DETERMINANTS OF OBESITY IN GHANA

By

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Abstract

Background

There is a limited understanding of factors determining obesity in Sub-Saharan Africa, particularly Ghana. This thesis, therefore, aimed to contribute to knowledge on obesity determinants in Ghana to guide evidence-informed obesity policies.

Methods

Multiple approaches were used in this study. These approaches included a literature review, two stakeholder engagements, a survey, Geospatial Information Systems (GIS) techniques and regression analyses. First, a literature review was conducted to identify literature gaps on determinants of obesity to direct this study. Then, key stakeholders were engaged to prioritise the literature gaps whose exploration was critical for obesity policies in Ghana. After, a multi-stage sampling approach was used to generate a current obesity dataset to address the stakeholder-prioritised research questions. Geospatial Information Systems (GIS) techniques and regression analyses were then conducted to identify single and multi-level determinants of obesity in Ghana. Finally, the stakeholders were engaged again to explore interventions to tackle the identified obesity determinants.

Results

The literature review showed gaps in multi-level determinants of obesity, the interrelationship between obesity and other lifestyle behaviours and the relationship between religion, culture, and obesity. The analysis of these gaps showed that a unit increase in the number of fast-food joints and supermarkets within a shorter radius (2km & 5km) increases the odds of obesity in Ghana. Additionally, being a Muslim (correlation coefficient (r) = 0.45) or Ga (r = 0.39) is associated with a 11% and 9% increased risk of obesity, respectively. Diet and physical activity are also interconnected lifestyle determinants of obesity. These lifestyle factors are determined by factors like sex, income status and perceptions. For example, individuals who perceive obesity as an inherited condition are less likely to consume a healthy diet (r = -0.24 and engage in physical activity (r = -0.29). However, those earning 2,000 Ghana cedis and above are more likely to eat healthily (r = 0.46) and exercise (r = 0.49). Additionally, men are 16% more likely to engage in physical activity and 5% less likely to consume a healthy diet, indicating that the predictors of the lifestyle determinants are comparable but dissimilar in some instances. Finally, the thesis also showed that obesity is prevalent in Ghana (53%), and about 45% of the population are neither physically active nor consume healthy diets.

Conclusion

Obesity is determined by religion, ethnicity, physical activity & diet, and the local food environment. These determinants could be mitigated by a trade-off between awareness campaigns and economic regulations, like taxation and food subsidies. Therefore, the government of Ghana and other relevant agencies should factor in these determinants and interventions when reviewing and implementing obesity policies in Ghana.

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List of Abbreviations

GHS	Ghana Health Service
MOH	Ministry of Health
MOE	Ministry of Education
GIS	Geospatial Information Systems
NCDs	Non-Communicable Diseases
SSA	Sub-Saharan Africa
SDGs	Sustainable Development Goals
NGOs	Non-Governmental Organisations
GBD	Global Burden of Disease
DHS	Demographic and Health Surveys
NOC	Newcastle Ottawa Checklist
AHRQ	Agency for Healthcare Research and Quality (AHRQ)
BMI	Body Mass Index
HIC	High Income Country
LMIC	Low- and Middle-Income Country
EMHB	Ecological Models of Health Behaviour
WHR	Waist to Hip Ratio
AC	Abdominal Circumference
IQR	Interquartile Range
GSS	Ghana Statistical Service
GDHS	Ghana Demographic and Health Survey
FAO	Food and Agriculture Organisation
ME	Marginal Effect
ICC	Intra-class Correlations technique
LR	Likelihood-Ratio
OR	Odds Ratio

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Dedication

I dedicate this thesis to my family.

Thesis' research outputs

- Agyemang, K., Banstola, A., Pokhrel, S., & Anokye, N. (2022). Determinants of Physical Activity and Dietary Habits among Adults in Ghana: A Cross-Sectional Study. *International Journal of Environmental Research and Public Health*, *19*(8), 4671. [IJERPH | Free Full-Text | Determinants of Physical Activity and Dietary Habits among Adults in Ghana: A Cross-Sectional Study | HTML (mdpi.com)]
- Agyemang, K., Pokhrel, S., Victor, C., & Anokye, N. K. (2021). Determinants of Obesity in West Africa: A Systematic Review. *medRxiv*. https://www.medrxiv.org/content/10.1101/2021.04.27.21255462v1.
- Mapping obesogenic related area level indicators to lifestyle behaviors: a GIS analyses. Submitted to the British Academy led Book (To be Published as part of Cambridge-Africa AlPHA international project)
- Presented a paper on the 'Nexus between physical activity and diet in Ghana' at the 2022 International Society for Physical Activity and Health (ISPAH) Conference
- Nominated as a Rising Star in Public Health Research by Frontiers in Health Services.

Chapter 1: Introduction

1.1 Background

Obesity is a global public health concern. The World Health Organization (WHO) has estimated that it affects 500 million people worldwide, with this burden projected to increase to one billion globally by 2030 (Hill et al., 2008; WHO, 2008). In addition, it is a modifiable risk factor for non-communicable diseases (NCDs), such as cardiovascular disease, diabetes (type 2) and various cancers (Hill et al., 2008; Dalal et al., 2011). In 2018, NCDs were responsible for 41 million (71%) of the world's 58 million deaths, with 15 million dying prematurely (between the ages of 30 and 69 years) (WHO, 2018). Low- and middle-income countries, including Africa, bear over 85% of the burden of these premature deaths, resulting in cumulative economic losses of US$7 trillion over the next 15 years and millions of people trapped in poverty (WHO, 2015). Specifically, deaths from NCDs are likely to increase by 27% (about 28 million additional deaths) in Africa and are projected to exceed other deaths combined by 2030 in the region countries (WHO, 2018).

Sub-Saharan Africa (SSA) was minimally affected by the obesity epidemic due to under-nutrition and a significant burden of HIV and tuberculosis (Micklesfield et al., 2013). However, in recent years, the African continent has seen a rapid rise in overweight and obesity prevalence and its associated comorbidities (Ziraba et al., 2009; Mayosi et al., 2009). In addition, Africa is undergoing a rapid epidemiological transition and is growing to be the continent with the highest prevalence of obesity (Micklesfield et al., 2013). These dynamics coupled with the epidemic of NCDs, and their risk factors create an urgent need for evidence-based sustainable actions that could address the obesity epidemic. The agenda of the Sustainable Development Goals (SDGs) 2030 is to make cities inclusive, safe, resilient, healthier, and sustainable through the efforts of governments (e.g., local policymakers) and non-governmental actors (e.g., researchers and NGOs).

In Ghana, four out of ten people are overweight or obese (Ofori-Asenso et al., 2016), and it is projected that about 15.1% of women aged from 15 to 49 years will be obese by 2023 (Dake et al., 2013). A 2003 survey in one rural and two urban communities in Ghana showed a 4.6% and 20.2% crude prevalence of obesity in men and women, respectively (Amoah, 2003). Ten years after this survey, the Global Burden of Disease (GBD) reported a nearly 10% increase in the 2003 prevalence of obesity in men and women adults after surveying nine communities in Ghana (Ng et al., 2014). Similarly, the 2014 Demographic and Health Surveys (DHS) indicated an increasing obesity prevalence in Ghana, especially among women aged fifteen to forty-nine years (DHS, 2015). Furthermore, the findings of a systematic review by Ofori-Asenso et al. (2016) confirmed that the national prevalence of obesity has increased to 17.1%, approximately a 3% increase in the 2015 prevalence (Lartey et al., 2019).

Like many other developing countries, Ghana is currently facing a double burden of infectious and chronic non-communicable diseases, like malaria, obesity, and diabetes, due to rapid urbanisation, globalisation, and urban poverty, resulting in increased morbidity and mortality (Agyei-Mensah & Aikins, 2010). Therefore, obesity prevalence projection, like that from Dake et al. (2013), only suggests an imminent decrease in life expectancy, low productivity, and an overall increased socioeconomic burden in the country. Presently, obesity is recognised as one of the most visible health problems that negatively impact individuals and national resources in Ghana (Ofei, 2005). According to Akowuah & Kobia-Acquah (2020), the increasing rise in obesity prevalence in Ghana is of worrying concern because it has severe implications on the health and productivity of the country.

The Ghana Health Service (GHS) and the Ministry of Health (MOH)-Ghana, recognising the national burden of obesity and its related NCDs, developed two main policy guidelines to address the menace comprehensively. The policies are the *National Nutrition Policy for Ghana* and *the National Policy for the Prevention and Control of Chronic Non-Communicable Diseases (NCDs) in Ghana.* (Kenkhuis, 2016; Ministry of Health, 2012). The overarching objective of these policies, developed in 2013 and 2012, respectively, was to reduce the burden of NCDs to the barest minimum to alleviate its socioeconomic impact. Despite these pragmatic policies by GHS and MOH, the obesity prevalence in Ghana continues to rise (Elvis et al., 2018). A case in point is the findings of the study by Amugsi et al. (2017) that showed a threefold increase in the prevalence of obesity in Ghana over the last decade. Furthermore, evidence from Lartey et al. (2019), Amugsi et al. (2017) and Asenso et al. (2016) show that the obesity policies in Ghana are, to a large extent, inefficient, and this may probably be due to a lack of regular review to ascertain their current relevance.

One explanation for the shortfall of the policies in Ghana is probably its inability to holistically capture the determinants of obesity (Bosu, 2012). Until the determinants of obesity in Ghana are identified through robust research, it may be challenging to develop and implement efficient and comprehensive obesity policies (Antwi et al., 2016). Furthermore, it would be challenging to operationalise a solution without identifying factors contributing to the problem. To date, there is limited evidence on the determinants of obesity in Ghana, as most of the studies are dated (Atuahene et al., 2017). Hence, there is an unmet demand for current and robust studies on determinants of obesity in Ghana that require urgent attention. The findings from such studies could advance knowledge on obesity and inform related context-specific interventions. Additionally, it would provide the foundation for future empirical studies. As such, this thesis aimed to examine the determinants of obesity in Ghana.

1.2 Research problem and aim

The sustained increase in obesity prevalence in Ghana has been associated with several bottlenecks in implementing and enforcing obesity policies. These bottlenecks include low funding, little political interest, low community sensitisation, high cost of structured screening and inefficient program management at national, regional and district levels (Bosu, 2012). Additionally, the policies are usually non-functional because they focus primarily on obesity as a risk factor and not a chronic disease (Rosen, 2014; Bosu, 2012). Also, they are usually limited in proffering comprehensive obesity interventions because of inadequate capturing of the determinants of obesity.

These lapses justify the need for current holistic obesity policies in Ghana, particularly policies that capture stakeholders' opinions and address key obesity determinants. These policies are urgently required, especially as obesity prevalence is increasing steadily in Ghana. Therefore, the overarching aim of the thesis was to contribute to the understanding of determinants of obesity in

Ghana and inform the formulation of comprehensive and evidence-based policies to address the epidemic. The objectives were:

1. To review existing literature on determinants of obesity to identify key research gaps
2. To investigate factors that determine obesity in Ghana.
3. To explore stakeholders' opinion on important interventions to tackle identified determinants of obesity in Ghana.

Several benefits could be generated from this thesis. First, as already indicated, it would provide new evidence to further knowledge and contribute to understanding the determinants of obesity in Ghana at the individual, organisation and community levels. Understanding obesity determinants at these levels is crucial to inform holistic interventions to address the menace, particularly given how these levels interrelate (Thomas et al., 2010). This is because data suggest that tackling the obesity epidemic at only the individual level may be an ineffective approach to direct a decrease in obesity prevalence (Nobles et al., 2021). This is even more evident in practice as obesity has continued to rise steadily despite several individual-level interventions, such as behaviour and lifestyle modifications (Nobles et al., 2021).

Additionally, individual-level interventions are likely to result in stigmatisation and other obesity-related mental issues, and this could reverse successes achieved in addressing the epidemic (MacLean et al., 2009). Similarly, tackling obesity from community levels alone could result in strategies that are incognizant of granular factors or inherent individual characteristics associated with increased odds of obesity (Padez et al., 2019; Sartorius et al., 2015). It may alienate the influence of individual-level factors, as espoused in obesity models/frameworks, and inform lopsided strategies (Cockerham, 2022). Thus, this thesis would aim to capture multi-level determinants of obesity to inform new strategies that could be effective at all population levels.

Second, this thesis's findings could help identify critical interventions whose implementation could reduce the incidence of other NCDs, notably diabetes and heart diseases, associated with obesity. Third, it could reduce the economic burden associated with obesity on individuals and organisations. Further, the findings may set a policy-relevant framework of analysis that considers multifactorial determinants in understanding lifestyle behaviour. Additionally, they could promote the continuous use of multi-level approaches to understand obesity in Ghana, especially given its complex nature.

1.3 Thesis Outline

Figure 1 provides a diagrammatic framework of the thesis, outlining the contents of each chapter, the link between chapters, and the associated contributions to knowledge. This thesis was organised into ten chapters including six empirical chapters. This current chapter introduced the research problem and outlined the specific objectives to address the burden. Chapter 2 reviewed the literature on obesity determinants in West Africa to identify knowledge gaps that this thesis could address. The chapter highlighted the paucity of research on determinants of obesity in Ghana and outlined three specific gaps in the literature: (a) insufficient research on the influence of culture and religion on obesity; (b) lack of studies on the interrelationship between the main arguments of the energy imbalance (i.e., diet and physical activity) that causes obesity; (c) the multi-level determinants of obesity.

Chapter 3 examined the policy relevance of the research gaps identified in chapter 2 and informed the conceptualisation of framework of understanding the area-level determinants of obesity in Ghana through a stakeholder engagement. Chapter 4 sets the scene for the empirical analyses by highlighting the gaps informed by both the literature review and stakeholder engagement that were addressed in the thesis. Chapter 5 addressed a significant gap in the literature, i.e., data unavailability on obesity in Ghana, by conducting the first-ever comprehensive survey on obesity in Ghana. This data formed the source of empirical analysis in chapters 6,7, and 8.

Chapter 6 addressed a second gap in the literature by assessing the relationship between culture, religion on obesity in Ghana. The chapter also examined the potential mediating role of these factors on the other determinants of obesity. This was followed by chapter 7, which analysed the interrelationship between the multiple lifestyle behaviours related to energy balance. Chapter 8 explored the multi-level determinants of obesity by drawing on the data generated in chapter 5 and a GIS-generated area-level variables, expounded in appendix 10. Chapter 9 presented potential policy scenarios to address the obesity determinants identified in chapters 6 to 8 using a stakeholder engagement approach and simulated the likely impact of the proposed interventions. Chapter 10 was the concluding chapter of the thesis.

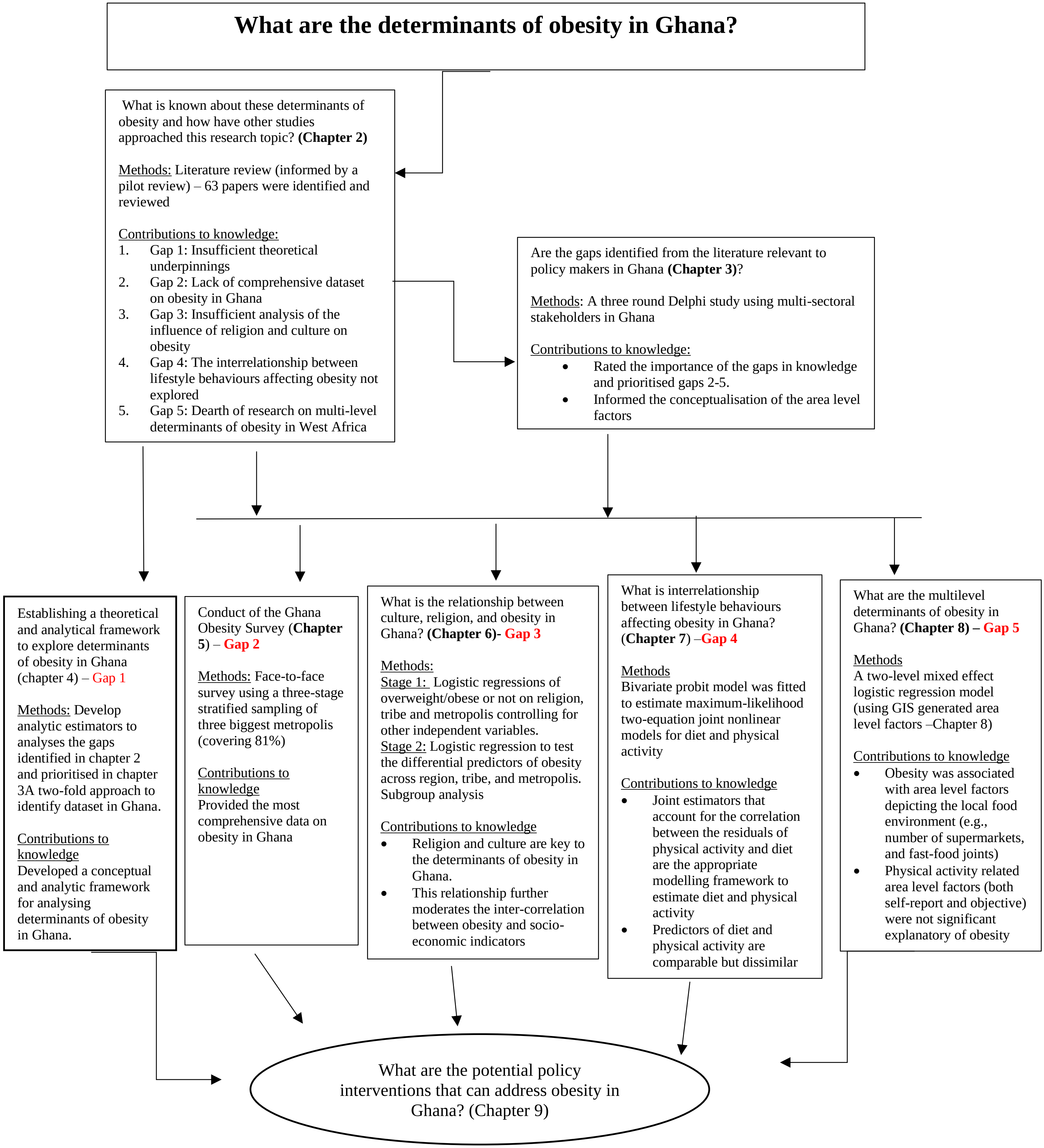


Figure 1: Diagrammatic Representation of Thesis Structure

Chapter 2: Literature Review of the determinants of Obesity in West Africa

2.0 Introduction

A literature review presents a unique approach to synthesising available evidence to inform policy and demonstrate aspects of research areas that require investigation (Synder, 2019). This avoids research built on incorrect assumptions and facilitates incremental additions to the knowledge base. There is an unmet demand for reviews of obesity determinants in West Africa. A scoping review conducted, as part of this thesis, in February 2020 found no comprehensive literature review on the determinants of obesity in the general population in West Africa. The few relevant reviews found were age/gender-specific or restrictive to specific domains of determinants.

Therefore, this chapter aimed to address this gap in the literature by reviewing obesity determinants in West Africa, the specifications of these determinants in practice; available data sources; the theoretical models underpinning this research area. It also aimed to identify gaps in current determinants of obesity research in West Africa to provide recommendations for future studies. The choice of study setting reflected the scope of the thesis as it seeks to contribute to policy formulation on obesity in Ghana, a West African country.

2.1 Methods

The methods provide an overview of the search strategy, the process for selecting and reviewing the relevant papers.

2.1.1 Search strategy

To inform the methods of this literature review, a pilot review was conducted in February 2020 using SCOPUS (the largest bibliography data base). Appendix 1 provides details of this pilot review. In line with the findings of this pilot review, a literature search was conducted in March to April 2020 using three electronic data bases (Scopus, web of science and PsycINFO). In addition, references of selected papers were screened for relevant studies and recommendations from authors sought as appropriate. The search terms applied in the databases are described in Table 1. To keep abreast with literature, search alerts were activated where possible in the databases.

Table 1: Search terms

Constructs	**Search terms**
Obesity	*obesity* OR BMI OR "*body mass index" OR* overweight OR "*weight gain" OR* "*body weight changes"*
Determinants	*determinan** OR facto* OR correlat* OR contributors
Setting*	*africa* OR *algeria* 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 *"Congo Democratic Republic"* OR *drc* OR *"Côte d'Ivoire"* OR *djibouti* OR *"Equatorial Guinea"* OR *eritrea* OR *ethiopia* OR *egypt* OR *gabon* OR *gambia* OR *ghana* OR *guinea* OR *guinea-bissau* OR *kenya* OR *lesotho* OR *libya* OR *liberia* OR *madagascar* OR *morocco* OR *malawi* OR *mali* OR *mauritania* OR *mauritius* OR *mozam bique* OR *namibia* OR *niger* OR *nigeria* OR *réunion* OR *rwanda* OR *" Sao Tome and Principe"* OR *senegal* OR *seychelles* OR *"Sierra Leone"* OR *somalia* OR *"South Africa"* OR *sudan* OR *swaziland* OR *tanzania* OR *tunisia* OR *togo* OR *uganda* OR *"Western Sahara"* OR *zambia* OR *Zimbabwe*

* These terms purposively had a broader coverage to get an overarching picture of the literature space prior to focusing on West Africa.

2.1.2 Eligibility Criteria

Papers were selected for full review if they had the following characteristics:

- Examined determinants of obesity.
- Written in the English language given the limited resources for translation.
- Used a sample from a setting in West Africa

All results were screened by titles to remove irrelevant studies and duplications independently by two reviewers. Disagreements were discussed with a third reviewer.

2.1.3 Review questions

Table 2 shows comprehensive review questions used to extract relevant data from the selected studies. The questions are outlined in two themes: general study information and methodology. These questions aimed to provide an understanding of what is known in West Africa on determinants of obesity and direct critical gaps that require exploration. After the researcher had extracted data from the studies, an independent reviewer randomly selected and reviewed 50% of those studies to guarantee data extraction quality. This second layer of review was in line with standard systematic review practice.

Following the data extraction, a quality assessment checklist was included to enable critical appraisal of the identified evidence. Based on the recommendations from a recent systematic review on quality appraisal tools (Zheng et al., 2014), the Newcastle Ottawa Checklist (NOC) was applied to longitudinal studies and Agency for Healthcare Research and Quality (AHRQ) checklist to cross sectional studies. See appendix 2 for the NOC and AHRQ checklists. Later, descriptive synthesis of data was performed to describe the methods, operationalization of methods, major limitations, quality, suggestions, and recommendations for future research.

Table 2: Review questions

Headings	***Review questions***
General Information	1. Authors 2. Year 3. Aim 4. Country
Methodology	5. What are the determinants of obesity? 6. How are these determinants specified in practice? 7. How was data on these determinants collected? 8. What is the dataset used? (If method of data collection is secondary) 9. If primary data, briefly describe method 10. How was obesity specified in practice? 11. Characteristics of sample 12. What was the statistical basis for sample size used? 13. Which sampling method used? 14. What was the type of data analysis used 15. if quantitative analysis, which type of statistical method was used? 16 what was the theoretical underpinning used in the study 17. Which statistical model diagnostics tests were reported?

2.2 Results

A total of 4,085 records were identified from the database searches. After removing duplicates, the titles, and abstracts of 3100 articles were screened for eligibility. A total of 71 articles were selected for paper review leading to 63 articles meeting the inclusion criteria and selected for full review. The selection process is illustrated in Figure 2.

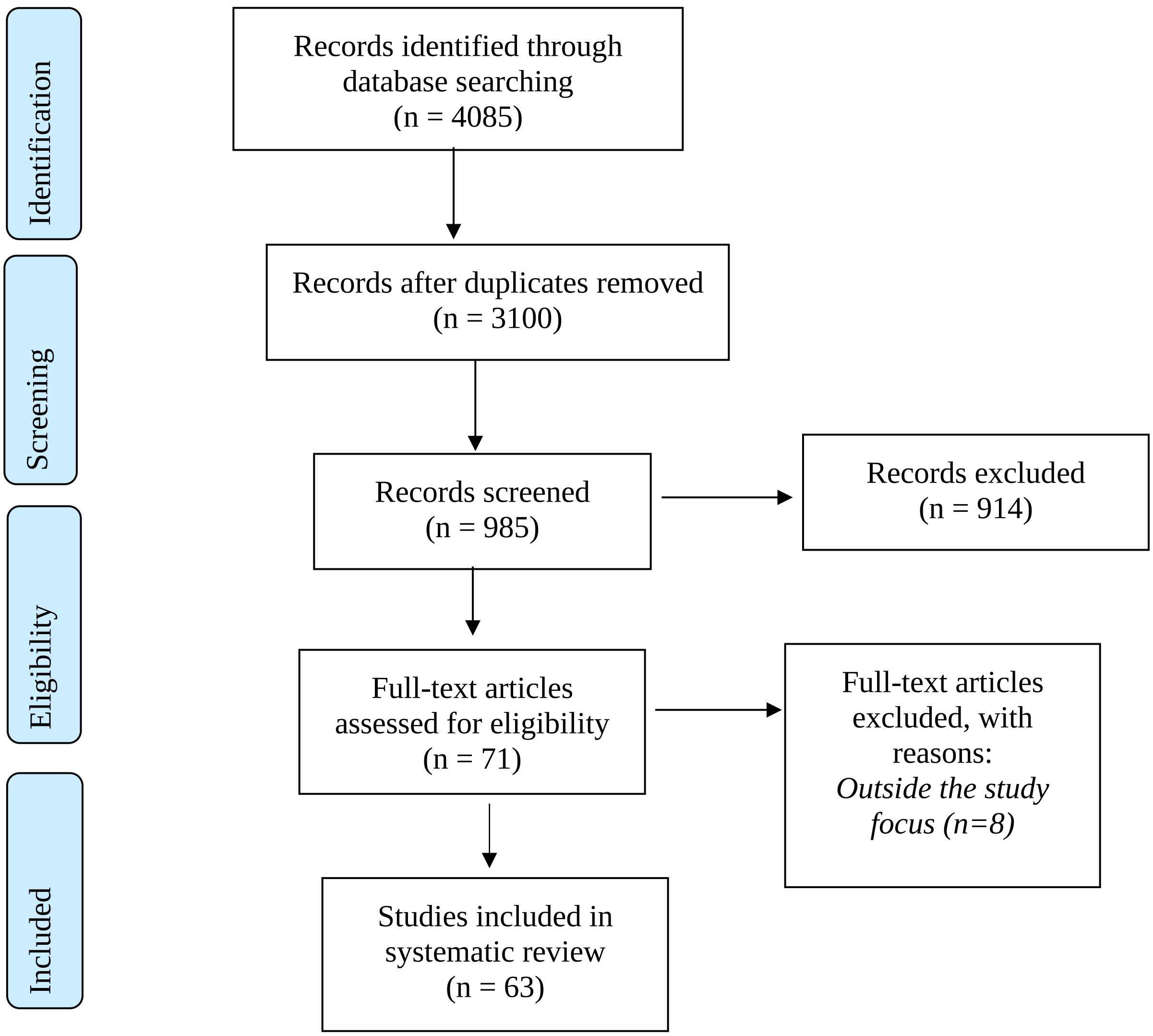
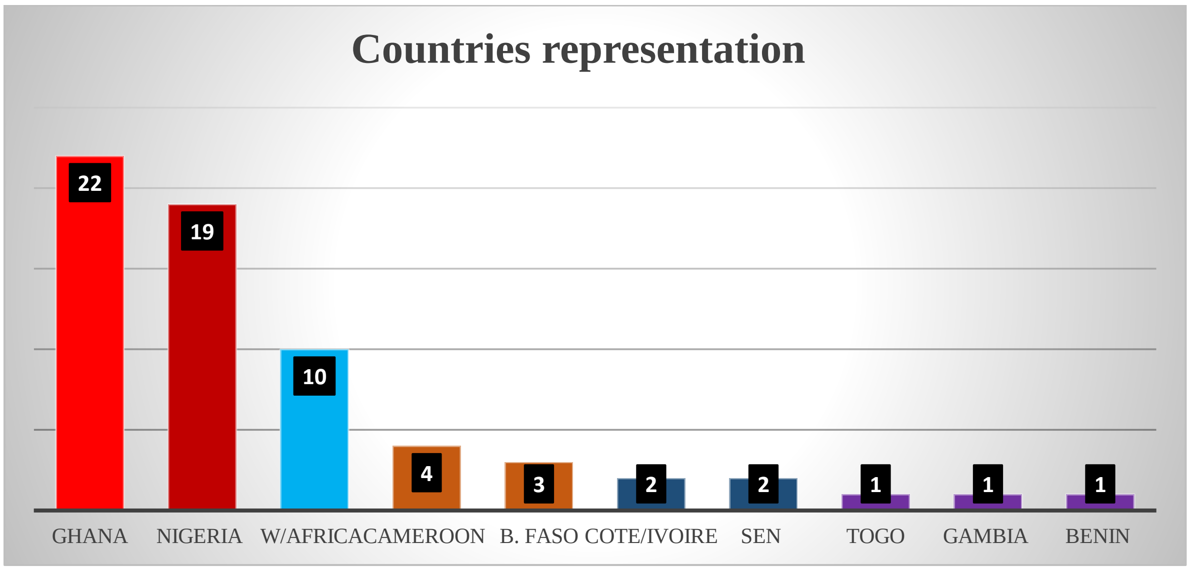


Figure 2: Flowchart for the Selection Process.

PRISMA diagram accessed from: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

The selected papers spanned ten countries. Most of them were conducted in Ghana (n=22), followed by Nigeria (n=19), Combined/West Africa (n=10), Cameroon (n=4), Burkina Faso (n=3), Cote d' Ivoire and Senegal (n=2). Togo, Gambia, and Benin had a study each. All the studies were published between 2003 and 2019, with the majority published in 2016 (n=10) and 2017 (n=10). See figure 3 for the country representation of the studies and appendix 3 for the characteristics of the sixty-three (n = 63) studies.



B. Faso – Burkina Faso, SEN – Senegal

Figure 3: Country representation of the studies

An overview of the broad aims or objectives showed that identified studies focused on seven (7) themes (Box 1).

Box 1: Overview of broad research aims of the studies

1. To identify the prevalence rate of Obesity in sample population. Some studies gave particular attention to the prevalence rate in terms of gender status, particularly among women.
2. To compare obesity determinants and risk factors between rural and urban dwellers.
3. To examine obesity and related risk factors.

