researcher's PhD project. The findings will also be published in a scientific journal and may also be presented at conferences and seminars. A copy will also be sent to you should you wish to receive it.

Who has reviewed the study?

This study has been reviewed and given favourable opinion by the:

1. University of Warwick's Biomedical & Scientific Research Ethics Committee (BSREC), **Ethical Application Reference**: **BSREC 115/18-19**; and the
2. Ethical and Protocol Review Committee [EPRC] of the College of Health Sciences, University of Ghana. Reference: XXXXXXXXXX

Who should I contact if I want further information or want to withdraw?

Daniel Mensah (Principal Investigator): Tel: 0503388357 E-mail:
d.mensah.2@warwick.ac.uk **or Oyinlola Oyebode:** *o.r.o.oyebode@warwick.ac.uk or Richmond Aryeetey: raryeetey@ug.edu.gh*

Your rights as a Participant

Participation in this study is voluntary and it is entirely up to you to decide whether to participate or not. It is therefore your right to refuse to participate without giving any reason or explanation. You can also withdraw your participation at any stage or point of the study. Your refusal to participate will not affect you in any way. You have the right to be informed before, during and after the study, including how we collect and use your personal data.

Who should I contact if I wish to make a complaint?

If you have any questions about your rights as a research participant you or any complaint about the way you have been dealt with during the study or any possible harm you might have suffered will be addressed. Please address your questions or complaint to the Ethical and Protocol Review Committee (EPRC) of the College of Health Sciences University of Ghana Office between the hours of 8am-5pm on **+233 [030] 294 0528, +233 [030] 266 5103** or email address: *eprc@chs.edu.gh*.

STATEMENT OF CONSENT/VOLUNTARY AGREEMENT

The above document describing the purpose, benefits, risks and procedures for the research titled "**Emerging adults' Attitudes and Perceptions towards Ultra-processed foods, Meat, Fruit and Vegetable consumption in a university food environment**" has been read and explained to me in detail. I have been allowed to ask any question(s) I have about the research and my question(s) has/have been answered to my satisfaction. I have been told that I may contact the EPRC on **+233 [030] 294 0528, +233 [030] 266 5103** or email address: *eprc@chs.edu.gh* of the EPRC Administrator and **Mr Daniel Mensah (Tel: 0503388357 or E-mail:** *d.mensah.2@warwick.ac.uk*) who is the Principal Investigator if I have questions about my rights as a study participant, to discuss problems, concerns or suggestions related to the research.

I understand that a copy of the information sheet and the informed consent forms will be given to me to take home after it has been signed.

I have read the consent form and agree to participate in this research study voluntarily.

_________________________________ _________________

Signature/Thumb print of Participant Date

_________________________________ _________________

Signature/Thumb print of Obtaining Consent Date

STATEMENT OF WITNESS

I was present while the benefits, risks and procedures were read to the volunteer. All questions were answered and the volunteer has agreed to take part in the research voluntarily.

_________________________________ _________________

Signature/Thumb print of Participant Date

_________________________________ _________________

Signature/Thumb print of Obtaining Consent Date

Appendix 6.7: Participant information leaflet and Consent form for BFPIs

Participant Information Leaflet for duo-interviews with emerging adults

Study Title:	**Emerging adults' Attitudes and Perceptions towards Ultra-processed foods, Meat, Fruit and Vegetable consumption in a university food environment.**
Principal Investigator:	**Mr Daniel Mensah**, Health Sciences Division, Warwick Medical School, University of Warwick, CV4 7AL, Coventry, United Kingdom. E: *d.mensah.2@warwick.ac.uk* T: +233244709597.

General Information about the Research

Introduction

You are invited to take part in a research study. Before you decide, you need to understand why the research is being done and what it would involve for you. Please take the time to read the following information carefully. Talk to others about the study if you wish. Please ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Who is organising and funding the study?

I am conducting this study as part of my PhD research at the Health Sciences Division of the Warwick Medical School, University of Warwick, UK. This project is part funded by University of Warwick Chancellor's International Studentship.

What is the study about?

The types of food we decide to eat affect our personal health and impacts the environment. Recent analyses suggest that changing diets in sub-Saharan Africa and other developing countries will offer the largest absolute health and environmental benefits. The aim of this research is to gather information on how to improve the university food environment to support students make better decisions about food.

1

What would taking part involve?

1. We would like to ask you and your best friend or close friend about food choice and the university food environment.
2. This will be achieved through in-depth interviews with you and your best friend (or close friend) on the university campus at the same time.
3. For the purposes of this study, a best friend (or close friend) will be defined as a person within your own age bracket (18 to 25 years) who you know very well, with whom you meet regularly (at least a couple of times a week), engage in activities with, 'hang out', and/or have fun or 'chill out' with, and with whom you share emotional or difficult moments. This can be someone from the same neighbourhood or the university, and not necessarily from the same college/faculty/department or hall of residence but must be a member of the university community.
4. You will be asked to provide written informed consent to participate and also complete a one-page questionnaire asking about your age, gender, hall/hostel of residence, etc. We will also measure your height and weight.
5. We will liaise with you regarding the date, time and venue for the interview, so this can be held at a time that is convenient for everyone.
6. The interview with you and your best friend pair will last no more than 90 minutes and the interview session will be tape recorded. We will also take notes during the interview.

Voluntary Participation

Do I have to take part?

It is entirely up to you to decide. Participation in this study is completely voluntary and choosing not to take part will not affect you in any way. You can also choose to withdraw your participation at any time, without giving a reason by contacting the researcher. Further details about withdrawing from the study are provided later in this document.