4. To examine the association between socio-economic characteristics and obesity
5. To review/ investigate the impact of lifestyle & dietary pattern on obesity
6. To examine the determinants of obesity and in different demographic segment
7. To analyse the association between socio spatial variations and obesity.

2.2.1 Methodological Features

2.2.1.1 Theoretical Models

Three of the sixty-three studies were informed by theoretical/conceptual models. The models were Household Production Model (Abdulai, 2010) and Ecological Models of Health Behaviour (Lartey et al. 2014; Onyeyemi & Adegoke, 2012). According to the studies, the model provided a framework to explain the interactions between their explanatory variables and obesity. For example, the ecological model guided the studies to explain how the conceptual ecological model of the study setting influenced obesity.

2.2.1.2 Study/sample characteristics

All the sixty-three selected papers used cross-sectional studies. With regards to the types of data, the majority used primary data (n=42). The dominant instrument used in collecting the primary data was structured questionnaires (n=28), with sample population ranging from as low as 59 to 6,959. Majority of the structured questionnaires were administered as structured interviews. On the other hand, nineteen (19) studies used secondary data from three major sources, which are further described on table three (3) below. The sample size for the secondary data ranged from 600 to 1,225,816. The reported sample population of the included studies were mostly adults aged 18 years and above. However, one study (Abdulai, 2010), reported the inclusion of children less than 4 years because the focus was on the relationship between obesity among mothers and children. Majority of the studies used simple random sampling approach to select the sample size. Few studies reported the use of simple stratified and quota methods.

Table 3: Description of secondary datasets

Dataset	Description
National Demographic Health Survey 1991-2016	Nationally representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, health, and nutrition.
SAGE Survey	A longitudinal nationally representative household survey with a sample size of over 40,000 respondents selected using a multi-stage cluster design.
National Population census Senegal (Dakar) 2008	Defines a population census as the total process of collecting, compiling, and publishing demographic, economic, and social data pertaining to a specific time to all persons in a country or delimited part of a country

2.2.1.3 Measurement of determinants

The included studies used several variables to explain obesity. The variables have been grouped into two categories namely, individual-level and area-level variables and these are briefly explained below.

2.2.1.3.1 Individual level variables

The types of individual-level variables measured by the studies are detailed below and summarised in appendix 4.

2.2.1.3.1.1 Household amenities / Wealth Index

Household asset ownership was used as a proxy measure for wealth index because in developing countries, it is a better reflection economic status than income. Ten key variables were used to create socio-economic wealth index in the studies: type of latrine, floor, roof, and sidewalls; type of fuel used for cooking; presence in the home of a paid domestic helper, electricity, television set, house phone, and fridge. A scoring method was used to calculate the wealth index based on the presence of these amenities. Continuous scale of relative wealth was then used to categorise the wealth index into five quintiles, poorest, poorer, middle, richer, and richest.

2.2.1.3.1.2 Biological Variables

Hypertension, ABO blood grouping, Rhesus factor, Hypercholesterolemia, hyperuricemia, and Diabetes mellitus were the biological variables identified in the included studies. Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg. Diabetes mellitus was defined as a fasting plasma glucose ≥7 mmol/L. Hypercholesterolemia was defined as blood cholesterol ≥200 mg/dl, and hyperuricemia was defined as excess uric acid (≥420 μmol/L) in human blood. The blood groups were specified based on the ABO classification and Rhesus factor was categorized as either negative or positive.

2.2.1.3.1.3 Demographic Variables

These included gender, age, education, occupation, marital status, and ethnicity.

2.2.1.3.1.4 Smoking Score

Smoking status and number of cigarettes smoked daily. The type of smoking included manufactured cigarette smoking, hand-rolled tobacco smoking, and pipe smoking.

2.2.1.3.1.5 Alcohol consumption score

Alcohol consumption was assessed by questioning the subjects about their habitual drinking patterns. It was self-reported in some studies. Subjects were asked about the average daily number of alcoholic beverages. A standard unit of one drink was used to assist respondents: 1 bottle of beer (33cl), 1 glass of wine (11cl) or 1 shot of distilled spirit (3.5cl).

2.2.1.3.1.6 Physical activity score

Data on physical activity was collected with three 24-hour recalls of activities. A physical activity score was computed taking account of both the intensity (light, moderate or vigorous) and the duration of the physical activity.

2.2.1.3.1.7 Dietary score

Dietary was assessed through three non-consecutive 24-hour food recalls conducted over an average period of one month. The dietary assessment included a *snacking score and modern foods score.* The snacking score assessed the frequency of consumption of foods such as déguè, milk, sweetened drinks, yoghurt, bread, fruits, outside the main meals. The modern foods score, however, focused on the modernity of the type of foods consumed. This included the frequency of consuming scrambled eggs, chicken, tomato sauce, pastas, cheese, meat, sodas, soup, French dressing, and hamburger.

2.2.1.3.1.8 Total globalisation

Total globalisation was measured using the KOF total globalisation indicator, which is an aggregation of three sub-components: Social globalisation, Political globalisation, and Economic globalisation. Total globalisation was then categorized into 4 quartiles: Total globalization quartile 1, Total globalisation quartile 2, Total globalisation quartile 3 and Total globalisation quartile 4.

2.2.1.3.2 Area Level variables

Only 22% (n=14) of the included studies used area level variables. These variables included the following: neighbourhood characteristics, GPS, Urban classes, District and PANES. Table 4 shows the specification of these area-level variables.

Table 4: Area level variables

Variables	**No. of studies**	**Description/Specification**
Neighbourhood	1	Area based primary sampling unit which corresponds to census enumerations area
Urban Classes	2	Upper Middle Lower
Districts	1	Structured Non- structured
GPS	1	Longitude and latitude coordinates from GDHS

Variables	No. of studies	Description/Specification
PANES	2	A 17-item questionnaire that examined environmental related elements such as: residential density pedestrian and bicycling facilities recreational facilities aesthetic qualities social environment street connectivity traffic safety
Region of Existence	1	Ten administrative government areas

2.2.1.4 Measurement of obesity

All the included studies defined Obesity based on the WHO's specifications, i.e., the Body Mass Index (BMI). Body Mass Index is measured by dividing an individual's weight in kilograms by the square of the height in meters (kg/m^2). The WHO BMI specifications are shown in Table 5 below.

Table 5: WHO obesity classification

Specification	BMI measure
Underweight	< 18.5 kg/m^2
Normal weight	18.5–25 kg/m^2
Overweight	25.0–29.9 kg/m^2
Obese	≥ 30.0 kg/m^2

Three of the studies further specified obesity using the obesity classification indicator, i.e., Class I BMI of 30–34.9, Class II BMI of 35–39.9 and Class III BMI of 40 $Kg/m^{2)}$ (Obirikorang et al., 2015, Chukwuonye et al. 2013 and Kolawole et al. 2011). However, they did not indicate the rationale for the additional obesity specification. Other specifications were percentage body fat and abdominal obesity measures (Obirikorang et al., 2015; Sodjinou et al., 2008; Addo and Leon, 2009). The percentage body fat was estimated using the formula: *Adult body fat% = (1.20 × BMI)*

$+ (0.23 \times Age) -(10.8 \times sex) -5.4.$ The cut-offs for the percentage body fat for men and women were 25% and 30%, respectively. Abdominal obesity was also defined as a waist circumference of ≥ 102 cm in men or ≥88 cm in women according to the WHO.

2.2.1.5 Data analysis

All the studies analysed their data at two levels: both descriptive and inferential analysis. Two studies, however, limited their discussions to descriptive analysis. Of those, one (Dake, 2012) complemented its analysis using spatial tools such as "ArcMap and ArcGIS' since the objective of the study was to examine relationships between obesity and spatial location. Generally, regression analyses were used to make inferences from the data analysis. Figure 4 below shows the various regression analyses found in this review.

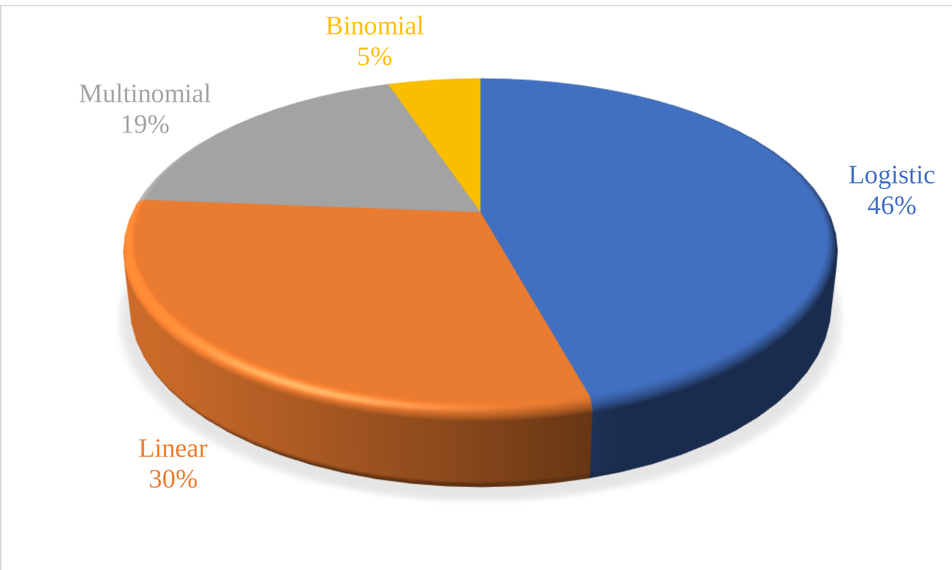


Figure 4: Types of regression analysis

Regarding approach to data analysis, majority of the included studies (n=62) designed their studies from a single-level approach and only 1 study used the multi-level approach (Dake et al., 2016). While single level approaches analyse associations from a single defined perspective, the multi-level approach explores relationships from multiple perspectives. The multi-level approach by Dake et al. (2016) is briefly presented below.

2.2.1.5.1 Multi- Level Approach by Dake et al. (2016)

Dake et al. (2016) examined the characteristics of the local food environment and its influence on residents in an urban poor setting in Accra, Ghana. The analysis was fitted around two levels:

- *Level 1*: This level examined associations between obesity and individual-level variables, such socio-demographic characteristics and lifestyle behaviours.
- *Level 2:* This level assessed association between the food environment and obesity. The analysis included area-level variables like abundance of out-of-home cooked foods, convenience stores, limited fruits and vegetables options, crime, social cohesion, and trust among community members.

2.2.1.5.2 Model Diagnostics

Majority of the included studies (n=60) did not report the use of any regression diagnostic tools. The three studies that assessed the validity of their models used the following diagnostic tools: Hausman-McFadden test, the likelihood-ratio test and Hosmer-Lemeshow test**.** Table 6 describes the identified model diagnostic tools.

Table 6: Description of the identified model diagnostic tools

Test	**Description**
Hausman McFadden	This tool is used to examine assumptions for multinomial logistic models
Likelihood-ratio test	This diagnostic tool assesses the goodness of fit between two models to identify the best model for a particular dataset.
Hosmer-Lemeshow	This is a chi-square test used to examine model fits for logistic regression.

2.2.2 Empirical findings

The main findings of the reviewed studies are summarized in two parts: Individual level determinants of obesity and area level determinants of overweight and obesity.

2.2.2.1 Individual level determinants of obesity

Gender was one of the most measured determinants of obesity in West Africa. Women were found to be significant predictors of obesity compared to men when confounding variables like age, marital status, education level and employment status are controlled. This finding was consistent across ten (10) studies conducted in four different countries: Ghana, Nigeria, Mali, and Burkina Faso. Some studies (n=6) also identified women to be associated with obesity in the presence of some specific variables. For example, Tuoyire et al. (2018) found out that women with television (TV) in their household, and high TV exposure to be significantly associated with obesity (OR=1.39, 95%CI=1.002 – 1.923) compared to those with no TV in their households, and no TV exposure.

Similarly, women in highly organized religious activities were found to be significantly associated with obesity (AOR=1.22, 95%CI=1.03 – 1.47) compared to those in low and medium organized religious activities (Peltzer et al., 2014). Also, married women and those who were living with partners had 2.91 likelihood of being obese (95%CI=2.77 – 3.04) compared to those who had never married (Yaya et al., 2018). In addition, women with higher level of education (OR=0.48, 95%CI=0.32 – 0.72) and higher salary grade levels (OR=4.13) were more likely to be obese than women with no formal education (Doku and Neupane, 2015) and lower salary grade (Olatunbosun et al., 2010). While all these significant associations were positive, Boua (2018) identified women who smoked to be negatively associated with obesity (β= -0.79, 95%CI= -1.2 to -0.37) compared to those who do not smoke.

Some studies (n=11) identified age as a significant correlate of obesity. According to Chigbu et al. (2018), every 1-year increase in age increases the risk of obesity by 1.03 (AOR=2.09, 95%CI=1.02 – 1.04). This was confirmed by Ajayi et al. (2016), who found out that increasing age, particularly from age forty-five years and above was a significant predictor of obesity in Nigeria. Aladeniyi et al. (2017) and Addo et al. (2015) found obesity to be positively influenced by age (AOR=1.4, 95%CI=1.1 – 1.8 and AOR=1.10 95%CI=1.01 – 1.20 respectively) while Boua et al. (2018) found it to be negatively influenced by age (β= -0.09, 95%CI= -0.12 to -0.69). More specifically, individuals from the ages of 30 – 39 (OR=8.02, 95%CI=3.57 – 18.02), 40 – 49 (OR=22.51, 95%CI=8.88 – 57.06) and ≥60 years predicted obesity than those below thirty years (Macia et al., 2010; Maruf & Udoji, 2015). Regarding the influence of marital status and obesity, Yaya et al. (2018), Aldeniyi et al. (2017), Ajayi et al. (2016) and Addo et al. (2015) suggested that obesity is positively influenced by marital status. With a sample size of 1463 participants, Ajayi et al. (2016) concluded that being married increases one's odds of being obese (AOR=4.49, 95%CI= 1.74 – 11.57) compared to being single. They deduced that unhealthy dietary habits, particularly in newlyweds, which is usually informed by cultural expectations, influenced the association that was found between marital status and obesity in the Nigerian participants.

The findings of Damorou et al. (2013) and Tyrovolas et al. (2016) indicated that lack and low levels of physical activity were positively associated with obesity (OR=3.57, 9f%CI=2.34 – 9.67; OR=1.80, 95%CI= 1.23-2.64) while participation in physical activity (OR= -0.34, 95%CI= -0.13 – -0.89), especially, moderate-to-vigorous activity (r= -0.71) were inversely related to obesity (Addo et al., 2015; Luke et al., 2014). Consequently, not meeting the recommended physical activity level is associated with higher odds of obesity (OR=3.23, 95%CI=1.13 – 6.23). Pasquet et al. (2003) and Aladeniyi et al. (2017) also suggested that participation in physical activity significantly reduces obesity levels in adults eighteen years old and above. In terms of dietary consumption, Becquey et al. (2010) identified the intake of modern foods, such as scrambled eggs, pastas, cheese sodas and hamburgers, to be associated with higher prevalence of obesity (OR=1.19, 95%CI=1.03 – 1.36). Obirikorang et al. (2016) also found a similar association between poor dietary habits and obesity. According to them, taking meals at stressful hours significantly predicts obesity (OR=3.33, 95%CI=1.4-8.2)

Nine studies explored the influence of education on obesity. Participants with primary (OR=1.19, 95%CI=0.74 – 1.89) and secondary (OR=1.17, 95%CI=0.86 – 1.59) education had marginally higher odds for obesity than those with tertiary education (Maruf & Udoji, 2015). Similarly, Damorou et al. (2013) found low education level as a significant determinant of obesity (OR=2.45, 95%CI=1.78 – 4.55). However, in contrast, Doku & Neupane (2015) indicated that participants with primary (OR=0.44, 95%CI=0.22 - 0.88) and no education (OR=0.22, 95%CI=0.11- 0.44), particularly in rural residents, were less likely to be obese compared to those with higher education. This finding is consistent with the finding of Pasquet et al. (2003). According to Pasquet et al. (2003), increasing education level predicts obesity (OR=1.9, 95%CI=1.3 – 5.6). In relation to employment/occupation, employed participants, particularly, those high on the employment hierarchy, like executive professionals, were hypothesized by some of the studies (n=3) to have a lesser likelihood of being obese compared to unemployed participants. Nonetheless, the findings of those studies could be surmised to indicate that unemployed participants have about the same odds as executive professionals of being obese (Diendere et al., 2019; Akinyeniju et al., 2016; Akarolo, 2014).

Smoking was also identified as a predictor of obesity (Yaya et al., 2018; Boua et al., 2018; Nonterah et al., 2017; Pasquet et al., 2003). Using a sample size of 771, Pasquet et al. (2003) indicated that smoking practices influence early obesity in adults who are 20 years old and above. The findings of Yaya et al. (2018) and Nonterah et al. (2017), however, contradicts the findings of Pasquet et al. (2003). Yaya et al. (2018) revealed that smoking reduces the risk of obesity (RR=0.78, 95%CI=0.70-0.86) in individuals from the age of 15 to 49 years. Nonterah et al. (2017) confirmed this finding in their study by showing that smoking is associated with lower BMI ($\beta = -0.216$; $p < 0.001$). Besides smoking, alcohol consumption also predicted obesity. Addo et al. (2015) and Aladeniyi et al. (2017) found obesity to be positively influenced by alcohol consumption. Their findings showed that any increase in alcohol consumption per week increases the odds of obesity (OR=3.00, 95%CI=1.35 – 6.68; AOR=0.7, 95%CI= 0.5 – 0.9). But their findings were inconsistent with the findings of Boua et al. (2018) and Nonterah et al. (2017). This is because the findings of Boua et al. (2018) suggested that excessive alcohol consumption decreases BMI by 0.89 (95%CI= -1.54 to -0.24). Similarly, Nonterah et al. (2017) found a 0.02 (p= 0.001) decrease in BMI with excessive alcohol consumption.

Biological factors, like hypertension, hypercholesterolaemia, ABO blood groupings, hyperuricaemia, and diabetes, were also explored as explanatory variables for obesity. The findings of Aladeniyi et al. (2017) study showed that individuals with diabetes mellitus (AOR=0.7, 95%CI=0.5 – 0.9) and hypertension (AOR=0.5, 95%CI=0.4 – 0.6) have significantly higher odds of being obese compared to those who are non-diabetic and non-hypertensive. This finding consistent with the findings of Nuertey et al. (2017). They also found diabetes mellitus (OR=2.25, 95% CI=2.0–3.0) and hypertension (OR=2.6, 95% CI=2.3–2.9) as significant determinants of obesity. Hypercholesterolaemia (OR=2.138, 95%CI=1.109-4.119) and hyperuricaemia

(OR=2.906, 95% CI 1.444-5.847) also significantly determined obesity (Wahab et al., 2011). Other factors that also had a positive influence on obesity are residence, ethnicity, wealth index, pesticide exposure and socio-economic status (SES). While Mbadaa et al. (2009) found men (OR=1.9, 95%CI=1.21-2.59) and women (OR=3.0, 95%CI=2.32-3.68) among lower SES to have significantly higher odds of being obese, Nonterah et al. (2017) found men (β= -0.074) and women (β= -0.109) in this group to have lower odds of obesity.

Finally, two studies found media (Bishwajit & Yaya, 2018) and globalization (Goryakin, 2015) to be significant predictors of obesity. According to Bishwajit & Yaya (2018), watching TV almost every day and at least once a week were associated with, respectively, 2.7 (95%CI =2.432 – 3.037) and 1.5 (95%CI = 1.053 – 1.63) times higher odds of being obese compared with those who never used TV. The findings of Goryakin (2015) showed that the second (r =0.117, p =0.003), third (r =0.147, p =0.003) and fourth (r =0.139, p =0.003) quartile of economic globalization significantly determined overweight in women aged 15 – 49 years from low- and middle-income countries in West Africa, specifically Ghana, Benin, Burkina Faso, Ivory Coast and Guinea. Table 7 summarises the individual level determinants of obesity, as reported by the studies.

Table 7: Individual level determinants of obesity in West Africa

Variable	Variable description	No. of studies reporting sign. with obesity[1]	Range of effect sizes			
			Effect sizes		C.I.	
			Low	high	low	high
Age	Age in years	11(11[+], 0[-])	0.09	24.44	0.12	65.91
Gender (women)	Men or women	11(10[+], 1[-])	1.38	17.91	1.18	55.40
Physical activity (inactive)	Active or inactive	10(10[+], 0[-])	0.34	3.57	0.13	9.67
Education (high)	Level of education attained	9(7[+], 2[-])	0.07	2.70	0.11	5.60
Marital status (married)	Married or not	4(4[+], 0[-])	1.81	4.41	0.96	4.49
Employment status (employed)	Employed or not Employment type	3(3[+], 0[-])	1.27	1.90	0.67	3.60
Alcohol intake	Yes or no	4(2[+], 2[-])	0.02	3.00	0.50	6.68
Smoking	Yes or no	4(2[+], 2[-])	0.22	2.00	0.3	2.50
Residence (urban)	Urban or rural	3(3[+], 0[-])	2.09	2.57	3.25	1.58
SES (lower)	Low, middle, high	3(1[+], 2[-])	0.07	2.4	1.91	2.88
Dietary (poor diet)	Healthy or not	2(2[+])	1.19	2.6	1.03	6.00
Diabetes	Yes or no	2(2[+])	0.7	2.5	0.50	3.00
Hypertension	Yes or no	2(2[+])	0.7	2.6	0.40	2.90

[1]Number of studies that measured significant associations (p-value between 1% and 5%)

C.I: Confidence Interval.

(+) - Positive significant association, (-) - negative significant association.

***** **-** Author did not state CI

2.2.2.2 Area level predictors of obesity in West Africa

Some studies (n=4) measured variables that were specific to the study settings and explored how they determine obesity. For example, Oyeyemi & Adegoke et al. (2012) examined the influence of neighbourhood environmental factors on overweight in 25 to 65 years old residents in Maiduguri, Nigeria. Their findings indicated that adjusting for sociodemographic variables, overweight was associated with distant access to commercial facilities (OR=1.49, 95%CI=1.02-2.18), poor neighbourhood aesthetics (OR=1.58, 95%CI=1.16-2.09), perceiving garbage and offensive odours in the neighbourhood (OR=1.41, 95%CI=1.05-1.89); and feeling unsafe from traffic (OR=1.56, 95% CI=1.17-2.07) and crime at night (OR=1.47, 95%CI=1.13- 1.91).

Significant interactions were also found between overweight and low residential density areas (OR=1.39, 95%CI=1.02-1.93), and poorly maintained pedestrian pathways (OR=1.89, 95%CI=1.13-3.17) among men. In women, overweight was associated with absence of beautiful things (OR, 2.23; 95% CI, 1.42-3.50) and high traffic making it unsafe to walk (OR=2.39, 95%CI=1.49-3.83). Oyeyemi et al. (2013) in a similar study, discovered that walking and total physical activity significantly mediated associations between BMI and perception of higher residential density (αβ= –.025 and –.037, respectively), absence of garbage (αβ= –.046 and –.076, respectively), and more safety from crime at night (αβ = –.044 and –.083, respectively). In addition, walking, moderate to vigorous physical activity, and total physical activity significantly mediated the association between BMI and perception of better aesthetics (αβ= –.035, –.022, and –.071, respectively).

Furthermore, Dake et al. (2016) found out that crime levels in a community positively predicts obesity (β=1.19) while staying in a community for ten years and over negatively predicts obesity (β= -1.73). Additionally, after controlling for lifestyle, socio-demographic, and community characteristics, they also discovered that for every additional convenience store in poor urban settings in Ghana, there is a 0.2kg/m^2 increase in BMI, and for every out-of-home cooked food place available, there is a 0.1kg/m2 reduction in BMI of residents. The findings of Osayomi & Orhiere (2017) were similar to the findings of Dake et al. (2016). Osayomi & Orhiere (2017) identified physical proximity to fast food outlets as a significant driver of spatial pattern of obesity ($\beta = 0.645$). See table 8 for summary of the area predictors of obesity and overweight

Table 8: Area level predictors of obesity in West Africa

Authors	Variables	Effect size	95% CI.
Oyeyemi & Adegoke et al. (2012)	Distant access to commercial facilities	1.49	1.02- 2.18
	Poor neighbourhood aesthetics	1.47	1.16-2.09
	Perceiving garbage and offensive odours	1.58	1.05-1.89
	Feeling unsafe from traffic	1.41	1.17-2.07
	Crime at night	1.56	1.13- 1.91
Oyeyemi et al. (2013)	Walking and residential density	-0.025	*
	Walking and absence of garbage	-0.046	*
	Walking and safety from crime at night	-0.044	*
	Total physical activity and residential density	-0.037	*
	Total physical activity and absence of garbage	-0.076	*
	Total physical activity and safety from crime at night	-0.083	*
Dake et al. (2016)	Crime levels in community	1.19	*
	Length of stay in community (≥10years)	-1.73	*
	Number of convenience stores	0.168	*
	Number of out-of-home cooked foods	-0.075	*
Osayomi & Orhiere (2017)	Physical proximity to fast food outlets	0.645	*

CI - Confidence Interval

*** -** Author did not state CI

2.2.3 Quality appraisal

The Agency for Healthcare Research and Quality (AHRQ) Methodology Checklist was used to appraise the quality of the selected papers because all the papers were cross-sectional studies. The AHRQ checklist has a total score of eleven (11). The scores of the reviewed studies ranged from four (4) to nine (9). Consequently, none of the studies met all the eleven checklists on the AHRQ. The studies (n=2) that scored nine on the checklist faced a common methodological challenge; they did not indicate whether the evaluators of the subjective components of their study were masked to other aspects of the status of the participants (Lartey et al., 2019; Fezeu et al., 2005).

Additionally, Fezeu at al. (2005) did not explain how missing data were handled in their analysis and Lartey et al. (2019) did not describe how confounders were assessed and/or controlled. Some studies (n=31) scored below six on the AHRQ checklist because of methodological limitations like, no explanation on missing data handling/analysis, no summaries on patient response rates and completeness of data collection, limited information on confounders assessment/control, no description on any assessments undertaken to ensure quality assurance of primary outcome measurements used and lack of explanation on any patient exclusions from analysis. Table 9 shows the number of studies that met the AHRQ checklists.

Table 9: Number of studies that met the AHRQ checklists

AHRQ Checklist	**Number of studies (N) that met it**
1) Define the source of information (survey, record review)	61
2) List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	50
3) Indicate time period used for identifying patients	47
4) Indicate whether or not subjects were consecutive if not population-based	44
5) Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants	23
6) Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)	9

AHRQ Checklist	Number of studies (N) that met it
7) Explain any patient exclusions from analysis	17
8) Describe how confounding was assessed and/or controlled.	22
9) If applicable, explain how missing data were handled in the analysis	12
10) Summarize patient response rates and completeness of data collection	31
11) Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained	8

2.2.4 Challenges faced by authors

The most common challenge stated by majority of the authors (n=41) was the inability to determine any causal relationship between explanatory variables and obesity. This was because their study designs were cross-sectional. Cross-sectional study design was also used by the remaining twenty-two (22), authors but they did not state any design related challenges. Other author-stated challenges include lack of external validity of findings (n= 6) and inaccurate measurement of specific explanatory variables like dietary consumption (Boua et al., 2018), estimate of household income (Akinyeniju, 2016), behavioral factors (Doku and Neupane, 2015); and misclassification of neighborhood units (Corsi et al., 2010). Addo et al. (2015) admitted that inadequate technical staff and insufficient funds limited their ability to measure the biochemical indicators of the WHO STEPWISE Approach for Non-Communicable Disease surveillance. As such, their findings did not capture all the possible correlates of obesity.

Corsi et al. (2010) also indicated that the use of BMI to measure obesity was a challenge because it could not provide accurate measure of body fat in participants. The perceived, as opposed to the objective measures of neighbourhood environments in Oyeyemi & Adegoke et al. (2012), limited the findings of their study because there is still limited evidence to show whether perceived measure of neighbourhood environments is more important to overweight and obesity than the objective measure (Boehmer et al., 2007).

2.3 Discussion

The review identified some specific individual and area-level variables as determinants of obesity. These variables included age, gender, social cohesion, and the food environment. Generally, the findings of most of the reviewed papers were in congruence; however, there were methodological limitations that could have implications for further research. This section provided plausible explanations for the review findings and discussed the implication of the observed methodological limitations for research and practice. It further discussed the strength and limitations of this review and its contribution to obesity knowledge. It also compared and discussed the review findings in relation to other systematic reviews on obesity determinants.

2.3.1 What are the determinants of obesity in West Africa?

The determinants of obesity were categorised into demographic, socio-economic, biological, lifestyle and environmental factors, according to the Dahlgren and Whitehead (1993) determinant of health framework. Regarding demographic factors, being a woman and increasing age were the common determinants of obesity. One possible explanation for sex differences in obesity determinants, as offered by Sidhu et al. (2017), is the influence of gonadal steroids on adipose tissue storage and distribution.

Evidence from several studies has fingered the endocrine mechanism as the cause of the different obesity phenotypic expressions across sex (Gambineri & Pelusi, 2019; Novelle & Diéguez, 2019; Insenser et al., 2018). The endocrine pathway predisposes women to have a higher likelihood of becoming obese than men in any given population. Also, natural processes, like menopause, influence sex variations in obesity prevalence. Women are more inclined to undergo hormonal changes, which can affect glucose regulation, during menopause, and this consequently could predispose them to increased risk of obesity (Kozakowski et al., 2017; Al-Safi & Polotsky, 2015). Regardless of these hormonal explanations, evidence also shows that gender, as a social construct, also predisposes to obesity than men (Frank et al., 2009; Afrifa-Anane et al., 2015).

According to Kaczynski et al. (2011) and Frank et al. (2009), women are less likely to engage in physical activities and more likely to consume foods high in added sugars, such as chocolate and ice-cream than men (Wardle et al., 2004). However, they are more likely to report healthy eating practices (Kanter, 2012). Additionally, studies indicate that most West African women settle for more sedentary occupations, like petty and table trading; as such, they remain less physically active and subsequently store more body fat (Afrifa-Anane et al., 2015; Guthold et al., 2010).