Possible Risks and Benefits

What are the possible benefits of taking part in this study?

1. You might learn something new about healthy and sustainable food.
2. You will learn more about health research.
3. You will have the chance to say what you think about the topic and get to practice and develop your communication skills.
4. The study may inform the design of future interventions which would benefit you directly or indirectly.

What are the possible disadvantages, side effects or risks, of taking part in this study?
There are no physical harms associated with this study. You will have to take time out of your day to take part which could have been spent resting or on academic work.

Will my taking part be kept confidential?

Yes. Your participation will remain strictly confidential. Your responses to the questionnaire will be typed into Excel spreadsheet and saved on a password protected computer, after which the paper forms will be destroyed. The interview will be held in a safe space that ensures privacy. As part of ground rules for the interview, you and your friend will be cautioned not to disclose any personal and sensitive information discussed during the interview to anyone outside the group. We will audio record the interview and also take notes. We will transcribe the audio recording with the assistance of a transcription service. All names and any identifiable data will be removed from the transcriptions and replaced with unique ID numbers. This is called anonymised data. After this the audio recording will be deleted. Only the researcher and first supervisor will have access to data containing your name. Your name will not be used in any report or publication. All other individuals involved in the project including other project supervisors at the University of Warwick in UK will have access to only anonymised data. Anonymised data will be kept securely for 10 years on University of Warwick server and may be shared with other trustworthy researchers who may request to use this data. All hard copies of data including signed consent forms will be stored securely in locked filing cabinets for 10 years, after which they will be destroyed. This is to allow publications to be completed.

Compensation

Refreshments will be provided for participants during the group discussions and participants will also be compensated with airtime vouchers and pens. Participants will also have the chance to win one of three £20 shopping vouchers or cash prizes.

Additional Cost

Expenses and payments: There will be no additional cost to you.

Right to leave the Research

What will happen if I don't want to carry on being part of the study?

You can decide to withdraw at any point by informing the researcher. You would not have to give any reason and your withdrawal will not affect you in any way. If you decide to withdraw before the start of the interview, all data relating to you (provided through demographic questionnaire) will be deleted.

If you wish to withdraw during the interview, simply inform the researcher and you are free to leave. Contact the researcher on the contact details supplied below if you want to withdraw after the interview has been conducted. Your data will be deleted from the transcriptions if you withdraw during or after the interview. If you decide to withdraw after the findings have been published, we can only remove your data from transcripts, but not from the published report.

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What will happen to the results of the study?

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This study has been reviewed and given favourable opinion by the:

1. University of Warwick's Biomedical & Scientific Research Ethics Committee (BSREC), **Ethical Application Reference**: **BSREC 115/18-19**; and the
2. Ethical and Protocol Review Committee [EPRC] of the College of Health Sciences, University of Ghana. Reference: CHS-Et/M2—4.12/2019-2020

Who should I contact if I want further information?

Daniel Mensah (Principal Investigator): Tel: 0503388357 E-mail:
d.mensah.2@warwick.ac.uk **or** **Oyinlola Oyebode:** *o.r.o.oyebode@warwick.ac.uk or Richmond Aryeetey: raryeetey@ug.edu.gh*

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Thank you for taking the time to read this Participant Information Leaflet

STATEMENT OF CONSENT/VOLUNTARY AGREEMENT

The above document describing the purpose, benefits, risks and procedures for the research titled "**Emerging adults' Attitudes and Perceptions towards Ultra-processed foods, Meat, Fruit and Vegetable consumption in a university food environment**" has been read and explained to me in detail. I have been allowed to ask any question(s) I have about the research and my question(s) has/have been answered to my satisfaction. I have been told that I may contact the EPRC on **+233 [030] 294 0528, +233 [030] 266 5103** or email address: *eprc@chs.edu.gh* of the EPRC Administrator and **Mr Daniel Mensah (Tel: 0503388357 or E-mail:** *d.mensah.2@warwick.ac.uk*) who is the Principal Investigator if I have questions about my rights as a study participant, to discuss problems, concerns or suggestions related to the research.

I understand that a copy of the information sheet and the informed consent forms will be given to me to take home after it has been signed.

I have read the consent form and agree to participate in this research study voluntarily.

____________________________________ ________________________

Signature/Thumb print of Participant Date

____________________________________ ________________________

Signature/Thumb print of Obtaining Consent Date

Appendix 6.8: Demographic questionnaire for qualitative study

WARWICK
THE UNIVERSITY OF WARWICK

DEMOGRAPHIC DETAILS QUESTIONNAIRE

Please answer the following questions in the spaces provided, circle or tick the most appropriate options.

1. Age: ________________________ □ Prefer not to say

2. Are you: (please tick as necessary) □ Male □ Female □ Other □ Prefer not to say

3. What is your height? ________________ □ Prefer not to say

4. What is your weight? ________________ □ Prefer not to say

5a. What is your nationality?

□ Ghanaian
□ Other African
□ Other nationality □ Prefer not to say

5b. If you answered Ghanaian in 5a, please indicate your ethnicity. Skip to Question 6 if not Ghanaian.

□ Akan
□ Ga-Dangme
□ Ewe
□ Guan
□ Gurma
□ Mole-Dagbani
□ Grusi
□ Mande
□ Others
□ Prefer not to say

6. What is your town and district/region of regular residence? __________________ □ Prefer not to say

7. Which religious faith do you belong to?

□ Not religious
□ Christian
□ Pentecostal/Charismatic
□ Protestant
□ Catholic
□ Adventist
□ Other Christian
□ Muslim
□ Traditional
□ Other
□ Prefer not to say

8a. What type of accommodation do you live in during term time?