Also, data indicates that in most populations, particularly in LMICs, gender-based food preferences, likely to be influenced by one's socio-cultural orientation, exists and these could inadvertently result in gender variations in obesity prevalence preferences are likely (Kanter, 2012; Wansink et al., 2003). Furthermore, studies have shown that most West African communities admire women with large body size (Aryeetey, 2016; Appiah et al., 2014; Benkeser et al., 2012). Thus, most of the women deliberately gain weight to meet these socio-cultural expectations.

The association between increasing age and obesity is also attributed to hormonal/metabolic changes that occur with ageing (Sidhu et al., 2017; Frasca et al., 2017; Jura & Kozak, 2016; Wagenmaker, 2016). According to Jura & Kozak (2016), ageing is associated with metabolic imbalance, which is a significant contributor to obesity. Also, Wagenmaker (2016) indicates that the increase in perivascular adipose tissue associated with ageing influences the risk of obesity among the aged population.

Additionally, ageing is also associated with less physical activities because of musculoskeletal changes, like reduced joint spaces and osteoporosis, that occur with ageing (Vincent at al., 2012). As most developing countries undergo demographic transition, the increasing burden of conditions, like obesity, is expected (Afshar et al., 2015). Also, an increase in life expectancy is usually correlated with increase susceptibility with chronic diseases, like diabetes, that is also associated with obesity (Jura & Kozak, 2016).

Nonetheless, the association between ageing and obesity can go both ways, as obesity can also hasten ageing phenotypic development (Frisbee et al., 2016). These findings on ageing and obesity re-enforce the need for stakeholders to map specific levels of interventions targeted at reducing disease burdens associated with ageing (Fruh, 2017). Apart from this review findings, increasing age is also reported by several studies as the common risk factor for obesity (Chigbu et al., 2018; Ajayi et al., 2016; Wahab et al., 2011).

Physical activity, cigarette smoking, alcohol consumption and dietary intake were the identified lifestyle determinants of obesity. Evidence suggests that increase in the consumption fast foods and other westernised foods rich in sugars account for the obesity epidemic in most LMICs (Patel et al., 2018; Ford et al., 2017; Mitchell & Shaw, 2015). Fast food consumptions are usually associated with increased weight gain, and subsequently and its related morbidities, like diabetes and hypertension (Otang-Mbeng et al., 2017). The association between dietary habits and obesity identified in this review is comparable to findings on obesity and dietary factors from HICs (Burgoine et al., 2018; Fletcher et al., 2018). This indicates obesity prevalence associated with poor dietary habit is now a problem of both HICs and LMICs; thus, effective obesity prevention and control policies in HICs can be adopted and contextualised in LMICs.

In terms of physical activity, Stranges (2019) and Ofori-Asenso et al., (2016) argue that globalisation and its related built environment in most urban settings in LIMCs, like West African countries, has affected transportation systems resulting in decreased physical activities. Physical inactivity is also associated with the nutritional transition, that has seen a shift from foods rich in fibre and grains to foods rich in sugar, salts, and oils (Hawkes, 2018). Sartorius et al. (2015) indicate that work demands have necessitated this shift to meet global standards. Evidence suggests that physical inactivity, nutritional transition, and globalisation are mutually exclusive in determining obesity (Agyei-Mensah & de-Graft Aikens, 2010). The demands for western culture, because of globalisation, influences urbanisation in most west African countries (Kruger et al., 2002). The spill-over is the emergence of the built environment in many urban areas in West Africa to meet population growths (Ofori-Asenso & Garcia, 2016).

The last decade has seen the conversion of most parks and 'available' lands, that hitherto were used for physical exercises, to commercial roads and residential communities, making it difficult for people to engage in physical activities (Ofori-Asenso et al., 2016). Despite the surge in the availability and awareness of fitness centres in most developing countries to compensate for the excesses of the built environment, physical inactivity continues to increase because going to fitness centres has become more aesthetic (Sartorius et al., 2015).

The conflicting finding on the influence of alcohol consumption on obesity is consistent with the literature (Traversy & Chaput, 2015; Sung et al., 2007). Evidence indicates that the biological relationship between alcohol consumption and obesity is complicated, as alcohol consumption intake may affect both energy expenditure and intake (Otang-Mbeng et al., 2017). Furthermore, other factors like the type of alcoholic drinks, volume consumed, and the pattern of drinking can influence the direction of influence of alcohol consumption on obesity (Traversy & Chaput, 2015). Just like alcohol consumption and obesity, cigarette smoking also had differing associations with obesity in this review. This discrepancy was also identified in the literature.

While some studies explain that the nicotine contained in cigarettes has anti-estrogenic effect and may result in high levels of stress hormones, like cortisol, which can trigger obesity (Clair et al., 2011; Tankó et al., 2004), others also suggest that the nicotine rather produces insulin resistance that results in weight loss; thus, smoking cessation instead increases the risk of obesity (Wu et al., 2015; Lakhan & Kirchgessner, 2011; Chiolero et al., 2007). According to Chiolero et al. (2007), cigarette smoking is associated with a lower likelihood of obesity because smoking lowers and decreases the influence of lipoprotein lipase on adipose tissue metabolism.

Education level, employment status and socio-economic status were the identified socio-economic determinants of obesity. Studies by Benkeser et al. (2012), Appiah et al. (2014) and Akinpelu et al. (2015) showed that large body size is usually tied to affluence and social status in West African countries, like Ghana and Nigeria. The systematic review of Ofori-Asenso et al. (2016) corroborated this finding. Therefore, individuals with high education and employment status may tend to gain weight to keep up with the social status that comes with affluence (Ofori-Asenso et al., 2016). Also, wealth usually comes with increased purchasing power, and this inherently increases accessibility to food choices that can be abused (Omari et al., 2013). Also, most fast-food outlets are in affluent neighbourhoods to attract high-earning clienteles to ensure business viability. This creates obesogenic environments that can be a catalyst for obesity (Omari et al., 2013).

Furthermore, the centralised systems of most West African countries put residential areas in city peripheries and work environments in city centres (Agyei-Mensah & de-Graft Aikens, 2010). Thus, most people would have to commute long distances to and from work. Consequently, most workers would stay late at work to beat heavy traffic from the centre to the periphery of cities. These could induce stress and result in late eating, factors that have been implicated in the obesity epidemic (Agyei-Mensah & de-Graft Aikens, 2010). The argument on high education and employment status and obesity can also hold for individuals low on the education and employment strata. For such individuals, their food choices are influenced mainly by their affordability (Ro & Osborn, 2018). In effect, this review has shown that obesity is multifaceted, as opined by Dahlgren and Whitehead (1993), so related interventions or policies must encompass these factors to ensure their feasibility.

2.3.2 Comparison of the review findings to findings of other systematic reviews

The finding of this review is consistent with the review findings of Balhareth et al. (2019), Asenso et al. (2016), Leech et al. (2014), Pearson & Biddle (2011), and Van Der Horst et al. (2007). Balhareth et al. (2019), Leech et al. (2014), and Pearson & Biddle (2011) indicated that low physical activities correlate with increased odds of obesity. These studies also found socio-demographic characteristics such as age, gender, educational level, and employment status, as significant determinants of obesity, just like this review findings. These consistent findings suggest that interventions that address these determinants are required to reduce the prevalence of obesity.

Comparing the results of this review to findings from High Income Countries (HICs), it is evident that the determinants of obesity are similar across these two divides (Nguyen et al., 2020; Li et al., 2014). Therefore, as already suggested, obesity prevention and control policies that are effective in HICs can be adopted and modified to suit the socio-economic, geographic, and cultural settings of LMICs, specifically, West African countries, to reduce the obesity epidemic in the subregion. Regardless of these similarities, this review provided additional information on critical obesity-related gaps whose exploration could add new evidence to the body of obesity literature in West Africa. These gaps and the rationale for addressing them are discussed below.

2.3.3 Strengths and limitations of this review

This is the first study to review the determinants of obesity in West Africa, to the best of the researcher's knowledge. Therefore, the findings could serve as foundation for other future reviews on obesity determinants in West Africa. Also, the review included many studies (n=63), compared to other published reviews (Asenso et al., 2016; Adeboye et al., 2012). As such, it presents with robust evidence on the determinants of obesity for policy and practice in

West Africa. Regarding limitation, this study presented the gaps in literature and suggested ways that the gaps could be addressed. However, it was limited in exploring the policy relevance of those gaps in practice.

In addition, even though this review included studies from most West African countries, there was significant imbalance in country representation because 65% of the studies were from Nigeria and Ghana. Thus, the evidence on the determinants of obesity in the underrepresented countries is limited. Furthermore, the heterogeneity across the reviewed studies could have influenced the findings of this review, and subsequently, its future implications. Thus, caution must be taken in the interpretation of this review findings to avoid biased inferences.

2.3.4 Gaps identified in the literature

2.3.4.1 Lack of analysis of multi-level determinants of obesity

Only one of the sixty-three studies reviewed in this study used a multi-level approach to explore determinants of obesity. The remaining sixty-two studies used the single-level approach, mainly the individual-level approach. Though this approach is common, and its related findings are relevant, current literature shows that this approach could create an underlying assumption that health determinants are single-level based, and this can result in the conceptualisation of health policies that may be inappropriate (Nobles et al., 2021; Diez-Roux, 2000). Nonetheless, the sixty-two studies aimed to contribute to understanding obesity from a single-level approach; thus, it may be inappropriate to query the policy relevance of their outcomes from a multi-level approach, especially as that was not their research intent. As already indicated, single-level approaches to understanding obesity determinants remain essential; however, given the multifactorial indicators of obesity and the need for complementary interventions, the multi-level approach is usually recommended (Pettigrew, 2006).

A multi-level approach to analysing health outcomes, like obesity, is essential to address all levels of factors/influence, i.e., the individual (micro) and structural (macro) determinants (Hollar et al., 2010). Petttigrew (2006) demonstrates that the multi-level approach is advantageous because it helps assess micro and macro factors' interdependency to prevent compositional errors. Additionally, findings from such approaches could be used to comprehensively address health outcomes because of their ability to integrate all the different levels of health determinants (Molina-Azorín et al., 2019).

The only study that used the multi-level approach was conducted in Ghana (Dake et al., 2016). The study provided valuable findings that could significantly influence interventions addressing obesity prevalence in Ghana. But it presented several drawbacks that need to be considered in future studies using a multi-level approach. Firstly, the study was conducted in three homogenous ethnic communities. As such, it was not inclusive of all the ethnic communities in Ghana. Apart from this homogeneity, there are also social and structural inequalities, like access to health care, among populations in Ghana that could influence health outcomes (Alfers, 2013).

These differences ought to be factored in population-based studies, like Dake et al. (2016)'s study, to ensure the generalisation of findings to the wider population (Huebschmann et al., 2019). The lack of inclusivity of all the diverse populations in their study, which inherently affected the external validity of the findings, creates a research gap that requires attention. Secondly, only individual and community levels of influence were accounted for in the hierarchical model. So, other levels, like national levels, were not included in the model analysis. This exclusion limited a comprehensive conceptualisation of the multi-level determinants of obesity in Ghana.

2.3.4.2 Insufficient theoretical underpinnings

Only 5% of the reviewed studies were informed by a theoretical framework. The absence of theoretical underpinnings in the remaining 95% of the studies questions their methodological approach, particularly given the evidence on the importance of theoretical frameworks in guiding research methodology (Eccles et al., 2005). Even the studies that were informed by a theoretical framework faced common methodological challenges. For example, the study by Oyeyemi & Adegoke (2012) was informed by the Ecological Models of Health Behaviour (EMHB). However, their scope was not comprehensive in the context of the EMHB model because they focused mainly on environmental determinants of obesity. Thus, other determinants, like biological and psychological factors, included in the EMHB model were excluded.

This limitation does not invalidate their results entirely, as their findings still provide evidence to expand our obesity knowledge base; however, it highlights the research-theory linkage gap. Therefore, future studies on obesity must be informed by relevant theories to address these gaps and ensure the applicability of research findings. Relevant theories provide an explanation and understanding of emerging themes and guide research progression (Grant & Osanloo, 2014). They also set the foundation to predict and, to some extent, challenge existing knowledge on a particular phenomenon (Grant & Osanloo, 2014).

2.3.4.3 Limited assessment of the interrelationship between obesity and other lifestyle behaviours

The reviewed literature identified a limited coverage of lifestyle behaviours as risk factors for obesity. The included studies focused largely on lifestyle variables like smoking (n = 21 studies), alcohol intake (n = 21) and physical activity (n = 25). Perhaps, these variables were informed by contextual nuances such as research priority areas, health statutes and indicators and national agendas, making their findings relevant for contextual policy. More specifically, these studies were country/geographic explicit, so their rationale to include lifestyle variables that could ensure findings generalisation to those settings was warranted. It would have also been more robust if they had included other lifestyle behaviours, such as sleep and sedentary behaviour, given the emerging evidence on the association between these variables and obesity (Talarico & Janssen, 2018; Colley et al., 2018; Chaput et al., 2018).

Apart from the inadequate coverage of the lifestyle variables, the analytic approach used to account for these behaviours was limited. This limitation is also applicable to the global literature on obesity. Some studies assume the independent relationship between obesity and other lifestyle behaviours. This assumption tends to lead to inaccurate estimates and policy formulation because common underlying latent variables may instantaneously influence the propensity to engage in interrelated lifestyle behaviours (Anokye & Stamatakis, 2015). First, they could inform policy guidelines that would focus only on these observable lifestyle factors. Second, they could absolve the influence of latent variables on obesity, which could hamper efforts to prevent the risk of obesity.

2.3.4.4 Insufficient analysis on influence of religion and culture on obesity

Of the sixty-three studies included in this review, only seven and eleven examined associations between religion, culture (assessed as ethnicity in the studies) and obesity, respectively. Even the seven studies on religion focused on only Christianity and Islamic religion, excluding other religions like traditional African beliefs. So, their findings are valid but are limited to only these two religions. Osemaka (2014) and Schlosser et al. (2009) argue that religion generally influences the lives and choices of people. Narrowing this argument to the West African setting, culture tends to influence the people's perceptions, beliefs and how they interpret their everyday experiences (Adeboye et al., 2012), whilst religion provides the moral and practical guides for behaviour and lifestyle choices (Cline & Ferraro, 2006). Therefore, health decisions are inherently influenced by these variables. For instance, in most religions, gluttony signifies moral deviance and non-conformity (Cline & Ferraro, 2006). Thus, most religious adherents would avoid it to stay faithful.

Similarly, most cultural fanatics mirror overweight and obesity, particularly in women, as the ideal body image to define beauty and good living (Holdsworth et al., 2004). These cultural opinions tend to affect perceptions about body image and dietary choices. Therefore, these variables must be considered when conceptualizing policies for obesity management in West Africa, especially now that the sub-region is witnessing increased religious activities (Osemaka, 2014).

2.3.4.5 Obesity measures

All the reviewed studies measured and categorized obesity using the BMI formula (BMI=weight 9kg)/height (m)^2), as per the WHO standards for obesity measurement and specifications. Even studies that measured obesity using Waist to Hip Ratio (WHR) and Abdominal Circumference (AC) still included BMI as the one of the indicators of obesity. Even though the WHO BMI measure of obesity is usually regarded as the gold standard, it is flawed to some extent. For example, it is limited in determining whether excess weight is associated with excess fat, muscle, or bone mass (Antonopoulos et al., 2016).

Also, it does not take into consideration other factors, such as, age and gender, that could influence the relationship between BMI and body fat (Gurunathan & Myles, 2016). Lastly, BMI measure tend to favour taller people compared to their shorter counterparts. Taller individuals may have low BMI, although they may be obese (Gurunathan & Myles, 2016). These limitations show that BMI to a large extent is a tool for describing the weight status of individuals and not necessarily a tool for diagnosing obesity. Thus, it is recommended that obesity tools that could fully capture adiposity be developed to ensure accurate estimates of obesity. While awaiting such development, future studies can still use the BMI to measure obesity since it is currently the most appropriate tool.

Apart from the controversies on the BMI measure of obesity, majority of the studies (n=54) did not indicate whether the outcome measures they used to collect data on variables such as physical activity and dietary intake were reliable and valid. Therefore, this review could not ascertain the accuracy of the outcome measures in capturing the true and relevant data. Based on this, it will not be appropriate for this study to recommend their replication in future research.

2.3.4.6 Lack of methodological rigor in fitting of analytic estimators

Three of the reviewed studies assessed the validity of their models. This means that majority of the studies (n=60) did not evaluate their model assumptions to ensure a model fit. Since checking of model assumptions is essential to choosing a model and ensuring that it is fit for purpose, the lack of model diagnosis in 95% of the studies questions the accuracy of their predictions. Apart from the model diagnostics, majority of the studies (n=51) also did not provide any information on missing data, especially how they were analysed if identified. Hence, this study could not determine whether the influence of missing data on the study findings were inconsequential.

Furthermore, the studies (n=12) that accounted for missing data used the deletion approach to handle the missing data. Whilst this approach is convenient, it could have led to omissions of vital information that could have significant implications for policy and practice for obesity management. Also, the deletion approach could have also resulted in inconsistent sample size that could have influenced the statistical power of the study, and further limit the generalization of the study findings (Hamer & Simpson, 2009).

2.3.5 Are these identified gaps research and policy relevant to Ghana

After identifying these literature gaps, thoughts and questions on their policy relevance remained. What if addressing these gaps does not contribute to obesity interventions, particularly in Ghana – the context of this thesis? This question aroused a need to involve obesity-related stakeholders to ensure the policy relevance of these gaps. Blok et al. (2015) opined that involving stakeholders is critical in the field of obesity as the rising level of obesity, despite numerous research, is partially attributable to the lack of stakeholder involvement in the formulation and execution of obesity research.

Practically, stakeholders' involvement was essential in this thesis, given that the identified gaps were from West African studies, and their exploration may not be policy-relevant in Ghana. Establishing the research relevance of these gaps was crucial to ensure the adoption of this thesis's findings in the Ghanaian obesity interventions and policy. Thus, the identified gaps in this review were presented to stakeholders to gauge their opinions on the gaps' research and policy relevance. The stakeholders' opinions on other area-level factors critical for obesity policies in Ghana were also explored.

2.3.6 Contribution of the review to obesity knowledge

Previous studies have advanced our knowledge of determinants of obesity (Gebrie et al., 2018; Asenso et al., 2016), but this current review is the first to synthesise evidence on the influence of area-level factors on obesity in West Africa. Thus, it contributed new and critical knowledge on the relationship between area-level factors, like neighbourhood characteristics, and obesity in West Africa that could have significant policy implications. This knowledge is critical because it provides the evidence to direct comprehensive obesity interventions. Apart from contributing to the arsenal of knowledge on area-level determinants of obesity, it also highlighted the need for a paradigm shift in how determinants of obesity research are conducted in West Africa. Though this need has been theorised in the literature, like the ecological model, it has been less explored in West Africa, as evident in this review.

Most of the included studies in this review examined the determinants of obesity from a single level (like individual, community etc. levels) perspective, creating monotonous policy directions. Moreover, even with the single levels, some focused on specific individual characteristics, like demographic factors, further narrowing the evidence base. This current review argued and added to the build-up evidence on the call for all-encompassing determinants of obesity research to drive the obesity agenda, particularly in West Africa (Sacks et al., 2009).

2.4 Conclusion

This literature review has shown key gaps in the evidence base on the determinants of obesity. Key among these gaps is the paucity of research around multi-level determinants of obesity, interrelationship between obesity and other lifestyle behaviours, the influence of religion and culture on obesity and lack of theoretical frameworks. These gaps were presented to obesity stakeholders in Ghana to establish their policy relevance in the next chapter.

Chapter 3: Setting policy relevant research agenda on obesity in Ghana: A Delphi study

3.0 Introduction

Chapter 2 identified research gaps in the literature and established a need for stakeholders' involvement to ascertain the relevance of these gaps to policy in Ghana. Stakeholder engagement, through a Delphi study, is essential to ensuring that research outputs are effectively used by end users (Boaz et al., 2018) and supports the attainment of policy relevant outcomes (Poger et al., 2019). Despite the increased use of stakeholder engagement in health research, there is paucity of its use in low and middle-income countries (Kapiriri, 2018). Although its importance, particularly in preventing NCDs, have been established (Yaya et al., 2018). This gap needs urgent addressing, particularly in obesity, given its complex nature requires the involvement of diverse partners in co-producing the strategies to addressing the complexity (Jancey et al., 2019).

In this chapter, following Boaz et al. (2019), stakeholder engagement is defined as series of interactions with various actors (e.g., patients, policy makers, practitioners, researchers, and general public) with interest in the management of obesity in the ecosystem. To the best of the researcher's knowledge, no obesity research has involved stakeholder engagement in Ghana. A literature search using SCOPUS (largest bibliographic database) found none, although there has been limited application in physical activity (Ocansey et al., 2016). Therefore, the aim of this chapter was twofold: a) to examine the policy relevance of the research gaps identified in the literature review, (b) inform the conceptualisation framework of understanding determinants of obesity in Ghana.

3.1 Methods

A three-round online Delphi study was conducted among stakeholders to identify and conceptualise policy relevant research questions for empirical studies on determinants of obesity in Ghana. Usually, three reiterations are enough to collect the needed information for a consensus. It is well documented that the Delphi technique is the most extensive used method in achieving consensus on specialists' ideas (Chalkley & Helmer, 1963). This technique adopts a chain of questionnaire to collect data from specialist (Hsu & Sandford, 2007). The Delphi technique is acknowledged by its prowess to provide anonymity to respondents, a controlled feedback process, and the suitability of a variety of statistical analysis techniques to interpret the data (Holey et al., 2007). These dexterity decreases group dynamics shortcomings, such as manipulation or coercion to agree to a certain perspective (Vogel et al., 2019).

Participants were recruited from the Ministries in Ghana (i.e., Health, Education (including academic staff), Food & Agriculture, Youth &Sports, Gender& Children & Social Protection, Works & Housing) and Ghana Health Service (including practitioners and charities/organizations representing members of the public with people with interest in obesity) and the Ghana Health Insurance Authority. The sampling frame was informed by the increasing need for a whole systems approach in obesity research (Bagnall et al., 2019). A purposive sampling approach was used to select the participants for the study. Table 10 shows the sampling frame for the selection of the stakeholders. The inclusion criteria were: (a) aged 18 years and above; (b) a member of any of the sampling units mentioned above; (c) resident of Ghana. Exclusion criteria: (a) below age 18 years; (b) not a member of the sampling units, (c) and not resident of Ghana.

Table 10: Sampling frame

Interest groups	**Rationale for inclusion**
Ministry of Health	Hub of health policy formulation in Ghana
Ghana Health Service	State institution responsible for health service delivery
National Health Insurance Authority	Responsible for the provision of quality basic health care
Ministry of Education	Inform curriculum development around obesity
Ministry of Food and Agriculture	Inform production of healthier diet options
Ministry of Youth and Sports	Develop policies and strategies around physical activity
Ministry of Gender, children, and social protection	Responsible for the dietary provision or school children and to account for views of socially vulnerable groups
Ministry of Works and Housing	Creation of an enabling built environment
Practitioners	Forerunners of health care delivery
Researchers	Technical expertise in the literature
Members of the General Public	Living experience with obesity and policy target groups

To recruit participants, the gatekeeper (the Office of the President) sent an email to all potential participants (mentioned above) inviting them to voluntarily express their interest in the study by emailing the researcher. Upon receipt of an email indicating interest from a participant, the researcher sent them the participant information sheet and consent form to complete. In all, fifty-five (n=55) stakeholders consented to participate in this Delphi study. Ethics approval for this study was obtained from Brunel University's Research Ethics Committee.

3.1.1 First round

In the first round, the literature gaps identified in chapter 2 of this thesis were presented to the stakeholders, and they were asked to indicate priority obesity research questions that are policy-relevant in Ghana. They were also asked to indicate if there were any other area-level factors requiring research attention apart from what was identified in the literature review. The rationale for this second survey was to ensure a comprehensive capture of area-level factors that are of obesity importance in Ghana, particularly given the limited area-level factors identified in the literature review. Appendix 5 provides details of the questionnaire used in this first round. The responses from this round were categorised into themes by the author and an independent researcher. The generated themes were reviewed by a third researcher and any identified disagreements were discussed among the team with the third reviewer as a moderator. Descriptive analyses were conducted using proportions and frequencies to evaluate the popularity of themes.

3.1.2 Second round

The second round was conducted online using zoom and involved a combination of presentation, focus groups and nominal techniques. First, the themes generated from the first round were presented to the participants. Second, a 10-minute breakout section was given for the participants to reflect on the themes. Third, participants were put in 5 groups with 9 participants in each group to discuss the themes. Lastly, all the participants reconvened and a facilitator from each group presented the findings of their discussion.

3.1.3 Third round

An initial questionnaire developed based on the themes generated was screen shared and discussed with participants after the breakout session. The stakeholders were then presented with a final questionnaire (Appendix 6). In the first part of the final questionnaire, stakeholders were presented with a 7-point Likert scale ranging from 1(strongly disagree) to 7(strongly agree) on future research questions which are important to study on obesity. In the second part, stakeholders were presented with a 7-point Likert scale ranging from 1(strongly disagree) to

7(strongly agree) on area-level factors which are important to understanding determinants of obesity. The median and Interquartile range (IQR) were calculated to examine the priority of each of the factors and the research questions.

3.2 Results

3.2.1 Findings from the first round

Forty-five (n=45) out of the 55 stakeholders responded to the survey on policy-relevant obesity research questions and area-level factors essential to understanding obesity determinants in Ghana. The most mentioned research question was assessing the relationship between other lifestyle behaviours and obesity (n=16 participants). Some of the themes regarding this research question are:

'How does lifestyle contribute to or propagate the increase in the prevalence of Obesity?' (Participants 016).

[What is the] '*interrelationship between obesity and other lifestyle behaviours?' (*Participant 003).

Other priority research questions included examining the determinants of obesity across different ethnic groups/regions (n=12 participants). Some of the themes on this research question include:

'What is the incidence rate of Obesity across all tribes or ethnic groups in Ghana?' (Participant 016).

'Are the factors that affect obesity different across ethnic groups in Ghana?' (Participant 031).

See appendix 7 for the thematic analysis on the obesity research questions cited by the stakeholders and table 11 below for a summary of the cited research questions.

Table 11: Policy-relevant obesity research questions by the stakeholders (n=45)

Research questions	**Frequency of mention**	**Proportion**
Assessing the relationship between *other* lifestyle behaviours and obesity.	16	36%

Research questions	Frequency of mention	Proportion
Examining the determinants of obesity across different ethnic groups/regions	12	27%
Exploring the effects of socio-demographic and cultural (particularly around body image) and religious factors on obesity	9	20%
The role of biological factors (particularly genetics) in explaining obesity	6	13%
Effect of obesity on communicable & non-communicable diseases	4	8%
Conducting longitudinal instead of cross-sectional studies	3	6%
Investigating micro and macroeconomic determinants of obesity	3	6%
Economic impact of obesity	2	4%
Obesity among children and adolescents	2	4%
Identifying generic determinants (push and pull factors) of obesity	2	4%
Assessing multi- level determinants of obesity	1	2%
Incorporating alternative measures of obesity in observational studies	1	2%

On area-level factors to understand obesity, most of the stakeholders mentioned physical/mental health status and related behaviour as important factors to explore as determinants of obesity:

'The future studies should also entail intrinsic factors of individuals: example: psychological and emotional factors' (Participant 037).

'Individual's health status' (Participants 011).

Other stakeholders mentioned socio-economic factors, such as:

'Income level; Occupation type; Level of education (Participant 004)

'Testing of the knowledge or technical know-how of the interviewees' (Participant 005)

The quotes and corresponding themes from the stakeholders are presented in appendix 8 and the most frequently cited themes are summarised in figure 5 below.

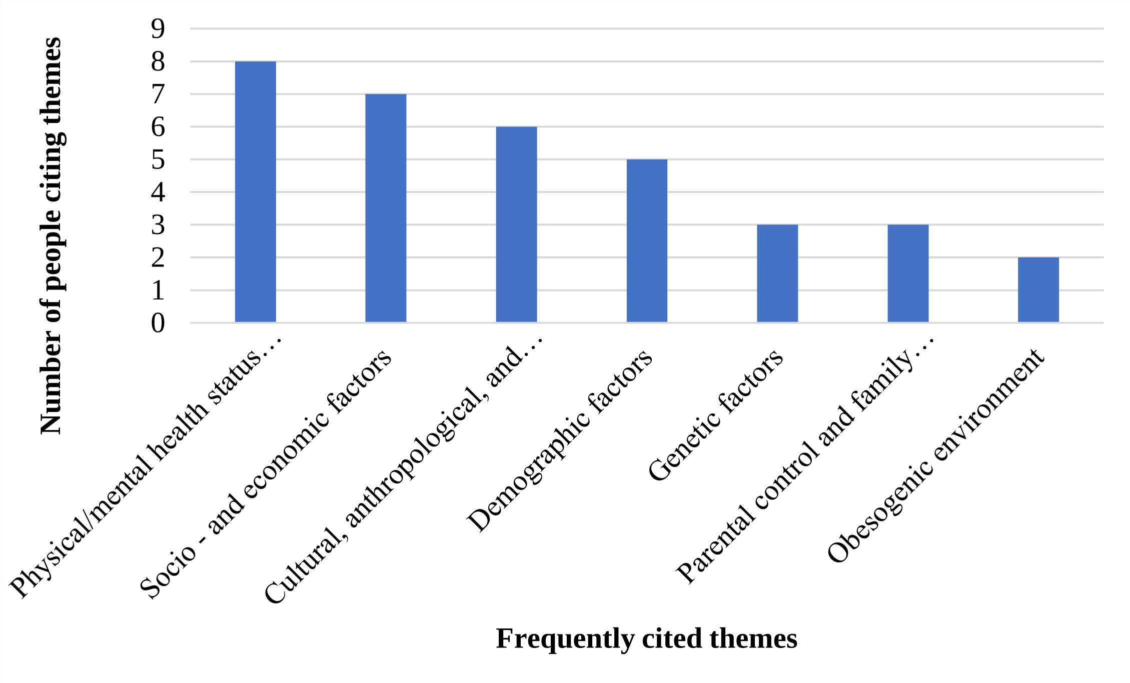


Figure 5: Most frequently cited area-level factors (n=45)

3.2.2 Findings from round two

In the second round, facilitators from the five groups presented their findings from the group discussion. After the presentation, there was a group consensus to merge these two themes on area-level factors important to understanding obesity in Ghana: Obesity rate at the community and household level and the Obesogenic environment. This study defined the consensus as >70% of the stakeholders' strongly agreeing/agreeing or strongly disagreeing/disagreeing with specific statements on future research questions and factors to understand obesity that were presented to them. This consensus definition is consistent with current literature (Vogel et al., 2019).

3.2.3 Findings from round three

The stakeholders' ratings from the third round were analysed descriptively using medians and IQRs. The median scores of the future research questions ranged from 5 to 7. Research questions with median scores ≥6 were regarded as important while those <6 were considered least important. Thus, the following questions: *assessing multi-level determinants of obesity*, *assessing the relationship between other lifestyle behaviours and obesity*, *examining the determinants of obesity across different ethnic groups or regions* and *exploring the effects of* *socio-demographic and cultural and religious factors on obesity* were the future research questions that the stakeholders strongly agreed to be most important.

Conversely, those on *incorporating alternative measures of obesity in observational studies*, *effect of obesity on communicable and non-communicable diseases*, *economic impact of obesity*, *investigating micro and macroeconomic determinants of obesity* and *obesity among children and adolescents* were regarded as least important. There were no don't know responses and consensus (>70% of participants agreeing/disagreeing to a question) was established among the stakeholders on the importance of the future questions. See table 12 for the descriptive findings on important future obesity research questions.

Table 12: Descriptive results on policy-relevant obesity research questions (n=45)

Research questions	**Median (1QR)**	**Min score**	**Max score**	**Consensus N (%)**	
				Agree	**Disagree**
Assessing multi- level determinants of obesity	7(6,7)	4	7	36 (80)	
Assessing the relationship between *other* lifestyle behaviours and obesity.	7(6,7)	1	7	34 (75.5)	
Examining the determinants of obesity across different ethnic groups/regions	6(6,7)	2	7	36 (80)	
Exploring the effects of socio-demographic and cultural (particularly around body image) and religious factors on obesity	6(6,7)	2	7	36 (80)	
The role of biological factors (particularly genetics) in explaining obesity	6(5,7)	1	7	35 (75.8)	
Conducting longitudinal instead of cross-sectional studies	6(5,7)	1	7	33 (73.3)	
Obesity among children and adolescents	5(4,7)	1	7		40 (88.9)
Investigating micro and macroeconomic determinants of obesity	5(4,7)	1	7		33 (73.3)

Research questions	Median (1QR)	Min score	Max score	Consensus N (%)	
				Agree	Disagree
Economic impact of obesity	5(4,6)	1	7		35 (75.8)
Effect of obesity on communicable & non-communicable diseases	5(4,6)	1	7		34 (75.5)
Incorporating alternative measures of obesity in observational studies	5(3,6)	1	7		32 (71.1)

On important area-level factors to understand obesity, factors with a median score ≥6 were considered very important and those with a median score <6 were perceived to be of low importance. Therefore, factors like *Level of pollution and time availability* were the least factors while *cultural, anthropological, and ethnocentric, socio and economic factors, obesogenic environment*, and *genetic factors* 7(6,7) were strongly agreed as important factors. See table 13 for the results on important are-level factors to understand obesity.

Table 13: Descriptive results on important area-level factors to understand obesity (n=45)

Factors	Median (1QR)	Min score	Max score	Consensus N (%)	
				Agree	Disagree
Genetic factors	7(6,7)	2	7	34 (75.5)	
Obesogenic environment	7(6,7)	1	7	37 (82.2)	
Socio - and economic factors	6(6,7)	2	7	36 (80)	
Cultural, anthropological, and ethnocentric factors	6(6,7)	2	7	36 (80)	
Physical/mental health status and related behaviour	6(5,7)	1	7	35 (77.8)	
Demographic factors	5(5,6)	2	7		33 (73.3)
Childhood experience	5(4,7)	1	7		37 (82.2)
Parental control and family setting	5(4,6)	1	7		34 (75.5)
Area of residence	5(4,6)	1	7		34 (75.5)
Labour and leisure time activity	5(4,6)	1	7		36 (80)
Time availability	3(4,6)	1	7		33 (73.3)

Factors	Median (1QR)	Min score	Max score	Consensus N (%)	
				Agree	Disagree
Level of pollution	3(2,6)	1	7		41 (91.1)

3.3 Discussion

Following the identification of literature gaps and the argument on the need for stakeholder engagements to ensure research-policy relevance in the previous chapter (Chapter 2), this chapter investigated the policy relevance of these gaps in Ghana through a Delphi study. As argued earlier, the rationale for the Delphi was to focus this thesis on critical research areas of priority to obesity policymakers in Ghana to ensure that the findings feed into Ghana's obesity agenda.

This chapter contributed new knowledge to Ghana's obesity literature by providing rating on obesity research questions that are critical for policy in Ghana. This evidence was critical to avoid potential research findings disuse. It was also to ensure fluid transfer of obesity knowledge to practice (Powell et al., 2017), which is one of the research-practice limitations in many disciplines (Starkey & Madan, 2001). Future studies may explore this Delphi approach to ensure research and practice linkage to avoid research-practice gaps. The chapter further added new obesity knowledge by conceptualising area-level factors needed to understand obesity in Ghana. Again, this knowledge could ensure focused and relevant obesity research in Ghana.

The chapter recruited 55 participants from critical institutions like the Ministry of Health, the Ministry of food and agriculture, and the Ministry of education to participate in this first-ever obesity stakeholder engagement in Ghana. A three-round online Delphi approach was used to achieve consensus on policy-relevant research questions and area-level factors to understand obesity. The findings showed that stakeholders deem research questions surrounding relationships between lifestyle behaviours and obesity, determinants of obesity across different religious and ethnic groups, and effects of socio-demographic and cultural factors on obesity as crucial future research questions in Ghana. Likewise, they indicated that area-level factors like culture and obesogenic environment are important to understanding obesity in Ghana.

The themes around the future research questions indicated by the stakeholders reflect the stakeholders' views on the potential influence of religion, genetics, culture, demographics, health and social perceptions on obesity, as espoused in the ecological model (Scott et al., 2013). Given the scope of global research on the influence of these factors on obesity, the themes from the stakeholders confirm that very little is known about interrelationships between multiple factors and obesity in Ghana. The consensus in themes from both practitioners and policymakers (members of the stakeholders) illustrates how pivotal studies on multifactorial determinants of obesity can provide an evidence base to link research and policy interventions to reduce obesity in Ghana (Chaloupka & Johnston, 2007).

Furthermore, on area-level factors to understand obesity in Ghana, the themes from the stakeholders suggested that obesogenic environments, like food environments (junk food availability and accessibility, food culture, food production and portion size etc.) and physical activity environments (cost of physical activity, exercise culture, physical activity-friendly environment etc.) are crucial to modify obesity prevalence. Research has consistently shown that obesogenic environments are emerging significant risk factors for obesity, yet they are rarely incorporated in obesity-related policies (Kirk et al., 2010). For instance, Ghana's National Policy for the Prevention and Control of Chronic Non-Communicable Diseases (NCDs), which captures obesity as a critical predisposing factor for NCDs, is explicitly silent on the dynamic role of the obesogenic environment (Ministry of Health, 2012). Therefore, citing it as an important factor for obesity by the stakeholders establishes the needed research basis for future studies to inform comprehensive obesity policies in Ghana and possibly the wider low-and middle-income countries that are bereft of obesity policies (Ford et al., 2017).

Concerning study strength and limitation, this is the first study to establish the significance of the literature gaps in chapter 2 in the obesity research and policy agenda in Ghana. Thus, the findings signpost researchers to important obesity research questions that need urgent attention to influence policy. Nonetheless, the study reports a non-response bias (as 10 out of the 55 participants were non-respondents), even though the response rate was 82%; therefore, this bias must be factored in when interpreting the findings of this chapter.

3.4 Conclusion

This chapter analysed the policy relevance of the identified literature gaps (chapter 2). It indicated that addressing the literature gaps around assessing the relationship between *other* lifestyle behaviours and obesity and analysing the influence of religion and culture on obesity are relevant to Ghana. Therefore, this thesis addressed these gaps to ensure a link between research and practice, as earlier argued.

Chapter 4: Framework for empirical analysis

4.0 Introduction

The literature review in chapter 2 identified paucity of conceptual/theoretical frameworks as a key limitation in the current evidence base on determinants of obesity. As already discussed in chapter 2, theories/frameworks are required to understand research findings and appreciate the pathway of influence, especially in studies like this that aim to understand factors that determine obesity. Thus, this chapter addressed the literature gap on theoretical/conceptual underpinnings limitation by setting out the conceptual framework of the empirical analysis of this thesis. This included justifying the theoretical model and the overarching data collection approach to empirical analyses.

4.1 Overview of the Research Questions

Chapter 2 identified several knowledge gaps in the literature on obesity in West Africa. Following discussions of these gaps with stakeholders (chapter 3), the ensuing research questions were identified to be of high priority to policy making in Ghana. The emphasis is on Ghana because the purpose of this thesis was to understand obesity in Ghana. See table 14 for an overview of the research questions.

Table 14: Overview of the research questions

Gaps in knowledge	Research questions	Analytical estimators	Thesis chapter
Lack of information on the influence of culture on obesity	1. Are there regional/tribal differentials in understanding obesity in Ghana? 2. If so, what role do cultural and religious factors play in this dynamic?	Group specific regression models was fitted for each of cultural and religious groups in Ghana. Prior to this, constructs of religion and culture was included as arguments in a global estimator.	Chapter 6
No evidence on the interrelationship between *other* lifestyle behaviours	1. What is the relationship between physical activity and	Simultaneous equations with mixed process estimators to be fitted and an assessment of how the interrelationship of the	Chapter 7

Gaps in knowledge	Research questions	Analytical estimators	Thesis chapter
	diet and obesity? 2. How do people choose diet and physical activity (key choices related to energy balance)?	behaviours correlated with obesity.	
Insufficient evidence on the multi-level determinants of obesity in West Africa	1. What are the area level determinants of obesity? 2. Are there differential effects of area vs individual level factors in understanding obesity? 3. Which strata contributes most to variation in obesity?	Geospatial Information Systems (GIS) analysis to generate area-level variables. Generalised multi-level system of equations to account for: (a) Latent variables associated with multilevel modelling (b) Independence within clusters of observations (subjects).	Chapter 8

To address these questions, a theoretical model and data, particularly for the first three questions, were required. These are discussed below.

4.1.1 Theoretical Model

Whilst contemporary health promotion paradigm is well-grounded in theory, majority of studies in the discipline is bereft of theoretical underpinnings (Broucke, 2012), as evidenced by the literature review section. Chapter 2 identified a theoretical model that accounts for context in understanding lifestyle behaviour as the most suitable for explaining the determinants of obesity. This model was selected because it facilitates a broader perspective to understanding health behaviour and recognizes that individuals are rooted within larger social systems and their behaviour is a function of the complex reciprocal interaction between personal and contextual factors. A widely recommended approach to understanding human behaviour/outcomes in public health (Golden & Earp, 2012).

Based on the seminal work of Brofenbrenner (1977), who previously outlined a multi-level structure to social discipline, McLeroy et al. (1988) argued that there are five dimensions that impact specific health behaviour, namely: intrapersonal factors, interpersonal processes and primary groups, institutional factors, community factors, and public policy. These propositions set the ground for the conceptualization of the ecological models.

Several authors have defined ecological models with varying conceptions, for example, McLaren & Hawe (2005) opined that the ecological perspective is a conceptual framework develop to highlight the environmental influences on human behaviour. The World Health Organization (2008) observed that ecological framework deals with the interaction of factors at different levels with similar significance to the influence of factors at a single level. In summary, ecological models promote a framework that seek to comprehend the multidimensional levels of society and how people and the environment connect within the social system. Ecological models postulate not only that there are several levels of influences, but also that these levels are collaborative and reinforcing. According to Stokols (1996) the social, physical, and cultural dimensions of the environment have a combined impact on health. From this viewpoint, health problems are seen as a consequence of mutual causation at individual and environmental spheres and hence requiring multi-level interventions.

In the past three decades, there have been a proliferation of the generic ecological models and specific applications to selected public health issues among scholars. This has also led to the development of various approaches (Table 15), leading to the data challenges and poorly defined parameters and social constructs (Jørgensen, 1999).

Table 15: Examples of contemporary ecological models in health promotion

Authors	**Focus of model**	**Key Dimensions**
Stokols et al. 2003	Typology of community assets for health promotion	1. Material resources: economic capital, natural capital, human-made environmental capital, and technological capital 2. Human resources: social capital, human capital, and moral capital

Authors	Focus of model	Key Dimensions
Best et al. 2003	An integrative framework for community partnering to translate theory into effective health-promotion strategy	1.Social ecology model 2. PRECEDE-PROCEED model 3.Life course health development model 4. Community partnering
Hovell et al. 2009	The behavioural ecological model	1.Principles of learning with emphasis on contingencies of reinforcement 2. Influences from genetic, biological, and behavioural learning history interact with influences from the physical and social environment
Burke et al. 2009	A theoretical approach to social context	1. The relationship between individuals and their social context is complex and is shaped and constituted by social, cultural, economic, political, legal, historical, and structural forces. 2. This relationship is multidirectional, co-constitutive, and constantly in formation The multi-layered influences in which individuals are embedded are often beyond the level of individual consciousness

Ecological models have been criticized for challenges in cultural adaptation (Rowley et al., 2015). Nonetheless, these models have been successfully applied to understanding the key constructs of the energy balance, physical activity, and diet (Richard et al., 2011) and formed the basis of global (e.g., *The WHO Global Strategy on Diet, and Physical Activity and Health, 2004*) and national policies (e.g., *The US Healthy People, 2010*)

4.1.2 Ecological structure of Ghana

To establish a cultural validity of the ecological model to Ghana, this section sets out the ecological structure of Ghana. Ghana, like most countries in Africa, is a multi-ethnic, multi-religious and multicultural society. The major groups are the Akan, the Mole Dagbani, the Ewe, the Ga Adangbe, the Guan, the Gurma, the Grusi and the Mande-Busanga (Ghana Statistical Service (GSS), 2000). Despite its rich ethnic diversity, easy geographical and social mobility have scattered people from various ethnic groups throughout the country without destroying or weakening their ethnic bonds. However, the uneven distribution of social and economic amenities has contributed to inequalities among the population (Osei-Asibey, 2015).

In terms of political administration, Ghana is now divided into sixteen geographic regions, but the assemblies are the highest units of local government. There are three types of assemblies: metropolitan, municipal and district assemblies. There are also sub-district political and administrative structures which are subordinate bodies of the assemblies. These include sub metropolitan, district, urban, town, zonal and area councils, and unit committees. There are three different communal classifications in Ghana, this includes: rural communities, urban communities, and peri-urban communities (GSS, 2012). This translates to an ecological structure that is depicted in figure 6 below.

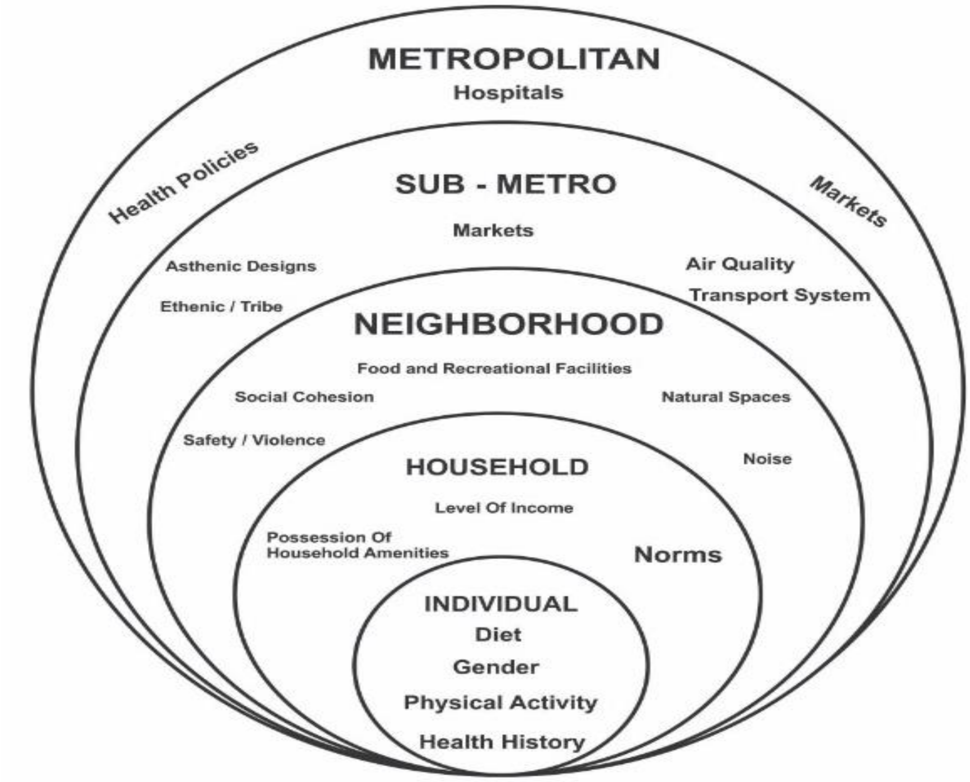


Figure 6: Ecological Structure in Ghana

Most of the economically active population work in the informal sector and are self-employed. The main forms of employment are skilled agricultural, forestry or fishery (41%), sales and services (21%) and craft and related trades (15%). The largely affluent Ghanaian come from both the informal and the formal sectors of the economy. Based on the wealth quintile, there is a disproportional distribution of wealth in Ghana (GSS, 2016).

4.1.3 Data Search

To address the highlighted research gaps on table 14, data is required. Given that the ecological model postulates multi-level factors as the main predictors of obesity, the data search for empirical analysis aims at identifying datasets that have information on contextual factors relevant to the ecosystem outlined in Figure 6, in addition to obesity measures.

4.2 Methods

The search for datasets was conducted in April-May 2020 using a two-fold approach. First, a search was conducted in Google dataset search. Established in 2018, google dataset search is an electronic portal that hosts open access datasets from around the globe. Second, datasets were identified from chapter 2, the literature review,

4.2.1 Selection criteria

The following selection criteria was used:

1. Country of origin: a dataset (s) was selected if it primarily originated from Ghana and relate with adult population from 16 years and above.
2. Variables: A dataset that contained information area level factors of obesity and contextual factors identified through the literature review (chapter 2) and stakeholder engagement workshop (chapter 3).
3. Possibility of duplicate/ similarity: In the event of two datasets sharing similarities, the dataset with comprehensive indicators of other lifestyle behaviours is selected. This is important because datasets with more coverage of the other lifestyle behaviours advance knowledge. Second, information on the year of data collection was examined because the most current dataset is more likely to provide a recent picture of obesity levels.

4.3 Search Results

Figure 7 below shows that 6 datasets were identified during the dataset search. After screening these datasets, 3 met the selection criteria and were subsequently selected for further review.

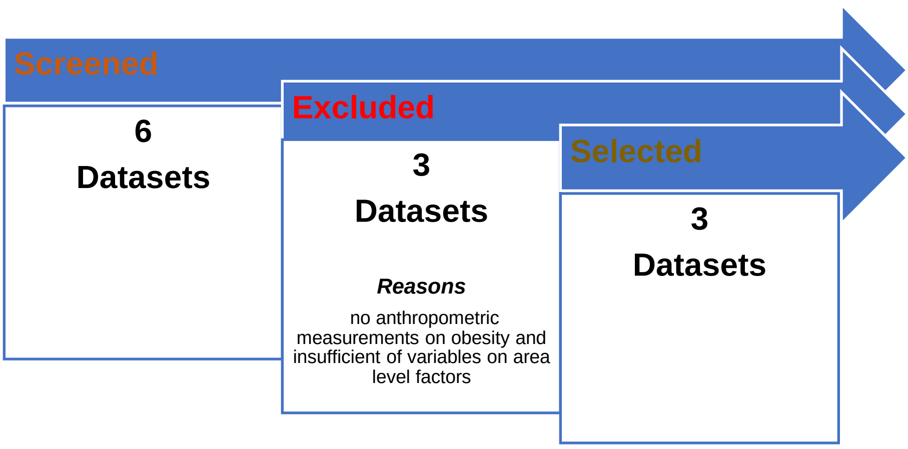


Figure 7: Selection of datasets

4.3.1 Characteristics of the Selected Datasets

Table 16 gives an overview of the three datasets selected for further review. The datasets were sourced from surveys conducted from 1998 to 2014. The sample sizes of the datasets selected ranged from 5000 to over 29,160 cases. There was a mixture of longitudinal and cross-sectional designs. Whilst the dataset had information on obesity, they were limited in their coverage of the ecosystem of Ghana and other lifestyle behaviours and religion & cultural factors.

Table 16: Description of secondary datasets

Dataset	Description	Commentary
National Demographic Health Survey 1988, 1993, 2003, 2006, 2008, 2011, 2014	Nationally representative repeated cross-sectional household surveys with a sample size of 5000 to 10000	Anthropometric data and limited coverage of the ecological structure of Ghana
SAGE Survey 2004, 2007, 2014	A longitudinal nationally representative household survey with a sample size of over 40,000 respondents selected using a multi-stage cluster design.	Anthropometric data Data on adults aged 50 years and older, plus a smaller comparison sample of adults aged 18–49 years, from nationally representative samples. Limited coverage of ecological structure and religio -cultural factors
Ghana Health and Demographic Survey 2003, 2008, 2014	A nationally representative sample of around 10000 (on average) men and women aged 15-49	Anthropometric data (height and weight), demographics and limited coverage of area level factors and no cultural and religious factors

4.4 Implications for empirical research

As shown in table 16, the selected datasets have demonstrated significant weaknesses. These weaknesses will challenge data analysis, especially those intended to guide policy direction. Also, the most recent dataset was in 2014, which given the rapidly changing trends of obesity in Ghana (Lartey et al., 2019), is dated. Based on the challenges discovered in the selected datasets, primary data collection designed specifically to suit the objectives of this current thesis seemed to be the appropriate option.

Sample size is key to primary data collection as it determines the likelihood of false-negative findings, thereby affecting policy direction and the interpretation of empirical research (Beau et al., 2008). To determine the effective sample size that reflects the population and ecological structure of Ghana, the Cochrane (1963) sampling formula was used:

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where: *n* = the desired sample size, N = Total population size

The sample size per study site was estimated based on the population size in the three most populous metropolises in Ghana (GSS, 2017). In addition, the metropolises are cosmopolitan in nature and reflect the varying cultures. Each study site is a major economic hub and over the years has attracted people across the geographical strata of the nation to these areas. All the major ethnic groups can be found in this area as well as the various economic classes. In practice, the sample size calculation was conducted using Qualtrics. Table 17 gives an overview of the effective sample sizes based on differing error terms.

Table 17: Overview of the sample sizes

Metropolis	**Population**	**Sample size**		
		Error term (3%)	**Error term (5%)**	**Error term (7%)**
Kumasi	3,348,000	1067	385	196
Accra	2,514,000	1067	385	196
Tamale	642,000	1066	384	196

4.5 Conclusion

This chapter addressed the literature gap on theoretical underpinnings in chapter 2 by establishing a theoretical framework to guide this current research. In establishing a framework for empirical analysis in subsequent chapters, it identified a gap in datasets available to examine the multi-level determinants of obesity in Ghana and hinted that the paucity of evidence in this area might be partially attributed to the data challenges. Given the current evidence, the empirical research of this thesis (see Table 14), will employ the approaches justified and described herein. The emphasis though would be on the collection of cross-sectional data because logistical constraints preclude the collection of longitudinal data survey. This decision was corroborated in chapter 3, the stakeholder engagement workshops.

Chapter 5: Development and conduct of Ghana Obesity Survey

5.0 Introduction

Chapters 4 demonstrated the lack of data on obesity in Ghana. Chapter 5 addressed this gap by conducting the first comprehensive primary data collection on obesity in Ghana. The objectives were two-fold: (a) to design a survey instrument and (b) to collect data on the indicators of obesity, lifestyle behaviours, socio-demographics, and contextual factors. Data collection was conducted in collaboration with GSS, Brunel Global Health Academy, and the Presidency of Ghana. The structure of the chapter includes a methods section that describes and justifies the processes of sampling and recruitment, questionnaire development and piloting, with a presentation of the descriptive results from the survey.

5.1 Methods

5.1.1 Development of the survey instrument

The development of the survey instrument involved two main stages - questionnaire design and piloting.

5.1.2 Questionnaire design

A face-to-face questionnaire was developed in line with the standard approach to data collection in the literature. Jackson & Furnham (2000) argue that adapting existing questionnaires is more efficient than developing a new questionnaire. This application, however, cannot be generalized, particularly in areas where access to validated questionnaires is a challenge. Based on the literature review findings in Chapter 2, authors of papers that collected primary data were contacted to access their validated questionnaires. This led to the adaptation of the neighbourhood environmental scale developed by Oyeyemi et al. (2013). In addition, existing national surveys in Ghana and elsewhere (via the UK data archive portal) was searched for survey questions.

In line with the research questions set out in Chapter 4, the questionnaire covered the sections shown in Table 18 (Full details of the source of each survey question can be found in Appendix 9). Following an introduction to the study, questions began on the range and intensity of Sports and Exercises undertaken. After a full listing of activities, the mentioned activities were selected for detailed questioning. Also, to test the hypothesis on the mediating role of longevity of residence on the impact of area level factors on obesity, a question was added on the length of stay at a residence.

Table 18: Description of Interview schedule

Modules	**Summary of content**
Introduction	• Introduction to the study • Making contact and checking respondent details
BMI	Height and weight measurements were taken using internationally standardised measurement scales.
Sports and Exercise	Question about sports and exercise in the past 4 weeks - people who had *not* participated in any sports or exercise in the past 4 weeks. Questions about the number of days spent undertaking activity, duration, and intensity of activity.
Other lifestyle behaviours	Questions about consumption of fruits and vegetables, sedentary behaviour, smoking and alcohol. The questions covered frequency of behaviour.
Neighbourhood environment scale	Questions about how people perceive their environment in terms of convenience, safety for activity, as well as sporting facilities.
Attitudes related to obesity	Cultural norms, and views on obesity were asked
Socio-economic	Questions were asked on: • Gender • Age • Marital status • Ethnicity • Religion • Employment status • Personal household income • Health status • Area of residence, and Longevity at Residence • Smoking status
Thanks	Thanks to respondents.

A check question was asked to avoid ‘double-counting’ of duration and frequency for different sports activities. The first check question was to avoid double counting the frequency of different activities. For example, where a respondent took part in two or more activities (e.g., football and swimming), they were reminded to separate the responses for the two activities, to allow separate recording.

5.1.3 Piloting

The piloting of a survey instrument offers a dress rehearsal to data collection and identifies potential issues that could affect survey respondents and interviewers, leading their resolution before the instrument is administered in the field (Bowden et al., 2002). The questionnaire was piloted in March 2021 to test: questionnaire duration, interviewing procedures, willingness to take part, willingness and ability to answer questions and the flow of the question regarding the consistencies. Interviewers fed back this information at a pilot debrief, and the questionnaire was further revised prior to fieldwork. The main changes made were amending the named activities for sports and exercise to reflect the traditional activities in Ghana and revising the questions on ethnicity and marital status to reflect major tribes and customary marriages, respectively.

5.1.4 Sampling method

A three-stage stratified sampling design was used in the survey (selecting enumeration areas, systematically selecting households, and randomly selecting individuals within households).

- *Stage one:* Generated primary sampling units based on 108 selected enumeration areas. The primary sampling units were allocated to three metropolises (Kumasi, Accra, and Tamale) using equal allocation, irrespective of the population size.
- *Stage two:* Systematically selected twenty households from each enumeration area to derive a total sample size of 2,160 from the three metropolises.
- *Stage three:* All adults household members 18 years or older were sampled for the study, and 3,348 adults were obtained for the study.

5.1.5 Data Collection

Data collection was carried out by 54 field officers of GSS in the three metropolises, and each team was made up of a supervisor and five enumerators. The questionnaire was converted from face-to-face to a short computer-aided interview (27 minutes) by GSS's questionnaire design and development hub, considering inputs from the researcher. Prior to data collection, a three-day workshop was undertaken for the staff. The fieldwork was conducted in April 2021. Ethical approval was provided by the GSS's Research Ethics Committee and the Brunel University Research Ethics Committee.

5.1.6 Data integrity

Data collected in the survey were checked at two levels. First, checks were included in the questionnaire to ensure that interviewers were alerted to values that might be out of range so that these could be checked with the respondent. The operations team at GSS also checked coding, e.g., sports and activities that were incorrectly entered as 'other' sports were put into the appropriate category. Finally, the edited dataset provided by the GSS team was labelled and derived variables generated. After these checks, the dataset was handed to the researcher.

Prior to data analysis, the veracity of the dataset was checked further checked. As a result, several issues were identified, particularly on coding and specification of variables. These issues were discussed with GSS and addressed. An overview of the content of the data assessment is described in Table 19.

Table 19: Overview of data assessment prior to analysis

Which aspects were checked?	**Method used**
Is coding and distribution of variables consistent?	Conducting descriptive statistics of all the variables to check if: • Missing data conventions are similar across variables? • Number of observations across and within question blocks are consistent (N/B: the only exception may be where the variable in question is a follow-up question)
Are variables being accessible?	Conducting descriptive statistics of all the variables
Are the coding and values of common variables consistent?	Conducting descriptive statistics of variables in the questionnaire blocks. The blocks of interest were frequency/intensity/duration of activities

Which aspects were checked?	Method used
Are the values of variables plausible?	Conducting descriptive stats of all the variables and to check if: • Categorical variables have their values labelled • Continuous variables do not have unusual outliers
Checking duplicates in the observations	Check the unique identifier and assessed to see if there were duplicates
How were the derived variables specified and these understandable?	Check the definitions (including statistics) of all variables particularly derived variables

5.1.7 Data Analyses

The analyses were conducted in two main stages. First, descriptive/bivariate analyses of the data. Analyses were conducted for the whole sample and the three main sampling units and separately for the three metropolises (Accra, Kumasi and Tamale). Second, missing observations analysis was conducted to examine the pattern of data missingness, if any, in the dataset.