□ University managed
□ Private hostel
□ Private landlord
□ Living with family/guardian/parents
□ Other: (please describe) ________________________________
□ Prefer not to say

8b. If you live in a University-managed or Private Hotel accommodation, name your hall/hostel of residence:____ □ Prefer not to say

8c. If you live in a Private hostel or rent from a Private landlord, how far is it from main campus in km □ Prefer not to say

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9. What course do you study? ____

10. Which year of your study are you in? __________________________________

11. Are you happy to be contacted in future for research purposes?

□ Yes (Contact details):____ □ No

1

Appendix 6.9: Semi-structured topic guide

WARWICK
THE UNIVERSITY OF WARWICK

FOCUS GROUPS: TOPIC GUIDE (EMERGING ADULTS)

- Welcome participants and explain research rationale
- Invitation of participants to ask questions
- Set ground rules, including reminding participants of their right to withdraw from the interview without any reason
- Seek final assent from participants to commence and to audio-record the discussion

Hello everyone, good day and welcome, I'm [name] and I will be leading the discussion. [Let any other member on the research team introduce themselves]. Would you like to share your names? Let's start by going around the circle and for the tape, have each person introduce themselves.

Thank you for making time to attend. I am conducting this study as part of my PhD research to understand young adults' food attitudes and what young adults consider in their decisions about food choices within a university food environment. The project aims to inform interventions to support emerging adults make healthy and sustainable food choices in a tertiary institution setting. We are interested in talking to you because you are young adults, key members of the university community and you all may have experience of making food choice decisions whiles on the university site that can help enhance our understanding. Your opinions and experiences you share with us will be used to study the factors considered and challenges in making good food choice decisions.

Participation in this study is absolutely voluntary and you are free to leave whenever you feel the need to do so. You would not need to explain or give any reason and your withdrawal will not affect you in any way. The information you provide today will be confidential and all your names and identifiable data will be removed from any data shared with individuals at the University of Warwick and also from any of our reports when they are prepared. This session will be tape recorded.

The findings will be written as part of my PhD thesis, presented at conferences and seminars, and published in a peer-reviewed journal. We will also present the study findings to appropriate University of Ghana authorities and hope that it will improve the food environment and support healthier food behaviour among students.

Before we start, I would like us to agree that one person speaks at a time, so the recorder is able to capture our discussion more clearly. Let us also agree that no confidential information discussed here today will be shared with anyone who is not part of this group. Shall we raise our right hand to show we all agree?

Does anyone have any questions so far about the study?

Should I start the recorder now if there are no questions?

We'd like to start with a general topic which will give us a little bit of background to our discussions today. There are no right or wrong answers and it's your views and experiences we're after.

SECTION 1: FOOD OUTLETS AND EATING HABITS

Campus Food Outlets

1. **What are the sorts of places on campus where food or food products are sold?**
2. **Which do you think are the 6 most popular among students?**
3. **Why do you think students prefer those food outlets?**

Eating Habits

4. **Tell us about your regular or typical routine for eating in any one day during term time.**

Let's use yesterday. Explain what you did from the time you woke up until the time you went to bed and include the times you ate and where you ate.

Prompts (Probe answers using)

- Is this a typical day?
- Why did you decide to eat at [name of eating place]?
- In what ways is this (eating schedules during term time) different or similar to when you are at home?

5. **Describe your typical eating schedule on a weekend [include breakfast, lunch and supper] during term time. How does it differ from during the week?**

   [Use card sorting activities with pre-labelled cards and some blank ones for participants to write any key factors that are absent].

Prompts (Probe answers using)

- What do you normally or typically have for breakfast? For lunch? For dinner?
- What sort of things do you consider in deciding what to eat for breakfast? For lunch? For dinner?
- Which (of the things you consider) are the most important to you and why?

- In what ways is what you normally eat during term time different or similar to what you eat when you are at home?

Food Shopping and Meal Preparation

6. **Tell us about your routine for food shopping and include who typically does the shopping and how you or that person decides what to buy.**

Prompts (Probe answers using)

- Where do you normally shop for food during term time?
- What are the sorts of food items on sale there?
- What are the sorts of foods you prefer to get from outside campus than buy on campus though available onsite? Why do you get those types of food from places outside campus?
- What are the sorts of foods you get from outside the campus because you cannot get them on campus?

7. **Do you typically do your own cooking during term time and how often?**

Prompts (Probe answers using)

- Do you normally prepare your own breakfast? Lunch? Supper?

To those who cook, ask

- What are the kinds of food they normally prepare during term time?
- What motivates them to prepare their own food during term time?

To those who do not cook, ask

- Why do you not prepare your own food during term time?

8. **If you could change anything about food shopping and/or preparing food during term time, what would it be?**

Eating Out

I would like us to use one scene to explore one issue connected with meal preparation and eating out and then I have a few questions to ask which are connected to the scene.

Hand round the scene on paper for participants to read [time?] and read out the scene using appropriate character names for the group

> **EFUA eats from food outlets on campus. EFUA says that her extra-ordinary academic performance is because she is able to make a lot of time for her books by not wasting time to cook. Her friend ABIGAIL is worried about her own poor academic performance. EFUA is advising ABIGAIL to stop cooking her own food and eat out so she makes time for her studies.**

9. **What are your views about this scenario?**

Prompts (Probe answers using)

- How often and where do you eat out when on campus?
- Where on campus do you normally have your breakfast or lunch or dinner during term time?
- What are the sorts of foods on sale there and what do you normally have for breakfast? Lunch? Supper?
- What are the sorts of foods you prefer to get from outside the campus than buy on campus though available onsite? Why do you get those types of food from outside campus?
- What are the sorts of foods you get from outside campus because you cannot get them on campus?