5.1.7.1 Descriptive /bivariate analyses

Tables 20 and 21 detail the descriptive and bivariate analyses, and statistical tests of associations used in this chapter, respectively. The descriptive statistics provided means, and proportions of both the dependent and independent variables. It also describes the bivariate analyses undertaken and their related statistical methods. The bivariate analysis investigated the significance of variations across groups. The choice of statistical tests of association was accessed using Peacock & Kerry (2012) and Bland (1995).

Table 20: Summary of descriptive & bivariate analyses

Study element	Questions	Type of analysis	Measures
BMI	What is the average BMI of the sample? Which proportion of the sample is overweight and obese and which region, religious and tribes/cultural groups are most overweight and obese?	Univariate analysis of the BMI Bivariate analyses between BMI and variables for regions, tribes and religious groups using both parametric and non-parametric tests of association	Mean (SD) The main statistical tests of association used can be found in Table 25
Other lifestyle behaviours	Which proportion of the sample exercise, eat healthily, do not smoke nor drink alcohol?	Univariate analysis of indicators of physical activity, fruit, and vegetables, smoking or alcoholic drinks	Percentages
Attitudes towards obesity	How do people perceive the causes and indicators of obesity? And do are differentials across regional, religious and tribal lines?	Bivariate analysis between attitudes towards obesity and indicators for region, region and tribes using both parametric and non-parametric tests of association.	The main statistical tests of association used can be found in Table 25

Table 21: Summary of statistical tests of association

Individual level variables	**Statistical tests used**
<u>*Nominal variables*</u> Income, health status	Fischer exact test[1] / Chi-squared test.
<u>*Binary variables*</u> Gender; attitudes to obesity; employed, overweight/obese, employed, disability	Fischer exact test / Chi-squared test.
<u>*Continuous variables*</u> Age	Wilcoxon sign test

[1] Alternative to chi-square test if small (below 5) number of observations is in one or more cells.

5.1.7.2 Missing observations

The approach used to account for missing data was determined by the cause and proportion of missing data. The cause of missing data was identified by checking the applicability of the data collection to individuals - item not applicable or truly missing (i.e., non-response). In the case where missing data is 'not applicable,' e.g., when questions are not asked because they are not relevant for some type of respondents (e.g., a question on frequency of smoking if a respondent reported no smoking), the most appropriate value was assigned (i.e., non-smoker or zero cigarettes smoked).

Where data is genuinely missing, patterns of missing resource use data were examined using descriptive statistics. To examine the mechanisms under which missing data occurs[2], chi-square and Fischer's exact tests were used to check the association between the indicators of obesity (dependent variable) and dummy variables representing their item non-responses to examine the mechanisms under which the missing data occurred (i.e., missing completely at random or not) (Briggs et al., 2003). Missing data were replaced using the mean-based imputation method. Whilst, this method is limited in reflecting the uncertainty around missing data points and reducing the variation in the dataset, this impact is expected to be minimal in this study. Furthermore, as the proportion of missing data was small (less than 5%), the method for addressing missingness is inconsequential (Schafer, 1999).

5.2 Results

A brief description of the sample is provided, followed by the results of missing observations and the set of unique identifiers for the sample. Finally, descriptive results are presented separately for metropolises, religious and tribal groups.

5.2.1 Description of sample

Of the 6000 cases issued, 3900 were eligible for inclusion. The overall response rate, including all those who agreed to participate in the phone interview, was 86% (3348 respondents of the 3900 eligible for inclusion). Of the 3900 potential respondents, 3348 completed a full interview. The majority of non-response consisted of non-contact (n=213). For example, some

[2]This could be: (i) missing completely at random, with no relation to the value of any other factors in the study population; (ii) missing at random but correlated in an observable way with the mechanism that generates the outcome; and (iii) not missing at random, but dependent on unobserved variables.

of the respondents had relocated. The co-operation rate (i.e., the proportion of those contacted who agreed to take part) was 90.8%, and the refusal rate was 8.2%. The average interview length during the main stage fieldwork was 27 minutes.

After data cleaning, a total effective sample of 3348 was achieved. Table 22 shows that the average age of the sample was 40 years. Of the sample, the majority were women (60%). Most were employed (88%), had no disability (87%), married or living with their partners (59%), had lived at their current residence for over five years (71%) and reported Christianity as their religion (55%). Similarly, the majority reported favourable health (87%). The sample was predominately Akans (38%) and Mole Dagbanis (34%), and there was a similar representation from the metropolises, with the Tamale metropolis slightly ahead by 37%. Many of them had monthly personal income below GH¢ 1000 (77%).

Table 22: Descriptive statistics of demographic variables (missing observations are indicated) (n= 3,348)

Variables	**Obs.**	**%/Mean (SD)**	**Variables**	**Obs.**	**%/Mean (SD)**
Age (in years)	3348	39.76(15.61)	Employment status		
Annual income			Employed	2944	87.93
> GH¢ 1000	2570	76.76	Unemployed	404	12.07
GH¢ 1000 to less than GH¢ 2000	613	18.31	Disability		
GH¢ 2000 to less than GH¢ 3000	129	3.85	Yes	399	11.92
GH¢ 3000 to less than GH¢ 4000	23	0.69	No	2931	87.54
GH¢ 4000 to less than GH¢ 5000	7	0.21	Prefer not to say	18	0.54
GH¢ 5000 and above	6	0.81	*Health status*		
Gender			Very good	1,330	39.73
men	1328	39.67	Good	1,602	47.85
women	2019	60.30	Fair	340	10.16
Other	1	0.03	Bad	69	2.06
Ethnicity			Very bad	7	0.21
Akan	1,268	37.87	*Length of stay at current address*		

Variables	**Obs.**	**%/Mean (SD)**	**Variables**	**Obs.**	**%/Mean (SD)**
Ga-Dangme	306	9.14	Less than 6 months	87	2.60
Ewe	145	4.33	6 months to 1 year	91	2.72
Guan	17	0.51	1 year to 2 years	226	6.75
Gurma	23	0.69	2 to 5 years	564	16.85
Mole-Dagbani	1,149	34.32	More than 5 years	2,380	71.09
Grusi	101	3.02	*Region of residence*		
Mande	1	0.03	Kumasi	1202	35.90
All Others	338	10.10	Greater Accra	918	27.42
Marital status			Northern	1228	36,68
Informal /living together	185	5.53			
Married (civil/ordinance)	407	12.16			
Married (Customary/traditional)	394	11.77			
Married (Islamic)	914	27.30			
Married (other type)	62	1.85			
Separated	129	3.85			
Divorced	84	2.51			
Widowed	228	6.81			
Never married	945	28.23			
Religion					
Catholic	225	6.72			
Protestant	288	8.60			
Pentecostal/Charismatic	1,140	34.05			
Other Christian	189	5.65			
Islam	1,393	41.61			
Ahmadi	7	0.21			
Traditionalist	17	0.51			
No Religion	79	2.36			
Other (specify)	10	0.30			

Obs. – observations.

5.2.2 Missing data

There was no missing data except for height, which recorded less than 1% (n=21) missing observations. The missing data were replaced using the mean-based imputation method. Whilst available, the person ID for the sample was observed to contain multiple duplicates. Only 13 (less than 1%) observations had a unique person ID. Therefore, a new unique identifier was created for the sample using the following steps (see Box 2).

Box 2: Generation of a unique identifier

Code Generation

The unique variable ID was generated using a combination of the key variables as a basis for the unique ID.

The first step in doing this was running a duplicate search on every column of data and identifying the columns which held key and unique information relevant to each line of data.

The unique data columns were then shortened, whiles maintaining their uniqueness and combined with other key variables to form the ID.

The first string in the formula for the unique ID utilised the CONCATENATE function to combine the first three values of cell L (containing regional location), cell F (containing District location) and cell E (containing local area location).

The second string in the formula was to generate a numerical value unique to each line of data. This was done using the SUM function and cells B+C+D and adding the results to the AVERAGE of cells T, U, DS, EG.

An IF clause was included in the third line of the formula string to ensure similar data lines did not generate duplicate unique IDs. The IF clause added 5% to cell EG before summing it up with the previous formula string IF EG was greater than 50 or reducing cell EG by 3.5% if the value of EG was less than 50.

The resulting variable was then checked for duplicates, of which none were found.

The formula used was:

```
=CONCATENATE(LEFT(L2,3),"-”, LEFT(F2,3),"-”, LEFT(E2,3),"-”, SUM (B2, C2, D2) +AVERAGE (T2, U2, DS2, EG2) +IF(EG2>50, EG2-5%, EG2-3.5%))
```

The UNIQUE ID was then generated as AAA-BBB-CCC-000.000
Where A- is the regional location
B- is the district location
C- is the local area location

5.2.3 Lifestyle variables and anthropometric measures

Table 23 shows that the average BMI (kg/m2) was 27.09(9.29), indicating that, on average, the sample was overweight. Most of the sample were overweight or obese (53%). More than half of the sample do not participate in physical activity (55%), and only 19.47% eat healthily (based on the WHO recommended level of fruits and vegetable consumption). More than half of the sample did not participate in any physical activity, close to 100% (98.6%) were non-smokers, and about 80% did not consume alcoholic drinks.

Table 23: Descriptive statistics of lifestyle variables and anthropometric measures (missing observations are indicated) (n= 3,348)

Variables	**n**	**%/mean (SD)**
Height (metres)	3327	1.64(0.0967)
missing	21	0.63%
Height(metres)	3348	1.64(0.097)
Weight (cm)	3348	72.25(21.14)
BMI	3348	27.09(9.29)
Obese or overweight?		
Yes	1777	53.08%
No	1571	46.92%
Healthy diet (meeting the WHO recommended level of fruits and vegetable consumption)?		
Yes	652	19.47
No	2,696	80.53
Participate in physical activity?		
Yes	1517	45.31%
No	1831	54.69%
Ever smoked cigar, cigarette or pipe?		
Yes	170	5.08%
No	3178	94.92%
Currently smokes cigarette?		
Yes	65	1.94%
No	3283	98.06%
Currently drinks alcoholic drinks?		
Yes	650	19.41%
No	2698	80.59%

5.2.4 Attitudinal variables

In terms of attitudes towards overweight/obese, most of the sample had favourable attitudes about obesity. For example, less than 30% perceived being overweight as a sign of good living and healthy and even less for 'a sign of beauty' (17%). Conversely, the majority (55%) believed that eating too much was not a cause of overweight. However, insufficient exercise was seen as a cause of overweight (63%). See table 24 for a summary of the attitudinal variables.

Table 24: Descriptive statistics of attitudinal variables (missing observations are indicated) (n= 3,348)

Variables	**n**	**%**
Agree that 'Being overweight is something you inherit from your parents'		
Yes	2,159	64.49
No (or otherwise)	1,189	35.51
Agree that 'Being overweight is a sign of good living'		
Yes	945	28.23
No (or otherwise)	2,403	71.77
Agree that 'Being overweight is a sign of beauty'		
Yes	581	17.35
No (or otherwise)	2,767	82.65
Agree that 'Being overweight is unhealthy'		
Yes	2,464	73.60
No (or otherwise)	884	26.40
Agree that 'Most people who are overweight have put on weight because they eat too much'		
Yes	1,503	44.89
No (or otherwise)	1,845	55.11
Agree that 'Most people who are overweight have put on weight because they exercise too little'		
Yes	2,105	62.87
No (or otherwise)	1,243	37.13

5.2.5 Metropolitan, religio-tribal variations in overweight/obesity prevalence

Significant differences (unadjusted) were observed across tribes, metropolises, and religious groups (see Table 25). The Greater Accra region was found to have the highest proportion of overweight/obese (63.07%) and the Tamale region the least (44.06%). By tribes, Ga Dangme had the highest proportion of overweight/obese (69.93%) followed by Ewes (60.69%), with Mole Dagbanis having the least (44.04%). Christians recorded the highest overweight/obese levels (57.33%) and Muslims the lowest (47.79%).

Table 25: Unadjusted levels of overweight/obese by tribe, metropolis, and religious groups (n= 3,348)

Variables	**Proportion of overweight/obese**	**Significance**
Metropolises		
Kumasi	54.66%	***
Greater Accra	63.07%	
Northern	44.06%	
Tribes		
Akan	55.21%	***
Ga Dangme	69.93%	
Ewe	60.69%	
Mole Dagbani	44.04%	
Others	56.04%	
Religious group		
Christians	57.33%	***
Muslims	47.79%	
Others	49.06%	

5.2.6 Risk factors for overweight/obesity

Tables 26 to 28 demonstrate statistically significant differences, albeit unadjusted, among metropolises, religious and tribal lines, for sample characteristics and potential risk factors for overweight/obesity. For example, the Tamale metropolis had more men (46%) than the other two metropolises and the youngest (38 years) and healthiest (7% reporting a disability versus 15% for the other metropolis). The Kumasi metropolis had the highest perception that being overweight is a sign of beauty (22%) and the least perception that overweight is caused by overeating (42%). See table 26

Table 26: Metropolitan variations (unadjusted) in risk factors for overweight/obesity prevalence

Variables	**Kumasi %/Mean (SD)**	**Greater Accra %/Mean (SD)**	**Tamale %/Mean (SD)**	**Sig.**
Men	38.94%	32.79%	45.52%	***
Employed	71.88%	74.62%	78.75%	***
Health status				***
Very good	50%	41.39%	28.42%	
Good	35.86%	44.55%	62.05%	
Fair	10.40%	11.98%	8.55%	

Variables	Kumasi %/Mean (SD)	Greater Accra %/Mean (SD)	Tamale %/Mean (SD)	Sig.
Bad/very bad	3.74%	2.07%	0.98%	
Have a disability	14.56%	14.49%	7.41%	
Personal income				***
> GH¢ 1000	80.03%	81.48%	70.03%	
GH¢ 1000 to less than GH¢ 2000	15.89%	15.90%	22.48%	
GH¢ 2000 and above	4.08%	2.61%	7.49%	
Marital status				***
Married	45.01%	37.25%	72.80%	
Informal living/never married	41.76%	41.83%	19.87%	
Separated/divorced	5.41%	12.85%	2.44%	
Widowed	7.82%	8.06%	4.89%	
Age	40.16(16.84)	41.55(16.18)	38.04(13.65)	***
Agree that 'Being overweight is something you inherit from your parents'	62.40%	66.99%	64.66%	*
Agree that 'Being overweight is a sign of good living'	26.04%	19.83%	36.64%	***
Agree that 'Being overweight is a sign of beauty'	20.97%	12.75%	17.26%	***
Agree that 'Being overweight is unhealthy'	76.12%	73.86%	70.93%	**
Agree that 'Most people who are overweight have put on weight because they eat too much'	41.26%	44.88%	48.45%	**
Agree that 'Most people who are overweight have put on weight because they exercise too little'	60.07%	59.59%	68.08%	***

Significance levels: 1%****, 5%**, 10%*

In terms of religion, Muslims were the oldest group (mean age of 42 years) and with the lowest personal income levels. Christians and other religious groups had less favourable attitudes towards obesity, with over 27-37% of them perceiving being overweight to be a sign of good living. Whilst all religious groups perceive overweight to be caused by little exercise, the other religious groups (e.g., traditionalists) had the firmest conviction (68%). See table 27.

Table 27: Proportion of respondents at risk of overweight/obesity by religion (n= 3,348)

Respondent's characteristics (Number (n))	**Christians %/Mean (SD)**	**Muslims %/Mean (SD)**	**Others %/Mean (SD)**	**Sig.**
Men (1328)	38.94%	32.79%	45.52%	***
Employed (2944)	71.88%	74.62%	78.75%	***
Health status				***
Very good (1330)	50%	41.39%	28.42%	
Good (1602)	35.86%	44.55%	62.05%	
Fair (340)	10.40%	11.98%	8.55%	
Bad/very bad (76)	3.74%	2.07%	0.98%	
Have a disability (399)	14.56%	14.49%	7.41%	
Annual income				***
> GH¢ 1000 (2570)	80.03%	81.48%	70.03%	
GH¢ 1000 to less than GH¢ 2000 (613)	15.89%	15.90%	22.48%	
GH¢ 2000 and above (165)	4.08%	2.61%	7.49%	
Marital status				***
Married (1777)	45.01%	37.25%	72.80%	
Informal living/never married (1130)	41.76%	41.83%	19.87%	
Separated/divorced (213)	5.41%	12.85%	2.44%	
Widowed (228)	7.82%	8.06%	4.89%	
Age (3348)	40.16(16.84)	41.55(16.18)	38.04(13.65)	***
Agree that 'Being overweight is something you inherit from your parents' (2159)	62.40%	66.99%	64.66%	*
Agree that 'Being overweight is a sign of good living' (945)	26.04%	19.83%	36.64%	***
Agree that 'Being overweight is a sign of beauty' (581)	20.97%	12.75%	17.26%	***
Agree that 'Being overweight is unhealthy' (2464)	76.12%	73.86%	70.93%	**
Agree that 'Most people who are overweight have put on weight because they eat too much' (1503)	41.26%	44.88%	48.45%	**

Respondent's characteristics (Number (n))	Christians %/Mean (SD)	Muslims %/Mean (SD)	Others %/Mean (SD)	Sig.
Agree that 'Most people who are overweight have put on weight because they exercise too little' (2105)	60.07%	59.59%	68.08%	***

Significance levels: 1%****, 5%**, 10%*

Apart from income, there were statistically significant differences among the tribes. The dominant tribes, Akan and Mole-Dagbani had the least perception that obesity is inheritable (62%), and the Akans had the least awareness that overweight/obesity is related to overeating (40%). Ewes had the highest awareness that obesity is a sign of beauty (21%), followed by the Mole-Dagbanis (19%). The Mole Dagbanis, the second dominant tribe, were the youngest (38 years, on average) and healthiest (8% reported disability) sample (See table 28).

Table 28: Proportion of respondents at risk of overweight/obesity by ethnicity (n= 3,348)

Respondent's characteristics (Number (n))	Akan %/Mean (SD)	Ga %/Mean (SD)	Ewe %/Mean (SD)	Mole Dagbani %/Mean (SD)	Other %/Mean (SD)	Sig.
Men (1328)	39.59%	31.37%	31.72%	44.47%	36.04%	***
Employed (2944)	71.77%	73.86%	76.55%	79.03%	75.21%	***
Health status						***
Very good (1330)	47.79%	36.60%	48.97%	29.16%	49.92%	
Good (1602)	38.88%	45.75%	34.48%	60.75%	46.04%	
Fair (340)	10.57%	13.73%	14.48%	8.96%	8.33%	
Bad/very bad (76)	2.76%	3.92%	2.07%	1.13%	2.71%	
Have a disability (399)	14.20%	17.97%	17.93%	7.66%	10.42%	***
Annual income						
> GH¢ 1000 (2570)	77.37%	81.70%	78.62%	74.85%	76.04%	
GH¢ 1000 to less than GH¢ 2000 (613)	17.59%	15.69%	19.31%	19.41%	18.96%	
GH¢ 2000 and above (165)	5.05%	2.61%	2.07%	5.74%	5%	
Marital status						***
Married (1777)	42.43%	32.03%	39.31%	73.28%	50.52%	

Respondent's characteristics (Number (n))	**Akan %/Mean (SD)**	**Ga %/Mean (SD)**	**Ewe %/Mean (SD)**	**Mole Dagbani %/Mean (SD)**	**Other %/Mean (SD)**	**Sig.**
Informal living/never married (1130)	43.85%	37.25%	42.76%	19.23%	36.88%	
Separated/divorced (213)	7.26%	17.32%	8.97%	2.61%	5.21%	
Widowed (228)	6.47%	13.40%	8.97%	4.87%	7.50%	
Age (3348)	39.68(16.24)	45.99(16.73)	40.10(16.16)	38.48(14.08)	38.96(15.64)	***
Agree that 'Being overweight is something you inherit from your parents' (2159)	61.99%	69.93%	68.97%	66.49%	61.46%	**
Agree that 'Being overweight is a sign of good living' (945)	23.58%	18.63%	26.21%	37.95%	23.96%	***
Agree that 'Being overweight is a sign of beauty' (581)	18.06%	11.44%	20.69%	18.80%	14.79%	***
Agree that 'Being overweight is unhealthy' (2464)	73.90%	75.82%	77.24%	70.41%	77.92%	**
Agree that 'Most people who are overweight have put on weight because they eat too much' (1503)	39.75%	48.69%	44.14%	51.61%	40.21%	**
Agree that 'Most people who are overweight have put on weight because they exercise too little' (2105)	59.15%	58.82%	66.90%	66.67%	65%	***

Significance levels: 1%****, 5%**, 10%*

5.3 Discussion

This chapter addressed the gap identified in chapter 4 on the lack of obesity-related dataset in Ghana. It contributed immensely to the obesity literature by collecting and providing a comprehensive and current obesity dataset in Ghana, in collaboration with GSS. The chapter first developed and piloted a survey instrument per standard approaches and based on the methods identified in the reviewed studies in chapter 2 (Epstein et al., 2015). After, a multistage sampling design was used to collect data from adults aged ≥18 years from twenty households in each of the 108 enumerated areas within three metropolises, i.e., Accra, Kumasi, and Tamale metropolises. In all, data from 3,348 adults were collected and analysed in this chapter using descriptive and bivariate analyses.

The descriptive findings indicated that more than half of the study population are overweight/obese (53%) and do not participate in any physical activities (55%). Additionally, about 19.47% do not consume a healthy diet, per the WHO recommendations. Further, many (55%) also believed that overeating does not cause overweight/obesity, but overweight/obesity is associated with insufficient exercise (63%). The percentage of overweight/obese (53%) is about 10% higher than that reported by a systematic review involving 48,966 adults in Ghana (43%) in 2016 (Ofori-Asenso et al., 2016). Regardless of the methodological differences between the studies, this percentage difference demonstrates that the overweight/obesity menace is increasing and becoming a growing concern that must be given all the critical attention. Also, the percentage of overweight/obese adults in this study is similar to other studies in Ghana (Addo et al., 2015; Agyei-Mensah & de-Graft Aikins 2010).

One possible explanation for the increasing obesity burden in Ghana may be the current rapid economic transition in Ghana and its consequent sedentary lifestyle (Ofei, 2005). The economic pursuits of most Ghanaian adults, particularly those in the urban areas and white-collar jobs, has resulted in a shift towards sedentary lifestyles (Ofori-Asenso et al., 2016). For instance, busy schedules and long commuting hours associated with the economic transition in Ghana tend to promote the consumption of highly caloric diets and reduced physical activity (Ofei, 2005). Furthermore, societal perception of quality lifestyles and the associated nutritional transition in Ghana promote westernised meal/diet practices that contribute to obesity. Additionally, the perception of body size as a sign of good living in most cultures in Ghana may stimulate overeating and add to the obesity burden. This is evident in this chapter as 22% and 42% of the participants believed that being overweight is a sign of beauty and is not caused by overeating, respectively.

Comparatively, this chapter's crude overweight/obesity prevalence is higher than that reported by a similar study in Ghana (Yorke et al., 2021). This difference may be due to methodological heterogeneity between the two studies and not evidence of a reduced obesity burden. For instance, York et al. (2021) sampled adults aged ≥50 years, while this study focused on those

≥18 years. This age disparity probably accounted for the variation of the results, especially given the influence of age on the risk of obesity, as discussed in chapter 2, pages 42 and 43. Further, this study' age bracket was more inclusive of the adult population than York et al. (2021) 's; thus, its prevalence estimate may be more representative of adults' obesity prevalence in Ghana. Additionally, the dataset used in this analysis is current compared to York et al. (2021) 's 2014/2015 dataset, making the findings here an add-on to the evidence from York et al. (2021). Therefore, the new evidence could contribute to current interventions to address obesity in Ghana. But the analyses herein are mainly descriptive, so caution must be taken when interpreting the findings.

The sampling process was robust; however, the chapter did not conduct sample weighting to ensure an equal representation of groups (like age, sex etc. groups) in the final sample included in the analysis. This limitation could have resulted in selection bias and non-representative (Pfeffermann, 2017). Despite its importance, sampling weighting could have also biased the sample selection in this chapter, given its tendency to overrepresent one sample, which might not reflect the entire population. However, it is recommended that future similar studies include sample weighting at each sampling stage to guarantee accurate sample group selection. In addition, the chapter did not compute for survey design effect to ensure a thorough and efficient survey. Accounting for survey design effect could have addressed any potential impact of the unequal weighting (Chatrchi & Brisebois, 2015); however, logistics constraints limited this approach. Even though the assumptions for survey design effects, such as the assumption of equal strata, may not be applicable in practice, it is recommended for future obesity surveys to allow robust analysis and precise estimates.

5.4 Conclusion

This chapter addressed the lack of obesity dataset in Ghana, as identified in chapter 4, using a standardised survey approach and further described the characteristics of the collected data using descriptive and bivariate analyses. The next chapter explored one of the literature gaps identified in chapter 2 and established as a priority obesity research area in Chapter 3, i.e., the influence of the culture and religion variables on obesity.

Chapter 6: Cultural, religio- specific determinants of Obesity in Ghana

6.0 Introduction

The literature review (chapter 2) and stakeholders' engagement (chapter 3) showed the paucity of research on the role of religion and culture in understanding obesity, particularly in Ghana. The need to include religious and cultural leaders in behavioural change interventions is well documented. For example, religiosity has been associated with health-promoting behaviours, such as improved diet, attendance to preventive care, exercise, and moderate drinking, contributing to overall improved health status (Hill & Pargament 2008; Persynaki et al., 2017). In addition, the findings of a qualitative study on influencing health behaviour by Heward-Mills et al. (2018) concluded that health-related behavioural change was much more effective when propagated through the indigenous religious leaders. This finding was further reiterated through Shariff & Norenzayan's (2011) study. They found that individuals are more likely to behave morally or honestly when they believe in fearsome and punishing supernatural agents.

Additionally, experiences, environment and, in some cases, genetics form the beliefs and attitudes of a community. In turn, these beliefs influence the behaviour and determine their actions. Beliefs that are widely accepted become part of the culture and, in many ways, shape their society. It is then commonplace for the religious and cultural system to form a crucial component of thinking patterns and play a vital role in forming self-identity and collective communal identity, which then shapes attitudes and cultural norms and influences individual and group behaviour (Kelemen, 2004). Therefore, this chapter (Chapter 6) examined the relationship between religion, culture and obesity and identified factors that affect obesity in the various religious and cultural groups in Ghana. The analysis and subsequent findings of this chapter addressed the gap on the role of religion and culture on obesity in Ghana, as identified in chapter 2.

6.1 Methods

6.1.1 Data for analyses

For data analyses, the data from the survey were categorized as either dependent or independent variables. The dependent variable is the construct to be explained, and the independent variables are the explanatory factors to be explored.

6.1.2 Dependent variable

The dependent variable was obesity. Obesity could take various specifications, including continuous indicators; however, for this study, the indicator of obesity was characterized in line with the WHO standard specification and the reviewed literature (chapter 2). Overweight/obesity was measured with a binary variable indicating whether individuals recorded a BMI of 25kg/m2 or more during the survey.

6.1.3 Independent variables

Independent variables were two-fold: main and covariates. The main independent variables are the constructs which this chapter intends to explore their relationship with the dependent variable. These include indicators of cultural and religious affiliations: (a) metropolis, (b) tribes, and (c) religion. Table 29 shows the specification of these variables and their distribution. In the literature (chapter 2), the specification of these factors was mainly based on religion. This chapter used a more comprehensive specification including both tribes and metropolises because in Ghana, religion, tribes and metropolises are aligned. For example, the descriptive analysis of the survey shows that whilst 88% of the respondents in the Tamale metropolis are Muslims, that of Kumasi and Accra are 16% and 12%, respectively. The reverse pattern was observed for Christianity.

Table 29: Specification of the main independent variables

Independent Variables	**Number**	**Percentage (%)**
Metropolis		
Kumasi	1202	35.90%
Greater Accra	918	27.42%
Northern	1228	36.68%
Tribes		
Akan	1268	37.87%
Ga Dangme	306	9.14%
Ewe	145	4.33%
Mole Dagbani	1149	34.32%
Others	480	14.34%
Religious group		
Christians	1842	55.02%
Muslims	1400	41.82%
Others	106	3.17%

6.1.4 Covariates

The covariates identified in chapter 2 to correlate obesity were included to allow a robust estimation. Table 30 gives an overview of the covariates. They comprised socio-demographic, attitudes to obesity and health indicators. The categories with few observations were combined as appropriate whilst noting practical interpretation to facilitate model estimation.

Table 30: Overview of covariates

Other independent variables	Specification	Type
Gender	*Men =1* *Women=0*	Binary
Employed	*Yes =1* *No=0*	Binary
Health status	Very good=1 Good=2 Fair=3 Bad/very bad=4	Nominal
Personal income	< GH¢ 1000=1 GH¢ 1000 to less than GH¢ 2000 = 2 GH¢ 2000 and above=3	Nominal
Marital status	*Married=1* Informal living/never married=2 *Separated/divorced=3* Widowed=4	Nominal
Age	In years	Continuous
Agree 'Being overweight is something you inherit from your parents'	*Yes =1* *No=0*	Binary
Agree that 'Being overweight is a sign of good living'	*Yes =1* *No=0*	Binary
Agree that 'Being overweight is a sign of beauty'	*Yes =1* *No=0*	Binary
Agree that 'Being overweight is unhealthy'	*Yes =1* *No=0*	Binary
Agree that 'Most people who are overweight have put on weight because they eat too much'	*Yes =1* *No=0*	Binary
Agree that 'Most people who are overweight have put on weight because they exercise too little'	*Yes =1* *No=0*	Binary

6.1.5 Data Analyses

Since the analysis in chapter 5 covered the descriptive assessment of all the variables in this chapter, the analyses herein were mainly multivariate analyses. Therefore, regression models were formulated to assess the correlation between religion, tribes and metropolises, controlling for other explanatory variables. In addition, the differential effects of the other explanatory variables were assessed.

6.1.5.1 Regression models

Figure 8 demonstrated the conceptual framework of the regression estimations. The estimation was conducted in three stages. The first stage explored the relationship between obesity and the indicators for religion, tribe, and region, controlling for the covariates. In stage 2, separate regression models were run for each metropolis, tribe, and religion. In total, 11 regression models were fitted. In all, the estimation stage was a simulation analysis to demonstrate the potential impact of target variables (changeable) at the national and tribal, religious and metropolis levels.

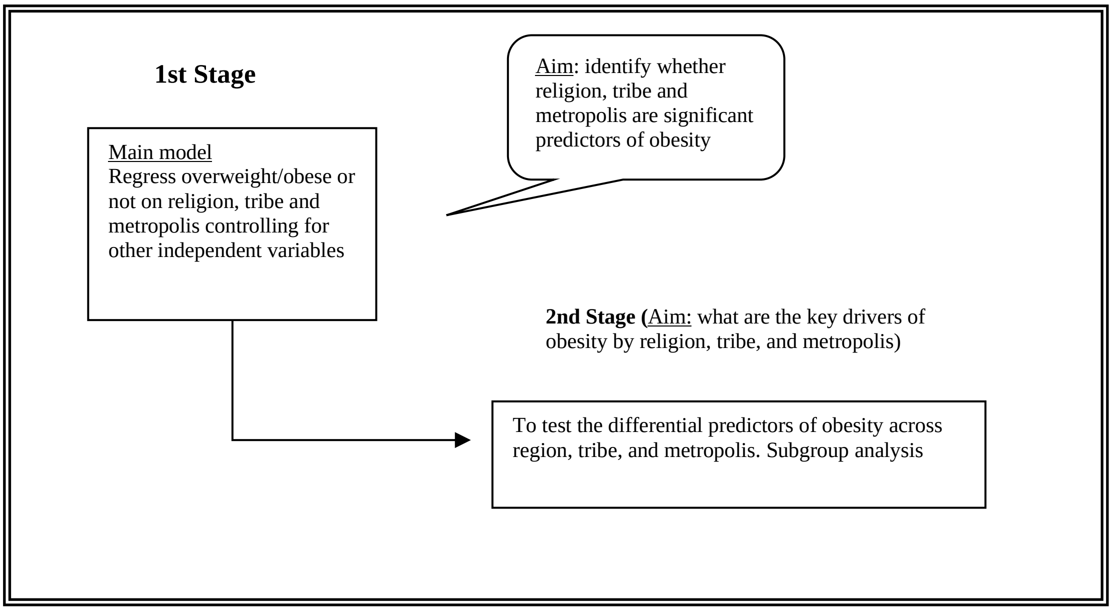


Figure 8: Conceptual framework for estimation of regression models. (Model was adapted from Anokye (2010). Available at: https://bura.brunel.ac.uk/handle/2438/4244.

As the dependent variable in all models is binary, a logit model was used for all the estimations. Binary regression models could either be logit or probit. The key variance between either model is the distribution of the error terms. For instance, whilst a logit model is specified on a logistic distribution, probit models follow a normal distribution (Jones, 2007). The choice between the two models is a matter of convenience or interpretation (Gujarati, 2003; Greene, 2008). In this chapter, logit models were estimated on whether a person would be overweight/obese.

In practice, the model is estimated as:

$Y_o = \beta_2 X_2 + e_2,$ $Y_o=1$ if $Y_a>0$; $Y_o=0$;

where $\beta_{2=}$ a vector of variables affecting the decision to become physically active

$e_{2\,=}$ the error term

All models were subjected to standard diagnostic tests. Thus, a Goodness of fit of the models was examined using the Hosmer Lemeshow test (Archer & Lemeshow, 2006; Hosmer & Lemeshow, 2000). Also, multicollinearity tests were conducted to examine the collinearity of the independent variables to improve the precision of estimates (Chatterjee et al., 2000; Gujarati, 1995). Furthermore, tolerance range was measured with the Variance Inflation Factor (VIF) (i.e., measures the amount of inflation of the standard error caused by collinearity) and 'tolerance', which shows the amount of collinearity a regression model can tolerate. For example, a tolerance value of 0.1 or less, and a VIF of 10 or more, shows highly collinear variables and are likely to provide imprecise estimates.

Marginal effects, estimated at sample mean values of independent variables, were computed for each variable. The marginal effects indicate how a unit increase or change from zero to one of an independent variable predicts the probability of an increase in the dependent variable (Greene, 2008). The threshold for statistical significance was set at $p \leq 10\%$ in all analyses because of the exploratory nature of the study. All analyses were undertaken using Stata version 13.

6.2 Results

Tables 31- 34 show the estimates for all regression models. All the models had a good fit. The results are first presented for the whole sample (stage 1) and then the 'group-specific models' (stage 2). Under each model, the correlation between obesity and main independent variables and the other explanatory variables are presented in that order.

6.2.1 Model 1: Main model – whole sample

6.2.1.1 Main independent variables

Table 31 indicates that Muslims were 11% more likely to be overweight/obese than Christians. Again, a significant relationship was found between culture and obesity. For example, compared with Akans, Gas had a higher likelihood (9%) of becoming obese. Mole Dagbanis were, however, 14% less likely to be obese. Similarly, residents of Tamale had a 13% lower probability than Kumasi residents of being overweight/obese.

6.2.1.2 Other explanatory variables

The most critical explanatory variable here was gender, as men were about 24% were less likely to be overweight/obese. This was followed by income, with high-income earners (GH¢ 1000 and above) having a 14%-22% higher likelihood of being overweight/obese. The next was employment status since about 5% of employed persons were more likely to be overweight/obese. Also, others who were more likely (5-7%) to be obese were people with relatively unfavourable health (good or fair health) compared to individuals with *very good* health. Disability had an even more significant correlation. People without a disability were 10% less likely to be overweight/obese.

Furthermore, age was positively related to overweight/obese, albeit minimal. Older individuals had less than a 1% increased probability of becoming overweight/obese. Also, marital status showed a significant relationship with overweight/obese. Compared with married people, singles or partners living together informally were 15% less likely to be overweight/obese. Finally, attitudes towards lifestyle behaviours did not influence whether an individual becomes overweight/obese or not**.**

Table 31: Estimation results of the probability of being overweight/obese

(Main model –stage 1)

Independent variables	**Coefficient**	**Marginal effects**
Religion[a]		
Muslims	0.446**	0.110
Others	0.090	0.015
Tribe[b]		
Ga	0.389**	0.093
Ewe	0.080	0.018
Mole Dagbani	-0.554**	-0.139
Others	-0.148	-0.037
Metropolis[c]		
Accra	0.176	0.045
Tamale	-0.529***	-0.127
Men[d]	-0.927***	-0.224
Employed[e]	0.208**	0.048
Health status[f]		
Good	0.230**	0.056
Fair	0.294*	0.070
Bad/very bad	-0.318	-0.081
Have a disability?[e]	-0.410**	-0.102
Personal income[g]		
GH¢ 1000 to less than GH¢ 2000	0.591***	0.142
GH¢ 2000 and above	0.973***	0.220
Marital status[h]		
Informal living/never married	-0.587***	-0.146
Separated/divorced	0.008	0.002
Widowed	-0.004	-0.001
Age	0.006*	0.002
Agree that 'Being overweight is something you inherit from your parents?[e]	0.042	0.011
Agree that 'Being overweight is a sign of good living'?[e]	0.013	0.003
Agree that 'Being overweight is a sign of beauty?'[e]	-0.113	-0.028
Agree that ‘Being overweight is unhealthy'?[e]	0.058	0.014

Independent variables	Coefficient	Marginal effects
Agree that 'Most people who are overweight have put on weight because they eat too much?'[e]	-0.086	-0.021
Agree that 'Most people who are overweight have put on weight because they exercise too little'?[e]	-0.069	-0.017
Constant	0.516***	
Observations	3348	
Pseudo R^2	0.096	
Goodness of fit[i]	0.542	

Significance levels: 1%****, 5%**, 10%* Reference categories: [a]Christians; [b]Akan; [c]Kumasi; [d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*; [i]Chi-square (8)= 6.95

6.2.2 Models 2-4: Moderating effect of religion on determinants of overweight/obesity

6.2.2.1 Main independent variables

Among religious groups, culture had minimal influence on obesity (Table 36). Only Christians showed a significant correlation, as 'Gas' were 10% more likely than Akans to be overweight/obese. The direction of effect for metropolis of residence was consistent across religious groups with residents of Tamale, whether Muslim or Christian, having a decreased likelihood (about 12%) of being overweight/obese compared with those of Kumasi. Conversely, Accra residents were more likely to be obese, irrespective of their religion, although only Muslims had a significant effect (11%).

6.2.2.2 Other explanatory variables

Like the main model (model 1), men were negatively associated with overweight/obesity across all religious groups (15-33%). Also, socio-economic indicators, including employment and income, showed a similar pattern but not as profound as the main model. Income had the second highest influence on overweight/obesity, albeit among only Christians and Muslims (13-23% higher likelihood of becoming obese). A significant positive association between employment and overweight/obesity (11%) was observed among only Christians. For age, a unit increase was associated with a <1% higher probability of becoming overweight/obese among Christians.

The strength and direction of the influence of marital status were consistent; singles had a 15% decreased likelihood of becoming overweight/obese. Health indicators mainly were instrumental among Muslims and, to a lesser extent, in Christians. In both groups, favourable health was negatively correlated with overweight/obesity (9-13%). A notable difference between model 1 and model 2 is the effect of attitudes on lifestyle behaviours. Unlike model 1, a significant correlation was observed here for attitudes. For example, Muslims who perceived heavy eating to cause overweight were 7% less likely to be overweight/obese. In contrast, in other religions, including African Traditional Religion, individuals who perceived overweight as unhealthy were 27% more likely to be overweight/obese. See table 32 for a summary of these findings.

Table 32: Estimation results of the probability of being overweight/obese across religious groups (stage 2)

	Christians (model 2)		**Muslims (model 3)**		**Others (model 4)**	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Tribe[b]						
Ga	0.408**	0.096	0.263	0.066	1.236	0.292
Ewe	0.166	0.040	-1.832	-0.350	0.153	0.038
Mole Dagbani	-0.035	-0.008	-0.721	-0.178	-1.978	-0.404
Others	-0.273	-0.067	-0.294	-0.073	-0.326	-0.080
Metropolis[c]						
Accra	0.120	0.029	0.446*	0.111	-0.323	-0.080
Tamale	-0.483**	-0.120	-0.516**	-0.128	1.285	0.298
Men[d]	-1.174***	-0.283	-0.605***	-0.149	-1.396**	-0.334
Employed[e]	0.430***	0.106	-0.031	-0.008	-0.716	-0.177
Health status[f]						
Good	0.178	0.043	0.328**	0.081	-0.287	-0.071
Fair	0.152	0.037	0.512**	0.127	0.286	0.071
Bad/very bad	-0.213	-0.053	-0.453	-0.110	-2.254	-0.407
Have a disability?[e]	-0.379**	-0.090	-0.529**	-0.131	-0.462	-0.115
Personal income[g]						
GH¢ 1000 to less than GH¢ 2000	0.562***	0.131	0.616***	0.152	-[l]	
GH¢ 2000 and above	1.096***	0.229	0.940***	0.225		
Marital status[h]						
Informal living/never married	-0.676***	-0.164	-0.558**	-0.137	-0.416	-0.103
Separated/divorced	-0.139	-0.034	0.181	0.045	0.272	0.118
Widowed	-0.305	-0.075	0.418	0.104	0.631	0.155
Age	0.010**	0.002	0.001	0.000	-0.030	-0.007
Agree that 'Being overweight is something you inherit from your parents'[e]	0.039	0.010	0.127	0.032	-0.752	-0.186

	Christians (model 2)		Muslims (model 3)		Others (model 4)	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Agree that ‘Being overweight is a sign of good living’[e]	-0.042	-0.010	0.040	0.010	0.272	0.068
Agree that ‘Being overweight is a sign of beauty’[e]	-0.222	-0.055	0.019	0.005	-0.769	-0.185
Agree that ‘Being overweight is unhealthy’[e]	-0.068	-0.017	0.141	0.035	1.133*	0.269
Agree that 'Most people who are overweight have put on weight because they eat too much’[e]	0.086	-0.021	-0.267**	-0.067	-0.285	-0.071
Agree that 'Most people who are overweight have put on weight because they exercise too little’[e]	-0.027	-0.006	-0.075	-0.019	-0.191	-0.048
Constant	0.420		1.380**		3.144**	
Observations	1842		1400		106	
Pseudo R^2	0.115		0.082		0.178	
Goodness of fit	0.500[i]		0.138[J]		0.749[k]	

Significance levels: 1%****, 5%**, 10%*Reference categories: [b]Akan; [c]Kumasi;
[d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*; [i]Chi-square (8)= 7.34; [j]Chi-square (8):12.31; [k]Chi-square (8):5.08; [i]ncome was predicted successfully

6.2.3 Models 5-7: Moderating effect of metropolis on determinants of overweight/obesity

6.2.3.1 Main independent variables

Table 33 shows that the moderating effect of metropolises on the determinants of overweight/obesity was not as prominent as that of religion. For example, the effect of culture (tribe) was similar in direction and strength to the main model, although no effect was found in Kumasi. A similar pattern was observed for religious groups, with Muslims having an increased likelihood of becoming obese (14%).

6.2.3.2 Other explanatory variables

Whilst the effect of gender was similar to previous models (1-4), the magnitude of the correlation was relatively lower here (9-30%). Age, health and marital status showed a parallel pattern. Conversely, income had a greater effect here, with higher income earners having a higher probability (9-24%) of becoming overweight/obese across all metropolises. Like model 1, attitudes related to lifestyle behaviours had no significant relationship with overweight and obesity.

Table 33: Estimation results of the probability of being overweight/obese across metropolis (stage 2)

	Kumasi (model 5)		**Accra (model 6)**		**Tamale (model 7)**	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Tribe[b]						
Ga			0.486**	0.107	-0.978	-0.211
Ewe			0.109	0.024	1.320*	0.308
Mole Dagbani			-0.421	-0.100	0.0951	0.023
Others			-0.126	-0.029	0.694*	0.172
Religion[c]						
Muslims	0.128	0.031	0.684**	0.141	0.251	0.061
Others	0.529	-0.125	-0.246	-0.058	0.302	0.075
Men[d]	-1.263***	-0.101	-1.265***	-0.295	-0.390***	-0.095
Employed[e]	0. 405**	0.106	0.335*	0.078	-0.059	-0.014
Health status[f]						
Good	0.092	0.023	0.078	0.018	0.412**	0.100
Fair	-0.003	-0.001	0.206	0.046	0.609	0.151
Bad/very bad	-0.712*	-0.176	-0.092	-0.021	-0.034	-0.008
Have a disability?[e]	-0.612**	-0.145	-0.113	-0.025	-0.520**	-0.129
Personal income[g]						
GH¢ 1000 to less than GH¢ 2000	0.354*	0.086	0.808***	0.166	0.630***	0.156
GH¢ 2000 and above	0.715**	0.165	1.168**	0.210	0.988***	0.241
Marital status[h]						
Informal living/never married	-0.663***	-0.163	-0.492**	-0.113	-0.682**	-0.160
Separated/divorced	-0.192	-0.048	0.108	0.024	-0.021	-0.005
Widowed	-0.414	-0.103	-0.044	-0.010	0.503	0.125
Age	0.012**	0.003	0.012*	0.000	-0.005	-0.001
Agree that 'Being overweight is something you inherit from your parents'[e]	0.157	0.039	-0.083	-0.019	0.046	0.011

	Kumasi (model 5)		Accra (model 6)		Tamale (model 7)	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Agree that 'Being overweight is a sign of good living'[e]	-0.188	-0.047	0.163	0.036	0.067	0.017
Agree that 'Being overweight is a sign of beauty'[e]	-0.155	-0.039	-0.062	-0.014	-0.076	-0.019
Agree that 'Being overweight is unhealthy'[e]	-0.118	-0.029	0.238	0.055	0.100	0.024
Agree that 'Most people who are overweight have put on weight because they eat too much'[e]	0.042	0.010	-0.100	-0.023	-0.216	-0.053
Agree that 'Most people who are overweight have put on weight because they exercise too little'[e]	-0.073	-0.018	-0.241	-0.055	0.053	0.013
Constant	0.717*		0.183		-0.205*	
Observations	1202		918		1228	
Pseudo R^2	0.117		0.112		0.060	
Goodness of fit	0.281[i]		0.885[J]		0.722[k]	

Significance levels: 1%****, 5%**, 10%*Reference categories: [b]Akan; [c]Christians;
[d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*; iChi-square (8)= 9.78; [j]Chi-square (8):3.68; [k]Chi-square (8): 5.33; [l] predicted successfully.

6.2.4 Models 8-12: Moderating effect of culture on determinants of overweight/obesity

6.2.4.1 Main independent variables

Table 34 below shows that the effect of religion was magnified by culture. The probability of Muslims being obese was highest, with an increased likelihood of 18% (from 11% in the main model). This effect, though, was significant only in the minority tribes.

6.2.4.2 Other explanatory variables

The magnitude of the relationship between gender and overweight/obesity was highest in this set of models. For example, Ewe men were 40% less likely to be obese than Ewe women. Also, men from the Akan and minority tribes had a reduced probability of being overweight/obese, 31% and 18%, respectively. Unlike previous models, the correlation between health status and overweight/obesity was mixed. Whilst a positive association was found among Gas (10%) with unfavourable health status, the relationship was negative among Ewes, with individuals with good health status showing a 25% less likelihood of being overweight/obese than those with *very good* health status.

Culture, like religion, demonstrated the effect of attitudes on the probability of becoming overweight/obese. For example, among 'Gas', people who think obesity is hereditary were 11% more likely to be overweight/obese. In Ewes, respondents who perceived overweight as unhealthy had a 22% probability of being overweight/obese. However, members of minorities who think obesity is a sign of good living were 15% less likely to be overweight/obese.

Table 34: Estimation results of the probability of being overweight/obese across tribes (Stage 2)

	Akan (model 8)		**Ga (model 9)**		**Ewe (model 10)**		**Mole Dagbani (model 11)**	**Others (model 12)**		
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficie nt**	**Marginal effects**	**Coefficie nt**	**Marginal effects**	**Coefficie nt**	**Margin al effects**
Metropolis[b]										
Accra	0.013	0.003	-12.411	-0.308	1.171*	0.282	0.189	0.047	0.447*	0.107
Tamale	-1.136***	-0.271	-15.342	-0.793	1.763	0.290	-0.709**	-0.175	0.185	0.045
Religion[c]										
Muslims	0.701	0.160	1.254	0.170	-1.479	-0.352	-0.168	-0.042	0.693**	0.168
Others	0.325	0.078	0.112	0.021	-0.084	-0.020	-0.785	-0.176	0.413	0.097
Men[d]	-1.311***	-0.316	-1.291***	-0.266	-1.73***	-0.402	-0.433**	-0.106	-0.722**	-0.177
Employed[e]	0.276 **	0.068	0.191	0.037	0.999*	0.240	-0.074	-0.018	0.708**	0.174
Health status[f]										
Good	0.081	0.020	0.556*	0.103	-1.055**	-0.248	0.376**	0.092	0.411*	0.100
Fair	-0.038	-0.009	1.329**	0.191	-1.170	-0.283	0.564**	0.140	0.595	0.137
Bad/very bad	-0.491	-0.122	0.690	0.109	-2.242	-0.485	-0.278	-0.067	-0.724	-0.179
Have a disability?[e]	-0.633**	-0.149	0.556	0.019	0.549	0.131	-0.558**	-0.139	-0.498	-0.116
Personal income[g]										
GH¢ 1000 to less than GH¢ 2000	0.562**	0.134	1.096*	0.167	0.444	0.098	0.563**	0.140	0.472	0.112
GH¢ 2000 and above	1.05**	0.165	1.797	0.205	0.535	0.113	0.733**	0.181	1.122*	0.236
Marital status[h]										
Informal living/never married	-0.721***	-0.177	-0.492**	-0.041	-0.676	-0.157	-0.644**	-0.152	-0.491*	-0.120
Separated/divorced	-0.144	-0.036	0.108	-0.004	-1.174	-0.285	-0.027	-0.007	1.331**	0.268
Widowed	-0.719**	-0.178	-0.044	-0.038	1.588	0.277	0.694**	0.172	0.299	0.071

	Akan (model 8)		Ga (model 9)		Ewe (model 10)		Mole Dagbani (model 11)	Others (model 12)		
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Age	0.008	0.002	0.018	0.003	0.014	0.003	-0.003	-0.001	0.018*	0.004
Agree that ‘Being overweight is something you inherit from your parents’[e]	-0.063	-0.015	0.560*	0.111	-0.660	-0.146	0.059	0.015	0.164	0.040
Agree that ‘Being overweight is a sign of good living’[e]	0.022	0.005	-0.018	-0.003	-0.252	-0.059	0.189	0.047	-0.615**	-0.152
Agree that 'Being overweight is a sign of beauty’[e]	-0.278	-0.068	-0.262	-0.052	-0.436	-0.104	-0.065	-0.016	0.252	0.061
Agree that ‘Being overweight is unhealthy’[e]	-0.191	-0.029	0.092	0.017	0.933*	0.224	0.116	0.028	0.230	0.057
Agree that ‘Most people who are overweight have put on weight because they eat too much’[e]	0.094	0.023	-0.362	-0.068	-0.182	-0.0428	-0.212	-0.052	-0.263	-0.064
Agree that ‘Most people who are overweight have put on weight because they exercise too little’[e]	0.038	0.009	0.260	0.050	-0.709	-0.157	-0.026	-0.006	-0.373	-0.090
Constant	0.717*		11.807		-0.489		1.056		-0.847	
Observations	1268		306		145		1149		480	

	Akan (model 8)		Ga (model 9)		Ewe (model 10)		Mole Dagbani (model 11)	Others (model 12)		
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**	**Coefficie nt**	**Marginal effects**	**Coefficie nt**	**Marginal effects**	**Coefficie nt**	**Margin al effects**
Pseudo R^2	0.116		0.112		0.235		0.056		0.164	
Goodness of fit	0.751[i]		0.455[J]		0.768[k]		0.041[m]		0.406[n]	

Significance levels: 1%****, 5%**, 10%*Reference categories: [b]Kumasi; [c]Christians;
[d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*; [i]Chi-square (8)= 5.06; [j]Chi-square (8)7.78; [k]Chi-square (8): 4.90; [l] predicted successfully; [m]Chi-square (8): 16.1; [n]Chi-square (8): 8.2

6.3 Discussion

This study is the first comprehensive research, covering over 81% of the metropolises in Ghana, to have investigated the relationship between culture, religion, and obesity. A major contribution of this chapter to the literature is the finding that religion and culture are key to the determinants of obesity in Ghana. This relationship further moderates the inter-correlation between obesity and socio-economic indicators. The results here are consistent with a cross-sectional descriptive study of adults in Accra who found BMI to be lower in other tribes compared to Akan (Amoah, 2003). Similarly, the findings here are corroborated by a similar study that explored the relationship between obesity and religion in Nigerian women aged between 20 to 49 years (Fagunwa, 2017). They found Christian to be two times more likely to be overweight and obese than people with other religious affiliations.

While the role of religion in obesity is well explored or investigated elsewhere, particularly in Northern America and Asia (Lancaster et al., 2014; Bharmal et al., 2015), there are limited studies in Ghana. In terms of rating, our results are comparable with the literature. For example, Asenso et al. (2016) found residents in greater Accra (55.2%) as more obese, and overweight compared to Ashanti (43.4%) and the northern region (32.4%). As reported in the literature, the a-priori expectations on the relationship between the covariates (age, gender, marital status, health status, employment, and income) were met in this study. Notably, the specification of health status in the literature and this study are comparable but not exact. The only studies (n=2) found in chapter 2 that investigated the relationship between health and obesity measured health as having hypertension or diabetes. However, in this study, health was measured as a self-assessment of health in general. This approach was in line with standard national surveys, for example, the health survey for England. Nonetheless, the relationship between obesity and health (favourable) using either specification was found to be positive.

The specification of culture in this study can be questioned, as culture is often referred to as a collection belief (Rajbhandar et al., 2014). Therefore, the use of geographical setting as an indicator can be flawed. One can argue that we could have multiple and varied beliefs in a cosmopolitan setting such as Accra and Kumasi. Nonetheless, Soini & Birkeland (2014) debate that culture and society, for example, metropolises, are often inter-linked. This was investigated through further exploration of the dataset and the findings showed that the metropolises were predominantly occupied by specific tribes. For example, in the Tamale metropolis, over 80%

of the residents are Mole Dagbani, while in the Kumasi metropolis, over 70% of the inhabitants belong to one cultural group, Akan. However, this pattern was not observed in the Greater Accra metropolis as our results showed no majority tribe. But this may not significantly impact our specification as the Greater Accra metropolitan constitutes about 27% of the sample. This assumption was tested to verify its empirical grounding. The testing involved re-running the base-case regression model and excluding observations from the Greater Accra. This analysis produced results that were consistent with that of the base-case model. That notwithstanding, further studies could incorporate anthropological constructs on culture to depict a more robust and accurate specification of culture.

The analyses in this chapter have a few limitations. Firstly, as discussed in chapter 2, BMI as a gold standard measure of obesity is fraught with limitations. For example, Antonopoulos et al. (2016) argue that BMI is flawed in depicting the association between excess weight, fat, and muscle or bone mass. Nonetheless, to date, BMI remains the gold standard for measuring obesity (WHO, 2021). Secondly, the representativeness of the data collected for analyses could be questioned. This is because the coverage for data collection included three out of six metropolises in Ghana. This sample potentially limits the generalisations and transferability of the results to other metropolises in Ghana. However, the selected metropolis covers the vast majority of Ghana and are the most populous (GSS, 2017). Moreover, the context of the analysis here further lends credence to this approach as all the major tribal, cultural, and religious groups were identified in the selected metropolis.

There are also several strengths in the analyses. Firstly, there was minimal researcher bias in the data collection given that the field administration was mainly conducted by GSS, the custodian of data collection in Ghana. Secondly, the model diagnostics demonstrated goodness of fit of the data; this can be considered a significant contribution, given that less than 15% of the papers reviewed in chapter 2 conducted model diagnostic. Thirdly, the use of a 1% error term in sample size calculation advances the precision of the analyses. Finally, whiles the comparison of sample size is not straightforward, the number of observations used in this survey could be argued as the most extensive primary data collection in the literature on obesity in West Africa.

Chapter 6 provides an indication for future empirical analysis in this thesis. While the analysis herein has helped explain the determinants of obesity, insufficient knowledge was provided on the complexity of behaviour patterns in obesity. It is well documented that obesity is a function of energy imbalances, with the key drivers of this imbalance being physical activity and diet. The trade-off between these two risk factors is critical in determining the BMI of individuals. Such knowledge is critical in informing policy targets and strategies in managing obesity. As shown in Sweet & Fortier (2010), multiple health behaviour interventions (physical activity and diet), as demonstrated, are more effective in managing obesity compared with single health interventions. Such strategies provide individuals with a wide array of policy options and hence the flexibility to adopt health behaviour changes that could be onerous, particularly at inception; therefore, it is essential to understand the trade-offs between physical activity and diet and their associated correlates. This argument, together with the literature gap and stakeholders' research direction on assessing the relationship between obesity and lifestyle behaviours informed the analyses in chapter 7.

Chapter 7: Interrelationship between lifestyle behaviours related to energy balance

7.0 Introduction

Chapter 6 analysed the cultural and religious-specific determinants of obesity in general. However, as indicated in chapters 2 and 3, the complexity of the obesity epidemic requires a holistic approach to understand the critical arguments connected to energy imbalance that causes obesity - physical activity and uptake of a healthy diet (WHO, 2004). A problem, however, is that the evidence-based on understanding the interrelationship between individual preferences regarding these lifestyle choices is lacking, particularly in Ghana.

This chapter aimed to fill this gap in knowledge by exploring the interrelationship between physical activity and uptake of a healthy diet and assessing which factors affect them jointly and separately. Whilst it is acknowledged that several lifestyle choices, including smoking, play important roles in the development of obesity, this chapter focussed on the choices related to energy balance (i.e., food and physical activity) as they are the main focus of policies to manage obesity (WHO, 2004, Sallis, 2009). Physical activity itself is multi-faceted and includes a wide range of activities such as sports and exercise, housework, and occupational activity (WHO, 2011). Whilst the importance of increasing movement among people is acknowledged, the focus here is the sports and exercise component of physical activity. It represents a planned aspect often aimed at attaining health benefits (Department of Health, 2004) and, thus, can be relatively easily targeted by policies to reduce obesity. In addition, it is subjected to less measurement error since sports and exercise activities are usually premeditated and hence easier to recall by respondents (Craig & Mindell 2009).

As shown in chapter 2, the studies have mainly either focused on physical activity or diet separately; although, the importance of both physical activity and diet in the prevention of obesity is well documented (WHO, 2011). This is corroborated by a recent literature review (that included Delphi survey and panel meetings of experts) of instruments for obesity prevention (Faulkner et al., 2011). Previously, the focus of obesity interventions has predominantly been on changing single behaviours, which is less effective, and efficient compared with intervening on more than one risk behaviours simultaneously (Spring et al., 2010). Therefore, the important question is what factors affect diet and physical activity, and are the factors (dis)similar and in the same direction – thus requiring similar or different policy target variables?

7.1 Methods

7.1.1 Data

The data used for the analysis was obtained in conjunction with GSS, as discussed in chapter 5. Demographic variables, physical activity, and diet were specified in line with the literature. Physical activity was defined as participation (or not) in sports and exercise and other physical activities (captured through traditional activities in the context of Ghana, e.g., shea nut picking, farming, fishing). Defining unhealthy eating is problematic as nutritionally defined `balanced food' does contain some high-calorie, high-fat ingredients. Likewise, defining `healthy lifestyle choice' does contain, for example, eating some `unhealthy' food. Therefore, in line with the WHO & the Food and Agriculture Organisation (FAO) recommended level, a healthy diet was specified as consuming fruit and vegetables each day (WHO/FAO, 2004). This accounts for the consumption of other elements of the composite diet for the day. The underlying assumption is that some choices are made in their own right, some displace others, and some are made together.

7.1.2 Data Analysis

The data analysis was two-fold: descriptive statistics and multivariate analysis. The former focused on the summary statistics of physical and diet and any potential correlation between them. The assessment of the correlation between physical activity and diet is informed by a range of possibilities that can happen between peoples' endeavours in lifestyle. For example, people could be physically (in)active and eat (un)healthy. These possibilities were estimated using proportions.