10. What are the things you consider deciding on WHAT and WHERE to eat?

[Use card sorting activity with pre-labelled cards and some blank ones for participants to write any keys factors that are absent].

Campus Food outlets and Food Choice

11. What are your views about the campus food environment in relation to what you or people normally eat?

Prompts (Probe answers using)

- How do you think the campus food environment influences what you normally eat?
- If you could change anything about the campus food environment, what would it be?

SECTION 2: KNOWLEDGE AND ATTITUDE TOWARDS HEALTHY FOODS (MEAT, FRUIT & VEGETABLE)

Now I'd like us to look at healthy diets, healthy eating and emerging adults attitudes towards them. There are no right or wrong answers and it's your genuine views and experiences we're after.

12. What do you think a healthy diet is? OR What do you think constitutes a healthy diet?

[Let participants write down what they think and go round to discuss what they have written as a group]

Prompts (Probe answers using)

For those participants who **mention** fruits and/or vegetables as part of a typical breakfast or lunch or dinner and as healthy, ask the following questions:

- Why do you take fruit and/or vegetable as part of your breakfast/lunch/dinner?
- How much do you take each day?
- How much fruit and vegetable do you think are enough for a day?
- Does anyone know/ heard/read about the WHO recommended daily intakes for fruit and vegetable?

For those participants who **do not include** fruit and/or vegetables as part of a typical breakfast/lunch/dinner but consider them as healthy, ask;

A number of you did not have anything like fruit or vegetables as part of their typical lunch/dinner but consider them part of a healthy meal

- Why did people not have them (fruits and vegetables) as part of things they have for breakfast or lunch or dinner?

Is it because;

- people first consider what will keep them full (satiety)?
- they are expensive?
- people do not find them to be tasty? or
- they are not available, etc.?

Where fruit and/or vegetable was **not mentioned** as part of a healthy diet, ask the following questions;

13. What about fruit and/or vegetable consumption? What are your views about it?

Prompts (Probe answers using)

- Ask why people did not have them (fruits and vegetables) as part of what they consider as healthy diet or things they have for lunch or dinner?

Is it because;

- people first consider what will keep them full (satiety)?
- they are expensive?
- people do not find them to be tasty? or
- they are not available, etc.?

14. **Would you be interested in increasing your daily fruit and vegetable intake and why?**

15. **What would motivate or support you to take fruit and vegetables daily? OR What would motivate or support you to increase your daily fruit and vegetable intake?**

MEAT CONSUMPTION

I'd now like us to think about meat consumption why people may or may not want to cut back on their meat and ASF consumption, so using another scene. There are no right or wrong answers and it's your views and experiences we're after.

Knowledge and Attitude towards Meat consumption

16. **What is/are your favorite meat and animal-source foods (ASF)?**

Prompts
[Let participants give additional examples of meat and ASF]

17. **How much meat do you normally take in a day or week and would you want to increase it?**

Prompts
[Let participants write on sticky notes how much meat they normally take in a day/week and whether they would want to increase it.]
Go round and discuss what factors go into the decision. Ask the following questions:

- What are the sorts of factors you consider in deciding how much meat to eat or how often to eat meat?
- Which of the factors is/are most important to you? *(Use card sorting activities)*

Prompts (Examples of the factors)

- Nutrition/ Health-related (positive/negative)
- Taste
- Status/Prestige
- Weight and Body Image (to gain/to lose)
- Environmental sustainability
- Animal welfare
- Religion/Faith
- Cost

Knowledge and Attitudes towards increasing Meat Consumption

I would like us to use one scene to explore one issue connected with meat and ASF consumption and then I have a few questions to ask which are connected to the scene.
Hand round the scene on paper for participants to read [time?] and read out the scene using appropriate character names for the group

> **ABENA has seen on the news that meat is a good source of protein, iron, vitamins and other micronutrients. This has made ABENA want to eat meat and other animal-source foods or increase the amount of meat she eats daily but ABENA's religious faith does not encourage this.**

18. **What do you think about increasing the amount of meat and ASF you normally eat in a day?**

Prompts (Probe answers using)

- What do you think about [ABENA's] decision/what want [ABENA] wants to do?
- How do you think [ABENA] should go about increasing her meat/ASF intake?
- Would you want to increase the amount of meat and/or ASF you normally take in a day/week?
- What would make you increase the amount of meat and/or ASF you normally eat in a day/week?
- Why would you or would you not increase the amount of meat you normally eat in a day?

Knowledge and attitude towards reducing meat intake

I'd now like us to think a little bit more about meat consumption why people may or may not want to cut back on their meat and ASF consumption, so using another scene:

Hand round the scene on paper for participants to read [if time will allow this] and read out the scene using appropriate character names for the group.

> **[KOFI] has recently read a social media post that reducing the amount of meat you take in a day to less than 70g will make you healthier/live longer and help climate change mitigation. This has made [KOFI] want to reduce the amount of meat and ASF he takes in a day. But HIS SISTER [AMA] says that their parents ate so much meat but are both healthy over-60's and also thinks that KOFI's meat intake alone will not make any difference to the environment. KOFI is therefore rethinking his decision.**

19. **Which views do you share and why?**

Prompts (Probe answers using)

- Do you share his sister's [AMA's] views?
- Do you share KOFI's (newly found) belief: reducing meat/ASF intake?