As Knauper et al. (2004) suggest, a person who craves unhealthy food but is aware of its high saturates/calories could eat the food and neutralise its negative health consequences by doing sports and exercise to burn off the excess calories (substitution effect). Conversely, a psychologist might argue that the uptake of healthy behaviour (sports and exercise) could lead to the uptake of another healthy behaviour (healthy food) because people would transfer their knowledge and confidence gained in one behaviour to another (Niggs et al., 2009). The implication of this hypothesis for public health is far-reaching as people would tend to complement one behaviour with the other in search of a balanced lifestyle. This further means that complementary effects between sports and exercise and diet can equally be possible (Nigg et al., 2011).

Both substitution and complementary effects could also `co-occur' whilst the occurrence of either effect could be a function of the ordering of behaviours as individuals may explicitly endorse the idea of compensating for healthy behaviour (Niggs et al., 2011). Thus, depending on the type and degree of motivation (or perceived benefits associated with the behaviours), people may substitute (complement) these health behaviours at a given time. A few studies elsewhere have explored this interrelationship but only partially, with attempts excluding physical activity and mainly limited to assessing the interaction between unhealthy and healthy eating via price changes using undergraduate students from the Netherlands, Taiwan, and the USA (Geisen et al., 2010; Yang et al., 2010) or US mothers (Epstein et al., 2007). For brevity, the description of the independent variables is not repeated here (see Chapter 5 for details).

7.1.2.1 Regression models

Previous analyses are heavily biased towards independence assumptions of lifestyle factors (as discussed in chapter 2). Therefore, single-equation regression models are usually fitted for physical activity participation and adoption of a healthy dietary habit. However, modelling the preferences for physical activity and a healthy diet is complicated as the functional forms could be based on varying process modelling frameworks, i.e., related, or unrelated preferences. Therefore, any attempt to model determinants of these preferences needs to correctly specify the dynamics of the decision process because missing this might lead to inefficient estimates and incorrect policy recommendations. Nonetheless, to date, it is unclear which of these modelling frameworks produces consistent and better estimates. This thesis will contribute to this debate by fitting joint estimators that account for either decision process or examine which produces better estimates.

This assumption of independence may be limiting because one could argue that individuals know *a priori* all possible scenarios in which they want to do various activities and gain a defined level of satisfaction from all those activities. Moreover, in technical terms, researchers do not always observe variables that may synergise between the two decisions—as such, just accounting for observables to study one behaviour at a time, ignoring the other may be erroneous.

As this research allows for joint effects in lifestyle behaviours, the subsequent regressions will need to correct the endogeneity effect arising from the fact that the error terms are correlated

(Greene, 2008). Therefore, a system of equations was estimated. Equation 1 specified an indicator of sports and exercise participation as a function of socio-demographic factors, health, and other indicators. Equation 2 specified an indicator of healthy food consumption as a function of socio-demographic factors, health, and other indicators.

In practice, a bivariate probit model (Mullahy, 2016) was fitted to estimate maximum-likelihood two-equation joint nonlinear models that indicate an individual's participation in physical activity (Y1) and consumption of healthy diet (Y2), respectively:

$$Y_p = X_p \beta_p + \varepsilon_p \qquad (1)$$

$$Y_h = X_h \beta_h + \varepsilon_h \qquad (2)$$

where Xp and X_h are correlates of physical activity and healthy diet respectively. $X_p \neq X_h$ and we also require $T > K_i$ (where T=total observations; K_i= total regressors).

$$\varepsilon = [\varepsilon_p, \varepsilon_h]$$

regressors are assumed to be strictly exogenous:

$$E\,[\varepsilon \mid X_p, X_h] = 0$$

For any given equation the errors terms are uncorrelated across observations but correlated across equations (1) and (2). Therefore:

$$E\,[\varepsilon_p\, \varepsilon_h \mid X_p, X_h] = \sigma_{ph}\, I_T$$

The null hypothesis (i.e., p >0.05) is that the estimation includes two probit models that can be estimated independently. This is tested via the rho and log-likelihood ratio (LR) statistics. The latter shows the strength of correlation, and the former proves (not) the null hypothesis. If the LR statistic is significant (p <0.05), it means the two equations, physical activity, and healthy diet, are correlated and ought to be jointly estimated and vice versa. Marginal effects, estimated at sample mean values of independent variables, were computed for each variable. The threshold for statistical significance was set at p≤10% in all analyses because of the exploratory nature of the study. All analyses were undertaken using Stata version 13.

7.2 Results

Table 35 and figure 9 provide credence to the hypothesis alluded to in the introduction and methods sections, i.e., people engaged in a combination of lifestyle behaviours. About close to half of the sample (45%; n=1520) did not engage in any of the healthy lifestyles. Thus, only a few were both physically active and adopted a healthy dietary habit (10%; n=341).

Table 35: Possible combinations of participation in physical activity and consumption of healthy diet

Combinations of physical activity and healthy diet	**Proportion**	**Number of observations**
Physically active and adopts healthy dietary habit	10.19%	341
Physically active and *does not* adopt healthy dietary habit	35.13%	1176
Not physically active and adopts healthy dietary habit	9.29%	311
Not physically active and *does not* adopt healthy dietary habit	45.40%	1520

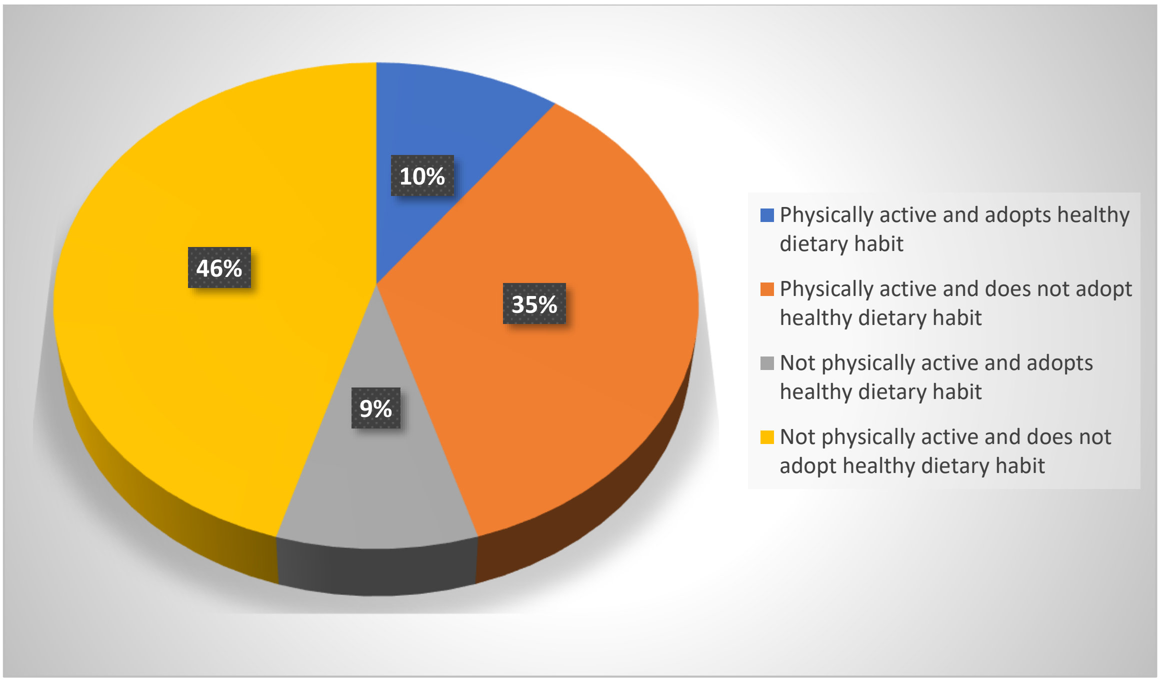


Figure 9: Possible combinations of participation in physical activity and consumption of healthy diet

Table 36 below showed the regression estimates for the joint estimation of physical activity and healthy diet. The results show that both equations are correlated (*r*=0.085), and that such correlation is not by chance ($p<0.05$). Therefore, modelling them separately as done in the literature might be incorrect, leading to biased estimates. Next, the correlate of the equations is presented in the account of each.

7.2.1 Physical activity equation

Area of residence had the most significant association with physical activity. Residents of Tamale metropolis compared with Kumasi residents were 26% less likely to engage in physical activity. Another important factor was gender, with men having a 17% more likelihood of being physically active. Religion had a mixed relationship with physical activity. While Muslims were more likely to be physically active (about 1% more) than Christians, individuals in other religions were 5% less likely. Tribe had a slightly higher but positive effect. Mole Dagbani's and other minority tribes had a 7-9% higher probability of being physically active than Akans. Other variables with a positive effect included income and employment. High-income earners (> GH¢ 1000 per month*)* and employed were 3-5% and 6% probable, correspondingly, to engage in physical activity.

As expected, unfavourable health was negatively associated with physical activity (about 4% less likelihood). The effect of attitudes was more prominent here than in the obesity equation, with 83% (n=5/6) of the indicators for attitude showing a significant but mixed correlation. Individuals who perceived overweight as either a sign of beauty, good living, or hereditary were 4-6% less likely to be physically active. On the other hand, perceiving that obesity is unhealthy or caused by heaving eating was associated with an increased likelihood (4%) to be physically active.

7.2.2 Healthy diet equation

Overall, the healthy diet equation had fewer predictors. Notably, it was neither associated with religion, culture, nor metropolis of residence. Conversely, marital status was associated with a healthy diet but not physical activity. People who were not married were 3% less likely to eat healthily. Where a variable was significantly associated with both physical activity and healthy diet, it showed the same direction of effect though with varying levels of magnitude. The only exception was gender. While men were more likely to be physically active, they were less likely to eat healthily (around 5%-reduced probability). Unfavourable health was associated with a 3% decrement in the probability to eat healthily. High income had a positive effect (3%). Half of the attitudinal variables, e.g., underweight being hereditary (ME: -0.021), a sign of good living (ME: -0.003) and little exercise (ME: 0.021) were significantly associated with healthy eating/diet. See table 40 for the results of the physical activity and healthy diet equation.

Table 36: Joint estimation results of the probability for doing physical activity and eating healthily

	Physical activity		**Healthy Diet**	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Religion[a]				
Muslims	0.713***	0.008	-0.003	-0.002
Others	-0.789***	-0.052	0.167	0.034
Tribe[b]				
Ga	0.149	0.067	-0.144	-0.028
Ewe	0.139	0.063	-0.136	-0.026
Mole Dagbani	0.236*	0.093	-0.125	-0.033
Others	0.216**	0.072	-0.015	-0.018
Metropolis[c]				
Accra	-0.176	-0.229	0.122	0.072
Tamale	-0.529***	-0.256	0.119	0.075
Men[d]	0.474***	0.166	-0.101*	-0.047

	Physical activity		Healthy Diet	
Independent variables	**Coefficient**	**Marginal effects**	**Coefficient**	**Marginal effects**
Employed[e]	0.148**	0.056	-0.074	-0.022
Health status[f]				
Good	-0.123**	-0.003	-0.290***	-0.031
Fair	-0.164*	-0.037	-0.142	-0.008
Bad/very bad	-0.271	-0.061	-0.261	-0.018
Have a disability?[e]	-0.077	-0.022	-0.025	-0.002
Personal income[g]				
GH¢ 1000 to less than GH¢ 2000	0.235***	0.025	0.328***	0.027
GH¢ 2000 and above	0.464***	0.051	0.491***	0.023
Marital status[h]				
Informal living/never married	-0.063	-0.001	-0.161**	-0.017
Separated/divorced	-0.154	-0.027	-0.208*	-0.018
Widowed	0.126	-0.011	0.334**	0.039
Age	-0.002	-0.000	-0.004*	-0.000
Agree that 'Being overweight is something you inherit from your parents'[e]	-0.244***	-0.039	-0.287***	-0.021
Agree that 'Being overweight is a sign of good living'[e]	-0.163**	-0.040	-0.104*	-0.003
Agree that 'Being overweight is a sign of beauty'[e]	-0.138**	-0.056	0.096	0.025
Agree that 'Being overweight is unhealthy'[e]	0.148**	0.043	0.041	0.005
Agree that 'Most people who are overweight have put on weight because they eat too much'[e]	0.016	0.010	-0.035	-0.006
Agree that 'Most people who are overweight have put on weight because they exercise too little'[e]	0.215***	0.038	0.264***	0.021
Constant	0.080		-0.493***	
Observations	3348			
Rho	0.085**			

Significance levels: 1%****, 5%**, 10%*Reference categories: [a]Christians; [b]Akan; [c]Kumasi; [d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*.

7.3 Discussion

As demonstrated in the literature review in Chapter 2, this is the first study to explore joint estimators for examining diet and physical activity determinants, particularly in sub-Saharan Africa. Thus, it contributed novel knowledge on the interrelationship between physical activity, diet, and obesity in Ghana. The findings showed the reliance on single estimators and the independence assumption of the influence of lifestyle variables on obesity may be flawed (as discussed in Chapter 2). Therefore, single-equation regression models for participation in physical activity and consumption of a healthy diet may be insufficient. Joint estimators that account for the correlation between the residuals of both behaviours have been shown to correctly identify the dynamics of the functionality between the two sets of regressions. Although there is limited evidence in the obesity field to relate the findings to elsewhere in lifestyle behaviour research, Anokye & Stamatakis (2016) showed similar findings. They found joint estimation for sedentary behaviour and physical activity to produce more efficient estimates than single estimators.

The predictors of physical activity and diet were comparable but slightly dissimilar. Participation in physical activity was a function of both religion and culture, but none of these correlates was related to consuming a healthy diet. Conversely, marital status determined diet but not physical activity. The typical indicators of both behaviours included attitudes towards overweight, health status and income. Interestingly, men were more likely to be physically active but less likely to eat well. The positive association between income, physical activity and a healthy diet is probably due to the purchasing power argument detailed in the discussion section of chapter 2. The relationship between men and physical activity may be emanating from the perception around physical activity and body image. For example, evidence from a current meta-analysis suggests that contemporary description of masculinity, male buoyancy and general body image may feed into the narrative around physical activity participation among the Male population (Bassett-Gunter et al., 2017).

However, the mechanism informing the relationship between physical activity and body image is unclear. For instance, some evidence suggests that *actual* changes in body composition associated with physical activity that align with current societal expectations of masculinity influence the desire to exercise (Ginis et al., 2005). Other data also indicate that the *perceived* changes in physical appearance associated with physical activity influence physically activity engagement (Bassett-Gunter et al., 2017). While the debate on perceived and actual body changes associated with men and physical activity participation continues, other studies have also identified social media as the current driver for increased men's physical activity participation (Gültzow et al., 2020). Social media trends promote the desire for a masculine physique, mainly through exercises, among its users. However, it is unclear whether that desire relates to actual participation in physical activity among men in the real world. Also, it may be necessary to investigate whether the social media promotion of men body image increases the likelihood of physical activity participation among users compared to non-users.

The relationship between men and the less likelihood of eating a healthy diet is similar to the findings of Saquib et al. (2016) and Masella & Malorni (2017). This finding may be mirroring sex differences in dietary habits. For example, Saquib et al. (2016) showed that women prefer eating fruits and vegetables to fat-based foods while men prefer the latter. Also, this difference could be linked to advertising companies that promote thinness as beauty among women and not men (Masella & Malorni, 2017). It may also be biologically induced, as demonstrated by Varì et al. (2017) or probably an artefact of the cultural and social characteristics of the men and women in the studies' samples. Notwithstanding, this finding implies that obesity-related health promotion policies must factor in these biological and behavioural differences between women and men when promoting healthy lifestyle behaviours.

7.4 Conclusion

This chapter examined determinants of physical activity and diet, indicators of obesity, using joint estimators. The findings showed some similarities and differences in the factors that determine these indicators. This suggests that policies need to be varied, where necessary to address the determining factors. The next chapter, chapter 8, explored multi-level determinants of obesity.

Chapter 8: Multi-level determinants of obesity

8.0 Introduction

The underlying argument made in chapter 2 of this thesis and backed particularly by the stakeholder's perception (chapter 3) relates to the potential influence of area-level factors on the propensity that an individual becomes obese or not. In addition to the statistically attractive properties of estimating area level effects (Petttigrew, 2006), such analysis could enrich policy formulation by facilitating the comprehensive coverage of different levels of determinants of behaviour (Molina-Azorín et al., 2019). The aim of this chapter is, therefore, to examine the multi- level determinants of obesity in Ghana.

Whilst studies elsewhere in the literature have investigated the impact of multi-level factors on lifestyle behaviours (Moraeus et al., 2012), chapter 2 showed lack of such analysis in the obesity literature particularly in West Africa. Our review showed only one paper (Dake et al., 2016) to have addressed this. As mentioned, (Discussion section in chapter 2), the study in question, was limited, as it covered three homogenous ethnic communities, mainly urban poor communities, located in one metropolis (Accra) of Ghana. In addition, they focussed on the local food environment. This chapter will address this limitation by using a relatively more representative sample covering Accra, Kumasi and Tamale Metropolis, (i.e., the Coastal, Northern and Southern belts) and a more comprehensive coverage of area level indicators covering both physical activity and diet.

To inform the methods in the literature on spatial analysis, this chapter incorporated the effect of self-report and objectives measures on obesity. It has been showed elsewhere, for example, the literature on pollution, that using self-report data on area level factors can lead to methodological problems emanating from systematic over-reporting – biases in reporting from those with the condition (Piro et al., 2008). Whilst this is yet be proved in the area of obesity, it can be argued that the effect of self-report might be significant herein, given the rifeness of socially desirable responses and social stigma with respect to obesity (Phelan, 2013).

8.1 Methods

8.1.1 Data

Data for this analysis came from the Ghana Obesity Survey 2021 (see chapter 5) and the GIS based analysis to generate area-level variables (see appendix 10). The data from the survey was classed into dependent and independent variables for data analyses.

8.1.2 Dependent variable

As in previous chapters, obesity was specified as a dummy variable indicating whether individuals recorded a BMI of 25kg/m^2 or more during the survey.

8.1.3 Independent variables

Independent variables were either main or covariates. The main independent variables are the constructs which this chapter intends to explore their relationship with the dependent variable. These variables include the independent and area-level accessed in this study.

8.1.4 Data Analyses

The analyses were in two-folds. Descriptive/bivariate analyses of the data were conducted followed by a multi-level modelling. Descriptive statistics provided means, and proportions of both the dependent and independent variables. The descriptive analysis covered an assessment of the missing data. For brevity, the descriptive analysis focussed on the area level factors. The summary statistics on the individual-level variables are provided in chapter 5.

8.1.4.1 Regression models

The influence of both area level and individual levels factors on obesity were examined using a multilevel framework analysis (Dake et al., 2013). Failing to use a multi-level model when there exists homogeneity among observations within clusters, tend to violate the independence assumption in standard regression model leading to increased errors in the estimation of regression coefficient and standard errors (Rice & Leyland, 1996). Particularly in the case of area level variables, their associated standard errors are likely to be underestimated resulting in incorrectly significant coefficients and narrower confidence intervals (Hox & Kreft, 1994)

The use of multi-level modelling, has however, been criticised for having unverifiable assumptions on the distributions underlying data with population average models seen as a more accurate estimator as the statistical assumptions are less restrictive (Hubbard et al., 2010). The challenge with population average models though is that they do not allow more than one cluster level (Holodinsky et al., 2020). On the balance, the multi-level modelling was chosen as it allows more flexibility in multiple levels and more critically there is significant differences empirically between both approaches (Gardiner et al., 2008).

In this chapter, the multi-level estimation fitted a two-level random effects model that was specified using individual level variables (specified in chapter 5) and area-level variables as community/enumeration indicators of the physical activity and the food environment (see appendix 10). The choice of the number and type of levels was based on standard approach in the literature review (chapter 2). Whilst the only multi-level analysis study in Chapter 2 used two levels, the analysis here intended to extend the number of levels to allow a more in-depth variations in behaviour dynamics. To do this, the intra-class correlations technique (ICC) was used (Holodinsky et al., 2020).

The ICC has a dual purpose; first, it tests the suitability of the dataset for multi-level analysis and, second, the level of variability within each potential level. For example, as per our dataset, the maximum area levels were three - individual, and two area levels (enumeration/community level, and metropolitan level). The ICC tests therefore provided an indication of the level of agreement within strata in the two area levels and data and level of variation within each of the area levels. In other words, how much variation in a person’s likelihood to become obese does his community of residence explain. Secondly, which level demonstrates the highest level of homogeneity among individuals. A non-zero ICC indicates the presence of correlations between observations in the strata and the suitability of the data for multi- level modelling. If ICC is zero, there is no clustering effect.

When the ICC was conducted, the model was not yielding convergence when all three levels were used. This was further explored by running two levels (individual level plus either community or metropolitan level) interchangeably. In both cases (metropolis, ICC=0.049; enumeration area ICC=0.051) provided evidence of a positive intra class correlation. This suggested a high suitability of the data for multi-level modelling. This is in line with finding in the literature, as ICC values are often less than 0.10. In terms of which strata to use, the decision was based on the magnitude of the correlation. The findings as shown above indicates the enumeration area strata provides a higher ICC, indicating that 5% of the probability to become obese can be attributed to the differences between community of residence.

Fitting multi levels models requires a random effects estimator as the underlying principle of these models is to account for potential intra cluster effects or associations. (Gardiner et al., 2008). In otherwise, one expects the sample belonging to the same area/cluster to have similar traits and, hence, correlated in the construct under investigation. For example, the behaviour of people in enumeration areas in Ghana could be argued to be the same given their exposure to common environmental features. The constituents of random effects therefore depict the number of strata to be accounted for in the analysis. The selection of the strata is based on contextual and general statistical properties.

A multilevel, two levels, logistic regression model was run conditioned on a set of random effects *rj*.

$$Pr(oij = 1|fij , rj) = C(fij\beta + mijrj) \qquad (1)$$

The dependent variable, binary, is specified as oij, where *oij = 1* if an observation is obese and *oij = 1*, if not obese. The fixed effects in the model are represented by the covariates. They are denoted by *fij*, with coefficients *(β)* and are statistically similar to the independent variables captured in the single level models conducted in chapter 6. As this is multilevel model, another vector, *mij,* is added to the functional form to account random effects and reflect the random coefficients and intercepts. This defines a vector space and is scalar 1. This means the random effects, *rj,* and follows a multivariate normal distribution with a mean of zero. The random effects are not explicitly estimated as parameters of a model as in the case of fixed effects but are indicated by variance components.

In practice, the output of the multi-level model shows the parameter estimates, which are the fixed effects, with their coefficients and level of statistical significance. Below the parameters is the random effects, indicated by the variance components, they estimate the random effects at the area level, which in this, chapter the enumeration area. This is followed by a Likelihood-Ratio (LR) test that examines the suitability of the data to multi-level model vis a vis a standard regression model. If the LR test is significant, it suggests the model is better suited to multi-level model. Otherwise, a standard logistic regression model is suitable.

As the underpinning distribution is logistic, the dependent variable is binary, the functional form denoted by C(.) in equation (1) follows a logistic cumulative distribution. It indicates the prediction of the oij =1 where,

$C(v) = \exp(v)/\{1+ \exp(v)\}$.

The threshold for statistical significance was set at $p \leq 10\%$ in all analyses because of the exploratory nature of the study. All analyses were undertaken using Stata version 13.

8.2 Results

8.2.1 Descriptive analysis

Tables 37 and 38 show the descriptive statistics for the area level factors. For clarity, they were demarcated into self-report (Table 37) and objective measures (Table 38).

8.2.1.1 Self-report area level factors

Majority of housing units were block apartments with multiple households per plot or flat (59%). Regarding access to destinations in the neighbourhoods, majority of participants reported that facilities were within walking distances to their houses (>70%). A similar pattern was found for street connectivity (71%). The 'norms' around physical activity participation appeared to be favourable in the sample as 81% of respondents reported that they see their neighbours engaging in physical activity. The neighbourhood facilities were also found to be conducive for physical activity, with majority (64%-75%) agreeing that recreational facilities and physical infrastructure convenient for physical activity were prevalent in their communities. Neighbourhood safety was also found to be high and encouraging for physical activity (50%-78%). On the other hand, the pedestrian pathways were not usually separated from the streets (54%) neither were the architectural design attractive (57%). See table 37 for the self-reported area-level factors.

Table 37: Self-report measures of area level factors (n=3348)

Variables	**Number**	**Percentage (%)**
Residential density		
Main type of housing in the neighborhood		
Detached single bungalows and duplexes	477	14.25
Mix of bungalows, duplexes and apartments/ yards with shared facilities.	511	15.26
Apartments/ yards with shared facilities or flats of 1-2 stories.	399	11.92
Blocked apartment with multiple households per plot or flats.	1,961	58.57
Access to destinations in neighborhood		
Agree 'many places such as shops, stores and markets to buy things I need are within easy walking distance of my home'		
Yes	2,874	85.84
No(otherwise)	474	14.16
Agree 'it is within easy walking distance from my home to access public buses and taxis in my neighborhood'		
Yes	2,914	87.04
No (or otherwise)	434	12.96
Agree 'there are many non- residential places such as schools, hospitals, workplaces etc. to go within easy walking distance of my home'		
Yes	2,661	79.48
No (or otherwise)	687	20.52
Street connectivity		
Agree 'there are many cross- junctions (Plus junctions) in my neighborhoods		
Yes	2,361	70.52
No (or otherwise)	987	29.48
Social environment		
Agree 'I see many people in my neighborhood doing things like walking, jogging, playing football and other sports'		
Yes	2,713	81.03
No (or otherwise)	635	18.97
Neighbourhood infrastructures		
Agree 'my neighborhood has several places such as open field, school playground, parks, public space and gymnasium to exercise and play sports'		
Yes	2,141	63.95
No (or otherwise)	1,207	36.05
Agree 'there are separated pedestrian pathways on most of the streets in my neighborhood'		
Yes	1,550	46.30
No (or otherwise)	1,798	53.70
Agree 'it could be safe to bicycle in or near my neighborhood because there is little traffic'		
Yes	2,519	75.24
No (or otherwise)	829	24.76

Variables	Number	Percentage (%)
Agree 'the walk and foot pathways in my neighborhood are unobstructed and good for walking'		
Yes	2,517	75.18
No (or otherwise)	831	24.82
Aesthetic quality		
Agree 'there are many beautiful things such as architectural design, shade trees, building varieties and attractive landscaping to look at while walking in my neighborhood'		
Yes	1,449	43.28
No (or otherwise)	1,899	56.72
Agree 'my neighborhood is generally free from unattended domestic animals like goats, cattle, dogs etc.'		
Yes	1,907	56.96
No (or otherwise)	1,441	43.04
Agree 'my neighborhood is generally free from garbage, stagnant water and offensive odors'		
Yes	1,754	52.39
No (or otherwise)	1,594	47.61
Neighbourhood safety		
Agree 'walking is dangerous in my neighborhood during the day because of inadequate security from molestation, crime and harassment from hooligans, rascals and drug addicts'		
Yes	742	22.16
No (or otherwise)	2,606	77.84
Agree 'Walking is dangerous in my neighborhood because of the speed of traffic and aggressive driving'		
Yes	1,038	31.00
No (or otherwise)	2,310	69.00
Agree 'walking is dangerous in my neighborhood during the night because of inadequate security from molestation, crime and harassment from hooligans, rascals and drug addicts'		
Yes	1,663	49.67
No (or otherwise)	1,685	50.33

8.2.1.2 Objective area level factors

Table 38 provides descriptive statistics of the area level factors generated using GIS analysis (see appendix 10). Overall, the number of fast-food joints per enumeration area was the highest among all the facilities, followed by number of restaurants and the least were gyms/sports centres. The number of fasts foods in an enumeration irrespective of the radius ranged from 13 (within 2 km radius) to 117 (within 10 km radius) selling points on average. Restaurants were on average 7 (within 2 km radius) to 90 (10 km radius) per enumeration area. On average, supermarkets were less than 2 (within 2 km radius) and about 21 within 10 km radius. Majority

(70%) of people did not have access to gyms/sports centres within 2 km radius. Access was, however, more favourable within 5km radius with over 73% of people have access to at least a gym/sport centre. Average distances to all the facilities were comparable as all facilities could be located within 5 km. Albeit insignificant differences, the fast foods were nearest to residence of respondents followed by restaurants. Gyms/sports centres were the farthest.

Table 38: Objective (GIS based) measures of area (enumeration area) level factors (n=3348)

Variables	**Mean (SD)**	**Median (IQR)**	**Min**	**Max**
Number of fast foods joints				
Within 2 km radius	12.81(38.82)	1(0,4)	0	207
Within 5 km radius	50.02(94.22)	8(3,17)	0	348
Within 10 km radius	116.74(177.74)	9(9,310)	0	460
Number of restaurants				
Within 2 km radius	7.19(11.46)	4(0,9)	0	72
Within 5 km radius	35.84(46.35)	21(9,27)	0	210
Within 10 km radius	89.76(109.168)	29(25,181)	0	335
Number of supermarkets				
Within 2 km radius	1.49(1.94)	1(0,2)	0	8
Within 5 km radius	8.48(7.58)	7(3,11)	0	34
Within 10 km radius	20.55(20.59)	11(8,32)	0	75
Number of gyms/sports centres				
Within 2 km radius	0.46(1.02)	0(0,1)	0	6
Within 5 km radius	2.37(3.32)	1(0,2)	0	15
Within 10 km radius	5.19(5.56)	2(2,11)	0	16
Average distance (any km) to fast food joints	5.32(3.94)	4.82(3.63,6.18)	0	42.14
Average distance (any km) to restaurants	5.41(3.92)	5.27(3.81,6.53)	0	42.23
Average distance (any km) to supermarkets	5.46(2.29)	5.48(4.15,6.45)	0	22.36
Average distance (any km) to gyms/sports centres	5.29(3.90)	5.05(3.32,6.34)	0	41.00

8.2.2 Results from regression model

The LR test which evaluates the statistical difference between a multilevel model and a single level model showed a statistically significant (p=0.0019) estimate indicating a significant inefficiency when a standard logistic regression model is used. The number of communities were 108 and the observations per community was 31, on average, with a minimum of 19 and a maximum of 43 people. Table 39 presents the regression estimates and the associated odds ratios for the parameters. Next the results are presented in the account of the categories of independent variables.