20. **What do you think about reducing the amount of meat/ASF you take in a day/week?**

Prompts (Probe answers using)

- Are you willing to reduce the amount of meat/ASF you normally eat?
- What factor(s) would make/motivate you to reduce the amount of meat you normally eat?

Attitude towards plant-protein as the alternative to meat and other ASF

21. **What about swapping meat and other ASF with plant protein?**

Finally, I would like us to explore recommendations to reduce consumption of meat and other ASF and replace with plant protein using another scene.

Hand round the scene on paper for participants to read [if time will allow this] and read out the scene using appropriate character names for the group.

> **AMA has just read a FACEBOOK post that says cutting back on meat and other ASF in favour of plant-based protein offers protection against certain diseases, promotes environmental sustainability and food security. She has decided to replace her meat/ASF consumption with plant protein. AMA wants her husband and children to replace meat and ASF with plant protein. But the husband and children are vehemently opposing this. They argue that their meat consumption will not make the earth 'crush'.**

22. **What are your views about AMA's resolve?** Do you share her view about reducing meat and other ASF and replacing with plant protein?

23. **What do you think about the husband and children's view?** Do you share the views of the husband and children?

Prompts (Probe answers using)

- Are you willing to reduce meat and other ASF and replace with plant protein?
- What would motivate or support you most to reduce/replace your meat and other ASF with plant protein?

[Let participants sort FACTOR cards individually and go round to discuss as a group]

We have come to end of this discussion; thank you for taking time to participate in this focus group discussion.

End

Appendix 6.10: Example quotes, environmental level determinants of food outlet choice

Sub theme	Example quotations
The price or affordability of food	"But then if we talk of most popular outlet then I'll say Bush Canteen and Night Market. Because its affordable…" (R3, FGD 2).
Location or proximity of food outlet	"... it depends on... how far the place is from you. Because me personally I'm in Legon Hall and sometimes coming to Night Market will include a little cost, so I just go to Commonwealth Hall or I go to the Legon Hall Canteen and buy food." (R1, FGD 6). "... I would like to get something close… So another thing will be how close is whatever I want to eat to me. So if... I'm hungry or very very hungry, I don't think about eh... Night Market or Bush Canteen. If I can get some table-top something or some snack here or if I can go to the dining hall and then there's food, I'm... I'm good." (R1, FGD 5). "Where to buy the food. I think some come from what I wrote: proximity…timing and proximity I think are the first things I consider. Then maybe the cost too will come. So I don't like to... I am at the Diaspora Hall and if is in the afternoon I wouldn't walk all the way to Night Market for food. I'll rather buy what is available in the hall. Whether I've been eating rice for a long time or what not, once is near the hall or is near me, nothing matters; taste, cost, whatever doesn't matter…" (R3, FGD 3).
Hygiene	"But then the canteen here… their food is expensive because just one scoop of rice is GH¢2.00. But there [N_M_ and Bush Canteen] you can get about three scoops for the same GH¢2.00. But they still come around and I think it's because they have a nice eating area where… you can sit and eat and the flies don't worry you… as much as… Night Market which I've observed and Bush Canteen because sometimes when you are eating there it's flies all over." (R2, FGD 2).
Variety of foods at the food outlet	"I think students also prefer those ones because there are more local foods at the Night Market and Bush Canteen. Because with... the dining halls and the... halls, they don't have the variety in terms of the local food. They just have a few. Maybe the popular ones like the banku and fufu. But the Bush Canteenand the Night Market, you may get... kenkey with pepper, you can get the gari and beans, you can also get... TZ [tuo-zaafi]." (R1, FGD 4).
Hours of operation	"... some even sleep there. So, any time you go there you can get something to buy." (R1, FGD 7).
Food vendor attitude	"The customer service is part… there are three bread and egg joints here... the other woman at G_ is very very rude. She's very very very rude. Any mistake you make, know that she'll sort you out there there… So most of the time I don't like going there. But then V_ and then A_, they are… so affable… So most of the boys like going there... But the other woman, you dare not!" (R3, FGD 2).
The surrounding environment/ atmosphere	"Sometimes too the environment where… you get to sit and eat. Sometimes you go and is chocked or sometimes it's like too open. If you're eating everybody will be watching you…. But for some places is quite enclosed…so you can feel free and eat over there. That's why most at times I usually go to Bush Canteen." (R1, BFPI 5).

Appendix 6.11: Example quotes, individual level determinants of food outlet choice

Sub theme	Example quotations
My Budget/ "How much am I willing to spend"	"…mine is cost… you consider… your budget… food at Night Market is cheaper than food at eh… maybe food at the Bush Canteen... So you… you consider maybe if you receive a budget of... let's say 200 cedis a week or in three days I think… you'll prefer going to the Bush Canteen every day to eat. But if you receive a low income, you have to stick to Night Market and those small vendors." (R2, BFPI 3).
What I want to eat	"Yes so… you also consider… and the type of food. So maybe eh… you want to eat fufu… and fufu mostly those at the Bush Canteen eh… yeah Bush Canteen, they're… they're… they're very good and they have a variety of places. But Night Market I think it's only one place that sells it." (R2, BFPI 3).
"We think about the quantity more"	"I vowed never to buy from her because... It got to some point, one day I bought waakye, it was more or less like rice water... From then I just stopped. I just stopped. But… because of the quantity... That one she'll fetch it for you. Ha! Ha! Because of the quantity some people go there..." (R3, FGD 5).
Quality, including taste and freshness	"For me, I... I like buying the vegetable... I'll like to buy the vegetables outside. Because the... those who sell local foods go out to buy it and keep them, if nobody buys it hardens. So... its not fresh most often if you go for them... so if you want to make a very good stew, you need vegetable from outside campus…." (R1, FGD 1). "Uhm... For food items normally, I don't like buying on campus. Yes. One, the cost. Two, some are not fresh. If you want them fresh, you'll not get them fresh to use. So, the cost and then how good it is." (R3, FGD 1).

Appendix 7.1: Example quotes, environmental level barriers to FV consumption

Sub theme	Example quotations
Fruit or vegetables are expensive on campus; 'Healthy is expensive'	"Ok… I think it has to do with cost 'cause there was one time I went to buy eh… onion at Night Market, GH¢1, she gave me one piece. It wasn't big. It was so small. I was like this one if I had gone to Madina Market (a wet market, 2 miles from campus) I would have gotten at least three for GH¢1.00. So I was so shocked…" (R1, FGD 2). "Ok. Foodstuff in... on campus in general is relatively expensive because from the market you can get... a bunch of carrots… for like a reasonable amount… but on campus… one carrot is 1 cedi, which doesn't make sense... But then because... we won't end up using all we just buy what we need here." (R1, BFPI 2). "I think first of all its availability issues too... because I go to... School of Nursing, that's where all my lectures are, and nobody sells fruit there. And I close at 5:30 pm and the routes I take I don't really find anybody selling fruit... Unless there is these other people who sell fruit at Night Market." (R1, FGD 3). "You see, if you go to the Night Market like this to go and buy stuffs, it's expensive compared to the outside market. Sometimes its like they are the only people there…I don't know if you'll get anywhere to buy it but is like monopoly." (R2, FGD 3).
"What is sold at what time"-food outlet opening hours	"… so I feel like it affects my eating habit in the sense that I only eat the popular things or the things that we are used to; the things that they normally available for us to buy. Yes." (R1, BFPI 8). "Is what is available, that's what we eat. We have no choice…. There should be lots of veggies. That is healthy for me. If I see a lot of vegetables, is healthy…." (R1, BFPI 4). "… in the night... late at night, if you want something to buy, maybe there should be food that you could easily digest but that is not what you see on the market. You see fried egg, you see... Indomie; noodles, you see those food that would actually not digest quite fast... you're left with no choice…" (R1, FGD 3).
Lack of storage or refrigeration	"…on campus… fresh… cocoyam leaves; 'kontomire'… is really hard to get it here on campus because they can't keep it. They don't have a separate fridge to keep it… in the market it is brought on a daily basis…because it can last for only two days. That is the farthest… it can go…" (R3, FGD 2).

Appendix 7.2: Example quotes, individual level barriers to FV consumption

Sub theme	Example quotations
Lack of knowledge/ information	"…for an adult I think… to me I think you should…an adult should ehm… take more fruits than vegetables, yes, in a day because we really need it when it comes to healthy living. Fruits really have…a greater percentage in influencing healthy living. So I think when it comes to healthy living the… amount of vegetables you take shouldn't... overshadow the amount of fruits you take." (R2, BFPI 6). "Ok, I think it would depend on first of all like you... do you eat a lot or do you eat… small? If you eat a lot, obviously you need more fruits. But if... you don't eat a lot, you need less. And then... also if you're not feeling well, I think you need to take more fruits than somebody who's feeling strong." (R2, BFPI 1). "Oh ok. Like if I'm eating kenkey, the kenkey is the carbohydrate part and there should be fish, that's the protein part. Then pepper, processed... Is not... is... pepper, I don't... I don't know what it falls under but I think it will be... I don't know. I've forgotten my...my JHS things but ehm... I think kenkey with pepper and fish is a bit balanced..." (R2, BFPI 2).
Value satiety	"I won't buy something that I won't even feel that I've eaten anything." (R3, FGD 7).
Out of sight, out of mind	"… it's not something …that comes to mind. Maybe if I'm walking and I just feel like buying banana I'll just buy it over there. I'll take... But it's not something I usually buy… It's not because of cost... it does not come in mind. Maybe if I'm walking and I see it and feel I like oh ok this banana, let me buy. Then I'll just buy…Yeah…so far as I don't see the thing. I just don't feel like…" (R2, BFPI 5).
Perceptions and misconceptions	"… Is something I'll like to follow but then living in University of Ghana is very very difficult. If you really want to get like a complete nutrition... like nutritious meal, you have to spend a lot…" (R2, FGD 5). "For me fruits and vegetables are for morning and evening. So lunch is like... is a daytime ehm...you're doing...there's like in a day you're doing something busy and you need energy to... to that. And you taking fruits and vegetable in the day, especially in the mor...what I've seen for instance, just going to digest everything across. So if I really want to take lunch and...fruits and vegetables in the afternoon, I will take it before I take my lunch. So that it will not affect my food." (R1, FGD 1).
No conscious effort to eat healthy/ fruit and vegetable.	"Ah! If it was available. Ehm... 'cause I nat... I don't hate them, I just don't like... I can't be bothered, honestly, in you need to go and buy it and then bring it to the room. And then wait till you're eating lunch and then you take an orange or like... I can't be bothered. Like it's not something that I consider when I'm eating…" (R1, BFPI 2).
Mistrust towards source of vegetable	"You see sometimes there is this notion… I don't know whether it's a Ghanaian thing or a student thing or it's a new thing. There's this notion around like certain foods and you don't want to eat it because of maybe how its prepared. So you don't know how it was prepared… Let's say… I like to eat banku 'paa' [a lot]. Let's… let me use banku and you see banku and you will be like oh, I don't want to eat outside okro. I don't want outside soup. I don't know how they prepared it. But then if it is rice, its rice. Like even though maybe they prepared it some type of way, in your head its just rice..." (R1, BFPI 8). "… I… I don't trust the salad, the salad creams I… I don't trust that much. Because like… with… with salad the… you have to take very good care. So with salad I don't… I don't normally like salad… buy salad… those salads. I'll either take macaroni or spaghetti….Eh! Working on salad needs patience and you have to sort out the good ones from the bad ones, the rotten ones so… and I think those selling because is in bulk, they don't really get much time to concentrate on it. They just take, wash it once, twice and that's it. They just cut. And I don't normally trust… I don't buy salads." (R2, BFPI 3).
Sensory aversion/ Dislike for fruit or vegetables	"Ha! Ok, I'm one person appearance and look is not natural to me. There are some things I've seen people eating it or seeing it is nasty. Ha! I don't wanna eat it so...Apple, I'm ok. Things that uhm...can look nice: apple, like ehm...grapes, I don't like it but I can try one. Ehm...watermelon, I can settle. The rest, tsk, tsk, tsk. [The sight of] People eating it, I don't like it…Orange. Urgh! I dislike the taste, the smell, the... it has this strong smell…pineapple and those thorns on it, argh!" (R1, BFPI 4).

Appendix 7.3: Example quotes, environmental level facilitators to FV consumption

Sub theme	Selected quotations
Affordability/ Price per quantity of fruit and vegetable	"… the price and the quantity they sell it if I'm being completely honest. Ha! Ha! At first, I said if like you increase my income then I'll buy more fruit right? Thinking about it and knowing myself, if you increase my income and then knowing that like... I will still not purchase more fruits. I'll still go in for higher quantity of the other food that will give me higher satisfaction. But if my income is increased and at the same time, even if they don't increase the price of the fruit but they increase the quantity per price, maybe I'll buy more fruits." (R6, FGD 1).
Advertising and visual prompts	"And I also think visibility is essential. If I don't normally see some. Like you're walking and you see them selling fruits, maybe it will attract you to buy or it will prompt you. But… but if you don't see some at all, it's off your head." (R1, BFPI 3).

Appendix 7.4: Example quotes, social level facilitators to FV consumption

Sub theme	Selected quotations
The home environment and significant others	"..for me, I take more protein and more fruits when I'm at home. The reason being that I farm. Yes, I own an animal farm; some chicken and eh... sheep. And what happens is when... when I come to school, see, because of the long stay on campus, by the time I get home, they're a lot; they've reproduced…So when I'm at home, I take more protein food and more fruits because I also grow some fruits. I grow pawpaw, I grow mango, I grow oranges." (R4, FGD 4).
Peer influence	"Ok. Maybe when he's (best friend, Respondent 1) going to buy the fruit, he can just call me that Respondent 2, I'm going to buy fruits. Ha! Ha! Ha! Let's go and get some fruits then... that one I will just go and buy. But if I'm there it doesn't even come in mind at all." (R2, BFPI 5).

Appendix 7.5: Example quotes, individual level facilitators to FV consumption

Sub theme	Example quotations
Health or Nutrition knowledge and education	"...I don't usually eat healthy.... But like there are days I call feasting, where I have everything I want and everything… I'm a nursing student so I know the four-star diet. So, there are days I try to achieve that. So, I have food with carbohydrate, protein, fruit and vegetables and food that I know contain particular supplement." (R1, FGD 3).
'When I'm sick'	"…I get cold more often... a lot than normal and I can't be taking antibiotics every time because of the immune system. So I rely on fruits when I have cold. It is when I have cold that I take fruits with my food...when I'm on campus." (R6, FGD 1).

Appendix 7.6: Example quotes, facilitators to ultra-processed foods consumption

Sub theme	Example quotations
Convenience and the time factor	"Sometimes maybe I'll take lunch and I won't even take heavy for supper or sometimes I'll take, depending on what I'm doing; how busy I am that day. But I'll take snack, like a lot of snacks. Like the malt, like the drinks, like soda..." (R4, FGD 5). "And…some [students] too from the beginning of the semester they won't learn till its examination time. Then everything will be piled up. That also counts. " (R2, FGD3). "…I'm thinking…as typical nursing students that ehm...even time management doesn't work for them because of their course work." (R1 FGD 3).
Availability, campus lifestyle, and campus norms	"Its what is available, that's what we eat. We have no choice." (R1, BFPI 4). "During weekdays, I don't eat in the morning, then I go to school. At my school [department], there is this ehm... vendor there. She sells snacks; biscuit and drinks. Mostly I go for Vitamilk and then biscuit; any cream cracker or soda biscuit is fine for me. (R1, FGD 3). "…I'm bad eating in the afternoon and in the evening. So I mostly eat twice a day. But I drink malt every day. I don't know why. I guess its 'cause its all over the place… Like I won't eat but I'll just drink the malt… depending on what I'm doing; how busy I am in a day…I'll take like a lot of snacks…" (R4, FGD 5). "…And one thing I always do is... like once I'm eating I don't know if the right thing I'm doing but I will be taking drink along. Interviewer: What sort of drink? Respondent 3: My Coca-Cola" (R3, FGD 1). "…I really don't have a specific time I go to bed…if I have something doing, I can stay up the whole night; I wouldn't sleep. Or maybe I'll sleep and wake up. I don't know for what reason, but I just wake up and then I sleep again later. While I'm up, I have to eat…I don't know, I get hungry a lot in the night. So most at times I have like drinks, biscuits, or milk in the fridge. When I'm up at night I just take those things." (R2, FGD 4). "…when I wake up, I just do what I have to do. If I have to go to class and everything. And I get hungry later. Like late afternoon... So I'll eat like at 1 or 2 and I don't eat anything again. Then I don't sleep early so maybe around 9 or 10 then I will be feeling hungry or something. So then I'll take a drink..." (R1, BFPI 8).

Appendix 8.1: Example quotes, motivation to increase/reduce meat consumption

Sub theme	Example quotations
'Everything can be bad for your health': Contesting meat-related health concerns.	"…you're a human being and just reducing the meat that you take, is just one factor. And there are a lot of factors that affect the health. And even life itself, it is chance that we are all alive. Anything can happen…" (R1, BFPI 1. Female). "…I don't really care. If it will make me die, I'll eat it and die." (R4, FGD 2. Female). "…At first I really liked meat that has the fatty aspect of it. Yes... I really loved it. It got to a time I realised it wasn't good for me. And it also depends. When you have a health... like as at now, if I have a health condition... and I go to the hospital and doctor says, "Ok. Respondent 2 like you have to stop eating meat from now on." I have no option because is my health." (R2, FGD 3. Female). "If... someone comes to say that if you eat too much meat maybe you'll fall sick or... something is happening... Something like… Bird flu, yeah, then I won't eat it." (R2, BFPI 2). "... if the particular kind of meat that I'm taking... it's been said that... there's a kind of disease, like when Ebola came that people stopped taking bush meat. Yeah. It'll make me stop." (R3, FGD 2, Female). "Oh for me it's eh… because of the dietician. Like she told me that for the red meat and other stuff I shouldn't be taking them. I should take chicken. And [even] the chicken 'koraa' its not the fried one. [But] The cooked [boiled] one." (R2, BFPI 5. Male). "For me what I consider is the fat intake. Yes... I'm someone who likes to check my fat intake. And I'm aware meat gives a lot of fat. Especially pork, the one I like. So that's why I'm moderate about taking meat." (R4, FGD 1. Male).
'Our body is meat and needs meat': Meat as a tool for growth and weight control.	"Yes, I think... when I got this [study advert], I was trying to understand the detail and you know if even I'm ok or not. So, I think I even have to gain a little bit more weight personally. So, for me I may want to increase my meat intake." (R1, FGD 4).
Willingness to stop or reduce meat consumption because of animal welfare.	"Animal welfare: we need…nutrients and they are in the animals… Ha! Ha! Ha! So rather I look at what I'm going to gain from the food. I don't look at… [the animal's welfare] ..." (R1, BFPI 6). "If… I will not eat an animal is not because I care about the animal. Is just because maybe I've not eaten it before so…" (R1, BFPI 8). "Ok, so animal welfare, me when I go out to buy food I don't really buy meat. The only meat I buy is ehm… should I say, chicken? But other types of meat maybe [like] goat… I don't buy those ones. If I don't buy chicken or fish, I buy egg. And that's it. Simply because I don't really know under which conditions… those animals were slaughtered and what type of meat it is." (R2, BFPI 6).
'I'm young and a meat person': Meat as a seal of youthful identity, a source of pleasure and joy.	"Oh, chicken, one: I like the taste. Two: like preparing it isn't that difficult. Sometimes the cow, if you get the meat of an older animal, you prepare it for hours so because of that like I like the chicken." (R1, BFPI 6, Female).

Knowledge and awareness of the environmental impacts of meat production and consumption.	"Yeah...the environment is...very important. Is a factor I consider, like let's say the market. The drainage system is very very poor. When...it rains, the place becomes very messy and then nasty. Then that'll that will take the environment... they should sustain it. The environment should be well kept and sustained. Because if the place is messy, I won't even go there. So like…Sustain the environment." (R1, FGD 5). "Environmental sustainability…When I'm going to buy a food from a place, I really check the environment... 'cause it has to be well kept" (R2, BFPI 7).
Willingness to stop or reduce meat consumption because of environmental reasons.	"Ok, it will be very difficult to reduce. Ha! Ha! Yeah, like very very difficult but I think maybe with me, trying to reduce I will start gradually… but at an immediate effect, I don't think it will work..." (R2, BFPI 1). "… Honestly 'cause... you see there was this video that came... about sausages. I saw they were putting live pigs in a machine. They are alive and the machine will just mill them... it was last year but I think afterwards...just that evening I took sausage. I don't really care… (R4, FGD2).
'Forbidden fruits': Meat and religion	"… 'cause before I will buy something, I need to check whether what I'm buying is haram or halal. Is… it forbidden? Or is…it good for me to eat? So, for instance, if the person is preparing food which is made with pork meat or… dog meat, there is no way I will buy the food. Because it's against my religion." (R2, BFPI 5). "So my priority is religion or faith. Because with my faith we don't take pork… So if… if I'm walking in the market and I see pork, it puts me off. And always when I see pork I look up to the seller. Then I think this is what you're selling? And the… buyers around, always I never pass by. Unless maybe I don't notice it… So religion or faith is the first thing because my faith holds me … of course I'm human. I sin but then there are… some avoidable things [sins] like not eating pork..." (R2, FGD 2).
The 'Meat socialisation'	"…the occasion or the event will determine the quantity of meat that I'll take or when I'll even take the meat because on a normal day its egg. Yes, then once in a while I'll take in fish. So when I go out with my boys, we'll take pork. Yes. And then maybe a bit of chicken wings and then one other alternative." (R5, FGD 1).