8.2.2.1 Individual level factors

The results of the individual level factors as presented in chapter 5 were not different here. For brevity, they are not repeated here.

8.2.2.2 Self-report area level factors

None of the self-report area level measures was found to be statistically significant.

8.2.2.3 Objective area level factors

The presence of an additional fast-food joint within a 5km radius from the centre of the community was associated with an increased likelihood of becoming obese (OR: 1.006). Conversely, an increase in the number of restaurants within 2 km radius had a negative correlation with the probability of being obese (OR: 0.935). The opposite effect was observed when the number of restaurants within 10km is high, as it increases the likelihood to be obese (OR: 1.019). The availability of supermarkets also had a mixed effect on probability to be obese. Within a shorter radius (2km radius), more supermarkets were related with a 10% more chance of becoming obese. However, if the additional supermarket is located a bit far (within 10 km), it reduces the propensity to becoming obese (OR: 0.918). Compared to residents of Kumasi metropolis, Accra residents had a higher chance of becoming obese (OR: 10.583).

Table 39: Regression estimates of multi-level regression model

Independent variables	**Coefficient**	**Odds ratio**
Covariates		
Religion[a]		
Muslims	0.502**	1.652
Others	0.056	1.058
Tribe[b]		
Ga	0.513**	1.670
Ewe	-0.012	0.988

Independent variables	Coefficient	Odds ratio
Mole Dagbani	-0.557**	0.573
Others	-0.135	0.874
Men[d]	-0.932 ***	0.394
Employed[e]	0.222**	1.249
Health status[f]		
Good	0.249**	1.282
Fair	0.289*	1.335
Bad/very bad	-0.294	0.745
Have a disability?[e]	-0.408**	0.665
Personal income[g]		
GH¢ 1000 to less than GH¢ 2000	0.578 ***	1.782
GH¢ 2000 and above	0.961***	2.613
Marital status[h]		
Informal living/never married	-0.602***	0.547
Separated/divorced	0.002	1.000
Widowed	0.016	1.016
Age	0.006*	1.001
Agree that 'Being overweight is something you inherit from your parents'[e]	0.059	1.060
Agree that 'Being overweight is a sign of good living'[e]	0.005	1.005
Agree that 'Being overweight is a sign of beauty'[e]	-0.108	0.898
Agree that 'Being overweight is unhealthy'[e]	0.032	1.033
Agree that 'Most people who are overweight have put on weight because they eat too much'[e]	-0.102	0.903
Agree that 'Most people who are overweight have put on weight because they exercise too little'[e]	-0.076	0.927
'Self-report' area level factors		
Type of housing[i]		
Mix of bungalows, duplexes and apartments/ yards with shared facilities.	0.011	1.012
Apartments/ yards with shared facilities or flats of 1-2 stories.	-0.069	0.934
Blocked apartment with multiple households per plot or flats.	0.168	1.183

Independent variables	Coefficient	Odds ratio
Agree 'many places such as shops, stores and markets to buy things I need are within easy walking distance of my home'[e]	-0.017	0.984
Agree 'it is within easy walking distance from my home to access public buses and taxis in my neighborhood' [e]	-0.039	0.962
Agree 'there are many non- residential places such as schools, hospitals, workplaces etc. to go within easy walking distance of my home' [e]	-0.098	0.907
Agree 'there are many cross- junctions (Plus junctions) in my neighborhoods [e]	-0.155	0.856
Agree 'I see many people in my neighborhood doing things like walking, jogging, playing football and other sports' [e]	0.104	1.011
Agree 'my neighborhood has several places such as open field, school playground, parks, public space and gymnasium to exercise and play sports' [e]	-0.058	0.944
Agree 'there are separated pedestrian pathways on most of the streets in my neighborhood' [e]	0.022	1.022
Agree 'it could be safe to bicycle in or near my neighborhood because there is little traffic' [e]	-0.025	0.975
Agree 'the walk and foot pathways in my neighborhood are unobstructed and good for walking' [e]	0.061	1.063
Agree 'there are many beautiful things such as architectural design, shade trees, building varieties and attractive landscaping to look at while walking in my neighborhood' [e]	0.131	1.140
Agree 'my neighborhood is generally free from unattended domestic animals like goats, cattle, dogs etc.' [e]	0.148	1.160
Agree 'my neighborhood is generally free from garbage, stagnant water and offensive odors' [e]	-0.000	0.998
Agree 'walking is dangerous in my neighborhood during the day because of inadequate security from molestation, crime and harassment from hooligans, rascals and drug addicts' [e]	-0.061	0.940

Independent variables	Coefficient	Odds ratio
Agree 'Walking is dangerous in my neighborhood because of the speed of traffic and aggressive driving' [e]	0.072	1.074
Agree 'walking is dangerous in my neighborhood during the night because of inadequate security from molestation, crime and harassment from hooligans, rascals, and drug addicts'[e]	0.047	1.048
Objective area level factors		
Number of fast foods joints		
Within 2 km radius	-0.001	0.999
Within 5 km radius	0.006**	1.006
Within 10 km radius	-0.006	0.994
Number of restaurants		
Within 2 km radius	-0.025**	0.975
Within 5 km radius	-0.011	0.989
Within 10 km radius	0.019**	1.019
Number of supermarkets		
Within 2 km radius	0.099**	1.104
Within 5 km radius	0.059*	1.060
Within 10 km radius	-0.086**	0.918
Number of gyms/sports centres		
Within 2 km radius	-0.201	1.223
Within 5 km radius	-0.053	0.948
Within 10 km radius	-0.070	0.932
Average distance (any km) to fast food joints	0.147	1.156
Average distance (any km) to restaurants	-0.167	0.846
Average distance (any km) to supermarkets	0.021	1.021
Average distance (any km) to gyms/sports centres	0.006	1.006
Metropolis[c]		
Accra	2.359*	10.583
Tamale	-0.458	0.632
Constant	0.648	1.911
Variance component	0.072	n/a
Observations	*3348*	

Significance levels: 1%****, 5%**, 10%*Reference categories: [a]Christians; [b]Akan; [c]Kumasi; [d]Women; [e]Yes; [f]Very good; [g]< *GH¢ 1000;* [h]*Married*; [i]Detached single bungalows and duplexes

8.3 Discussion

Based on the gap identified in chapter 2 of this thesis and the research policy-relevance in chapter 3, an analysis was conducted with a multi-level approach to examine the determinants of obesity in Ghana. The findings supported the presence of hierarchical structure and correlations within clusters, as conceptualised in chapter 4. It also indicated that objective area level measures were more significant explanatory factors of obesity than self-report area measures. One could argue that there are not enough grounds for comparison as the influential objective measures were diet related whilst the self-report measures were mostly physical activity related. Therefore, the finding here may be mere artefact of the data. It is plausible though that the findings reflect tendencies for socially desirable/acceptable responses associated with self-report measures (Larson, 2019; King et al., 2018).

Also, the self-report measure of BMI may have been affected by difficulty in current anthropometric measure recall, misreporting of weight, and differences in weighing instruments/scales calibrations, which could have affected the findings (De Rubeis et al., 2019). Even so, some of the possible limitations of self-report measures, like misreporting, may be a function of social desirability. For example, evidence from Burke & Carmen (2017) showed an association between misreporting and social desirability in BMI self-report. Therefore, as we advance, objective and self-report measures of obesity must be complimented to produce robust obesity measures.

Another key finding from the multi-level analysis is the association between the frequency of fast foods outlets, the number of supermarkets in an area, and the likelihood of obesity. Individuals in areas with many fast-food outlets and supermarkets, particularly in shorter radius, were more likely to be obese. This result corroborates the findings of Burgoine et al. (2018) and Dake et al. (2016). In Burgoine et al. (2018) study involving 51361 participants, they showed that exposure to fast-food outlets is associated with 1.51 increase odds of obesity. Similarly, in a multi-level analysis, Dake et al. (2016) indicated that increased access to convenience stores, like supermarkets, increased the odds of obesity. Furthermore, a recent spatial analysis by Hall et al. (2021) showed that increased density of residential fast-food outlets within a 0.5 mile is associated with about 7% odds of overweight and obesity. Based on the growing evidence on the significant association between fast-food outlets the odds of obesity, an evaluation of the built environment is critical to reducing the obesity burden. These evaluations could include a review of the global trends in the modern commercial food chain environment.

While the number of fast-food outlets and supermarkets in an area correlated with the probability of obesity, the reverse was identified with restaurant proximity. The findings showed that individuals proximal to restaurant locations (within 2km) were less likely to be obese compared to those within areas distal to restaurants (within 10km). Even though the mechanism accounting for this observation may be uncertain, sociocultural perception may be responsible. Perhaps, most people would prefer upscale restaurants as a sign of an economic evolution or growth, and these restaurants may be distant from their area of residence (Athey et al., 2018). Alternatively, the choice of distant restaurants could be a function of personal preferences to avoid intrusions from familiar people. Future research may be needed to provide more robust evidence on the choice of restaurants, restaurants location and obesity.

Finally, the findings showed that physical activity access was not associated with obesity, whether self-reported or objectively measured. This may be because access may not induce physical participation. Besides, access to physical activity facilities, like gyms, may come with unaffordable charges to the individuals within the area (Kaufman et al., 2019). Apart from monetary reasons, other factors, such as body image, school and work demand, lack of motivation and perceptions around physical activity may also limit physical activity engagement (Ofori-Asenso et al., 2016) among individuals who have access to physical activity, which could inherently influence the odds of obesity. This is evident in the findings of Armstrong et al. (2018). This finding, however, is inconsistent with Lee et al. (2016). They found that access to physical activity significantly influences physical activity participation. Notably, they used self-report measures while this study included both self-report and objective measures. This probably explains the differences.

8.4 Conclusion

This study is one of the few studies to examine determinants of obesity using a multi-level approach, particularly in Ghana. As such, the findings could inform new strategies to address the obesity epidemic in Ghana. However, our findings cannot establish causation due to the cross-sectional nature of the data. Also, the study included only three metropolises; so, the findings may not have a wider population implication. Chapter 9 will draw on the findings and suggest policy implications.

Chapter 9: A Delphi study to explore interventions to address the identified determinants of obesity in Ghana

9.0 Introduction

The previous chapters in this thesis, i.e., chapters 6,7 and 8, addressed the research gap and priority research areas on religion and culture, lifestyle behaviours and food environment identified and established in chapters 2 and 3, respectively. Their findings indicated that religion and culture, physical activity and diet, and the number of supermarkets and fast-food joints are significant determinants of obesity. After identifying these determinants, this chapter aimed to involve the stakeholders again to gauge their opinions on important interventions to address the determinants. The rationale for their involvement again was to inform them of the outcomes of their prioritised research areas and explore their views on practically feasible interventions based on their expertise as obesity policymakers to ensure the research outcomes benefit the larger Ghanaian population and avoid research findings disuse and in Ghana. Therefore, this chapter contributed new knowledge by identifying necessary interventions through critical policymakers to address all identified obesity determinants.

The chapter used the Delphi approach. As elaborated in chapter 3 of this thesis, the Delphi approach is a widely accepted and robust approach to synthesising experts' opinions on complex constructs or topics, like obesity, to inform policy direction (Hult & Khan, 2020). It provides anonymity, thus, reducing the risk of socially desirable responses. Additionally, it is characterised by a series of rounds, with findings of each round shared with the participants to promote reflective responses that could ensure optimal viewpoints on the subject or topic. This advantage of the Delphi method allows the subject or topic to evolve naturally to its advanced level through systematic analysis (Barrett & Heale, 2020).

However, this advantage could also have a reverse or rebound effect since the participants could alter their previous responses to conform with the majority's views, which could introduce bias. Nonetheless, Belton et al. (2019) argue that this limitation could be averted by providing the participants with their median responses instead of the majority or minority when providing feedback at the end of each round. Further, Hsu & Sandford (2007) indicate that Delphi methods can be time-consuming and sometimes fraught with high attrition bias; however, this could also be addressed by reducing the number of rounds and instituting social and financial rewards (Belton et al., 2019). As such, the recommendations by Belton et al.

(2019) were implemented to reduce the limitations associated with the Delphi approach mentioned above to reduce potential bias that could have implications for our findings.

9.1 Methods

9.1.1 Participants

The participants recruited for the stakeholders' workshop in Chapter 3 (see their detailed description in the methods section in chapter 3) were invited again via email to participate in this stakeholder engagement. The rationale for maintaining the same participants was to ensure coherence and fluidity in the research objectives of exploring interventions to reduce the obesity epidemic in Ghana, especially given that these participants directed the research questions in this study. Again, like the previous stakeholders' engagement, the participants were invited to express their interest in this current workshop through emails. Upon indicating their willingness to participate, they were provided with detailed information regarding the topic and a zoom link invitation to participate online, given the ongoing COVID-19 restrictions. Finally, on the day of the workshop, a two-round approach was used to explore important interventions to address the determinants of obesity identified in this study. The rounds were conducted as follows:

9.1.2 Round 1

In round 1, the participants were provided with detailed information on the empirical findings of this thesis. Then, their demographic data, such as age, gender/sex and level of education, were collected using a structured online questionnaire. After, they were provided with sets of questions based on this research's findings and were asked to provide possible interventions to address them. Box 3 shows the questions that were asked in round 1.

Box 3: Questions that were given to the participants

1. The research findings showed that religion and culture affect obesity in Ghana. For example, it was identified that Muslims are more likely to be obese. Similarly, Gas have a higher tendency to be obese. In your opinion, what are the possible interventions to address these factors? ***Please list as many interventions as possible****.*

2a. The research showed that about 80% of Ghanaians don't eat fruit and vegetables, and only 10% of Ghanaians are physically active and eat fruits and vegetables. Physical activity and diet are interconnected lifestyle variables that influence the odds of obesity in Ghana. In your estimation, what interventions could promote the practice of a healthy diet and physical activity? ***Please list as many interventions as possible***.

2a. Regarding the lifestyle variables, the findings showed that factors influencing them could be dissimilar. For instance, men were found to be more likely to engage in physical activities but less likely to eat a healthy diet. However, in some instances, the factors were comparable. For example, individuals who agreed that being overweight is inherited from parents were less likely to engage in physical activity and eat a healthy diet. Similarly, individuals with perceived good health status were at lesser odds of eating a healthy diet and participating in exercises. Given these findings, what do you think is/are possible intervention/s to address the factors that limit participation in physical activity and consumption of a healthy diet? ***Please list as many interventions as possible***.

3. The local food environment, i.e., the number of fast-food joints and supermarkets in an area, was found in the study to increase the risk of obesity in Ghana. In your opinion, what interventions could address the influence of the food environment on obesity in Ghana? ***Please list as many interventions as possible***.

After each question, a URL link was provided, and the participants were given forty-five minutes (45mins) to provide their responses using the provided links. Arguably, the participants could have been presented with a list of interventions to choose from; however, this could have introduced bias into the study as it would have indirectly influenced the direction of their responses. After the experts had indicated their possible interventions, thematic analysis was conducted through the following: first, the researcher familiarised with the data and identified common phrases and sentences by interpreting each of the responses from the stakeholders for each of the questions. Second, codes were used to describe common phrases and sentences through data coding. Third common codes were combined into single themes. Lastly, the themes were reviewed to ensure that they reflect the responses from the stakeholders. The final themes were discussed with an independent reviewer, and they agreed on a final list of interventions for each of the questions. The independent reviewer and the researcher also agreed to combine the themes for questions 2a and 2b since they both aimed to explore interventions to address the influence of physical activity and diet on obesity.

9.1.3 Round 2

In round 2, the list of interventions identified in round 1 after the thematic analysis was uploaded onto google forms and the experts were invited via email to rate their importance using a 5-point Likert scale ranging from 1 – not very important; 2 – not important; 3 – neutral; 4 – important to 5 – very important. The experts were given a week to respond to the survey, and regular reminders were sent to them (at the end of each day for the 1 week) to complete the survey using URL links sent to their emails. The survey questionnaire was in three parts, with each part focusing on a specific obesity determinant. After completing the survey, the responses from the experts were analysed quantitatively to identify interventions that were considered important to address the determinants of obesity. Interventions with a median score of ≥ 4 were considered important. Also, consensus on interventions was set at >70% agreement on the importance of the intervention, i.e., >70% of the participants rated an intervention as very important/important or not very important/not important. This approach to establishing consensus is consistent with current literature (Vogel et al., 2019).

9.2 Results

Fifty-eight (n= 58; 89.2%) of the invited sixty-five (n=65) stakeholders participated in the first round of the workshop. Many of them were men (n=43; 74.1%), aged from 30-39 years (n=39; 67.2%) and had first degree university qualification (n=32; 55.2%), and were drawn from the Ministry of Health/Ghana Health Service (n=16; 27.6%). Table 40 below summarises the participants characteristics.

Table 40: Stakeholders' characteristics

Stakeholders' characteristics	**Number (%)**
Gender/sex	
Men	43 (74.1)
Women	15 (25.9)

Stakeholders’ characteristics	Number (%)
Age	
20 – 29 years	12 (20.7)
30 – 39 years	39 (67.2)
40 – 49 years	6 (10.3)
≥ 50 years	1 (1.7)
Education Level	
First University Degree	32 (55.2)
Masters	23 (39.7)
PhD	3 (5.2)
Sample Frame	
Ministry of Health/ Ghana Health Service	16 (27.6)
Ministry of Education	14 (24.1)
Ministry of Works and Housing	5 (8.6)
Ministry of Food and Agriculture	4 (6.9)
General public	12 (20.7)
Ministry of Youths and Sports	4 (6.9)
Office of the president	3 (5.2)
Total	**58**

9.2.1 Findings from round 1

Tables 1 – 4 in appendix 11 give an overview of interventions provided by the stakeholders to address questions (See box 3 above for details of questions). The stakeholders indicated more than thirty (n = 30) possible interventions to address each of the questions. The interventions bordered on government’s laws and economic regulation and education campaigns on obesity, physical activity, and diet. For example, on culture, religion and obesity, one stakeholder [Participant ID – 001] mentioned that:

‘Education on the consequence of obesity, possible financial interventions to enhance quality nutrition, Community based association with the aim of campaigning against obesity in Muslim and traditional religious settings’ are important intervention to address the determinants in Ghana.

Similarly, on the food environment and obesity, participant 003 said that:

‘Educate food vendors on using healthy cooking ingredients, educate the populace on calorie intake, public education on healthy eating, enforce government policy on healthy eating and encourage physical activities amongst the populace’ to address the food environment as a determinant of obesity.

A thematic analysis of the stakeholders’ responses was conducted and at least nine interventions were identified as important to address each of the obesity determinants of obesity (see appendix 12). Table 41 shows some of the stakeholder’s proposed interventions.

Table 41: Interventions to address the determinants of obesity after the thematic analysis.

Interventions	***Stakeholders’ ID***	***Frequency***
Education campaigns/counselling on healthy lifestyles (consumption of fruits and vegetables, and physical activities) and its benefits by agencies, health workers and advocacy groups	008, 009, 011, 012, 013, 017, 020, 021, 022, 023, 024, 025, 026, 028, 029, 031, 032, 033, 034, 036, 038, 040, 042, 044, 046, 048, 051, 052, 053, 058	30
Education campaigns on obesity by Ghana Health Service, advocacy groups, traditional and religious leaders	010, 022, 040, 051, 046, 013, 005	7
Government regulations and monitoring of supermarkets and fast foods operations, food importations and food labelling	001, 004, 005, 007, 008, 009, 011, 018, 022, 023, 028, 030, 032, 036, 037, 038, 042, 045, 046, 048, 051, 053, 057, 060, 062	25
Government to enact laws, introduce taxes and subsidies to promote healthy eating	003, 013, 027, 035, 054, 080, 021, 035, 040, 048, 009, 026	12
Campaigns to create and promote community recreational/physical activity/training/fitness clubs	012, 018, 022, 040, 027, 042, 057	7

9.2.2 Findings from round 2

Forty-eight (n=48; 82.4%) of the 58 stakeholders in round 1 responded to the survey in round 2. They indicated that all the interventions proposed to address the influence of religion and culture on obesity were important (median ≥ 4), except bariatric surgery intervention. There was also consensus on important interventions to address the influence of physical activity and diet on obesity. For instance, most of the participants indicated that *campaigns to institute a national day of consuming fruits and vegetables* (87.5%) and *campaigns to encourage change in the mode of transportation (bicycles) in universities and Secondary schools (SHS) (83.3%)* were not important interventions to address the influence of physical activity and diet on obesity.

Conversely, *campaigns to create and promote community recreational/physical activity/training/fitness clubs (91.7%) and education campaigns for food vendors on best hygienic practices in cultivating and handling fruits and vegetables to promote its public consumption* were considered important interventions. For the local food environment and obesity, more than 70% of the stakeholders agreed that all the interventions identified in round 1 were important. No further rounds were conducted after round 2 since consensus on the interventions was achieved. See table 42 for a summary of the findings in round 2.

Table 42: Findings on ratings of interventions by stakeholders (N=48)

Interventions to address the influence of religion, culture and obesity			
Interventions	***Median***	***Consensus N (%)***	
		Very important/important	***Not very important/not important***
Education campaigns on causes, consequences, myth, and effects of obesity	5	47 (97.9)	
Education campaigns on obesity by Ghana Health Service, advocacy groups, traditional and religious leaders	5	45 (93.8)	
Setting/community-based education on obesity, exercises, diet and healthy lifestyles	5	44 (91.7)	
Awareness campaigns on dietary habits and dietary choices	5	44 (91.7)	
Public awareness campaigns on lifestyles modification (healthy diet, physical activity, good sleep, weight checks, medical checks, and stress reduction)	5	45 (93.8)	
Campaigns to provide recreational centres and safe exercise areas	4	43 (89.6)	
Financial incentives, reduced taxes on healthy foods, job creation and laws on obesity	4	40 (83.3)	

Education campaigns on healthy lifestyles for children and youth	5	44 (91.7)	
Bariatric surgery	2		36 (75.0)
Interventions to address the influence of physical activity and diet on obesity			
Interventions	***Median***	***Consensus N (%)***	
		Very important/important	***Not very important/not important***
Campaigns to promote government subsidies on fruits and vegetables and ensure fruits and vegetables availability and affordability	4	41 (85.4)	
Setting/community-based awareness programs on healthy lifestyles (exercises, diet)	5	44 (91.7)	
Campaigns to create and promote community recreational/physical activity/training/fitness clubs	5	44 (91.7)	
Early childhood education/school-based campaigns on exercises and diet	5	45 (93.8)	
Education campaigns/counselling on healthy lifestyles (consumption of fruits and vegetables, and physical activities) and its benefits by agencies, health workers and advocacy groups	5	44 (91.7)	
Campaigns to promote public cultivation of fruits and vegetables	5	38 (79.2)	
Awareness campaigns on the need for parents/schools to include fruits and vegetables on food menus	5	42 (87.5)	
Campaigns to promote Work-based exercises programs	4	38 (79.2)	
Education campaigns for food vendors on best hygienic practices in cultivating and handling fruits and vegetables to promote its public consumption	5	45 (93.8)	
Advertisements on benefits of healthy diet using mass media	5	44 (91.7)	
Increase taxation on unhealthy foods	4	39 (81.2)	
Campaigns to institute a national day of consuming fruits and vegetables	2		42 (87.5)
Campaigns to establish fruit and vegetable farms in every educational institute	4	37 (77.1)	
Campaigns to promote operation grow what you eat	4	34 (70.8)	
Campaigns to encourage change in the mode of transportation (bicycles) in universities and SHS	2		40 (83.3)

Special bicycle lanes to be provided in towns and cities	4	35 (72.9)	
Incentives to children to encourage exercises and fruit &vegetables consumption	4	36 (75.0)	
Campaigns for reality physical activity tv shows to be encouraged, like Di Asa	4	37 (77.1)	
Campaigns for governments to provide community security to promote physical activities	4	37 (77.1)	
Work-based physical activity breaks	4	41 (85.4)	
Campaigns to make BMI checks compulsory in health facilities	4	37 (77.1)	
Education campaigns on time management and screen time limitations	2		40 (83.3)
Interventions to address the influence of the food environment on obesity			
Interventions	***Median***	***Consensus (%)***	
		Very important/important	***Not very important/not important***
Government regulations and monitoring of supermarkets and fast foods operations, food importations and food labelling	5	41 (85.4)	
Education campaigns for supermarkets and fast-food vendors on obesity consequences and best dietary practices	5	43 (89.6)	
Public education on healthy diet and food-related attitudinal changes by government agencies, opinion leaders, religious and traditional leaders	5	46 (95.8)	
Government to enact laws, introduce taxes and subsidies to promote healthy eating	4	34 (70.8)	
Campaigns to encourage healthy meals in schools	5	47 (97.9)	
Campaigns to promote Ghanaian restaurants that sell local foods	4	35 (72.9)	
Campaigns to promote fruits and vegetables availability and affordability	5	45 (93.8)	
Campaigns to encourage home cooking and make home cooking affordable	4	37 (77.1)	
Campaigns for supermarkets to make fruits and vegetable stands more visible for easy access	5	40 (83.3)	

Laws to ensure that some percentage of supermarkets products are fruits and vegetables	4	37 (77.1)	

9.2.3 Ghana's future obesity strategy

Several interventions were identified through the stakeholders' engagement as critical to addressing the determinants of obesity in Ghana. These interventions were provided on an individual determinant basis; however, given the real-world interdependence of these determinants, the policies must be complementary to ensure a comprehensive obesity strategy in Ghana. Generally, three interventions, i.e., education campaigns, environmental changes, and government regulations were common for all the identified determinants. While these interventions are similar to those identified in the literature (Gortmaker et al., 2011; Swinburn, 2008), they presented some granularities/nuances that are specific to the Ghanaian context, like exact agents of change to employ and specific physical activity-related TV shows to promote. Thus, these nuances provide new evidence that could contribute to adopting acceptable and effective interventions in Ghana.

However, given the similarities of these interventions to those elsewhere, and the need to ensure complementary strategies that are effective in addressing the multifactorial determinants of obesity, the literature was searched again on 19/04/2022 to draw lessons for Ghana's obesity agenda. The rationale for the review was to ascertain the practicability of complementing the identified interventions in the real world, especially in a West African context. Scopus database was used for the literature search because it is the largest bibliographic database for peer-reviewed articles. The search terms for the search included a combination of the following keywords: 'education,' 'awareness,' 'campaigns' 'laws,' 'tax*,' 'subsidy*,' 'policy*,' 'intervention*,' 'obesity,' 'overweight' and 'effectiveness. These search terms were based on the interventions from the stakeholders. The search used database filters to limit the search results to studies published in the last 10 years (2012- 2022) to guarantee current evidence on obesity interventions. See table 43 for the search result.

Table 43: Literature search result

Database	Search term used	Initial hit	Filters used	Final hit
Scopus	Education OR awareness OR campaigns AND laws OR regulations AND tax AND policy* OR intervention* AND obesity OR overweight AND effectiveness	6	Exclude studies published before 2012– 1	5

Of the five (n = 5) from Scopus, one was removed because it was irrelevant to the focus of this review. The four remaining studies were from the USA, Mexico, and Canada (see appendix 13 for the characteristics of the studies). None of them was from Ghana or even West Africa. One reason for this observation could be the paucity of determinants of obesity studies to drive or inform related interventions, as evident in the literature review findings in Chapter 2. This gap reinforces the urgent need for studies on obesity determinants to inform further studies on obesity interventions. The interventions mentioned in the reviewed studies (in this current chapter) corroborate those espoused by the stakeholders. As such, it provides data to support the consideration of these interventions in the policies to address obesity in Ghana.

Nonetheless, the evidence on the effectiveness of some of the policies was conflicting. Two studies demonstrated that taxes, particularly on sugar-sweetened beverages (SSBs), could reduce obesity risk (Álvarez-Sánchez et al., 2018; Cawley, 2015). The others, however, argued that such policies could have reverse effects and possibly pose health risks to the public in the long term (Hemphill, 2018; Lusk, 2014). Hemphill (2018) further argued that government policies, like taxes, are sometimes tinted by political interests and vulnerability that could annihilate any intended impact. This argument resonated with Swinburn (2011), who indicated that such policies contributed to the global overconsumption crises, especially with the advent of neoliberalism. Besides, the taxes may unlikely affect the targeted food establishments as they set the conditions for these taxes to be transferred to the customers (Lusk, 2014). The systematic review by Nakhimovsky et al. (2016) further demonstrated that taxing SSBs may considerably affect net energy intake but not enough to influence population weight permanently.

In summary, all the studies asserted that individual/single interventions, especially those on taxation, are limited in addressing the obesity menace. Thus, a wide range of interventions, including social marketing campaigns, awareness/education campaigns, and environmental changes, must be complemented to assure efficacy (Cawley, 2015). However, this complementation must be informed by context to derive its full benefit. What this means for this research and, inherently, Ghana is that the three identified key interventions must be complemented per the country's social-economic fabric to reduce the burden of obesity.

9.3 Discussion

This chapter explored stakeholders' opinions on important interventions to address the determinants of obesity identified in this thesis using the Delphi approach. The rationale for involving the stakeholders again in this analysis was to ensure that the research findings feed fluidly into policy to avoid research disuse. Generally, the inclusion of stakeholders in this thesis maximised the advantages of the participatory research approaches, i.e., it upscaled the possibility of the research findings uptake and transfer to practice to benefit the wider population.

Several interventions like taxation, education campaigns and regulations of the local food environment, were rated by the stakeholders as important obesity interventions. These interventions are consistent with the literature on public health interventions to tackle obesity (Dhandevi & Jeewon, 2015; Faulkner et al., 2011; Sahota et al., 2001). They are also similar to global obesity strategies, specifically the global action plan on physical activity 2018–2030 (Who, 2018) and the global strategy on Diet, Physical Activity and Health (WHO, 2018), and the interventions identified in the earlier reviewed studies.

As mentioned earlier, the interventions by the stakeholders to tackle obesity determinants revolved around educational strategies, laws/regulations and environmental changes to facilitate obesity-related lifestyle changes at the macro level, i.e., at populations and subpopulations levels (Swinburn et al., 2011). However, since individual characteristics, such as beliefs and choices, could trigger the risk of obesity, it is essential for these interventions to be delineated at the individual levels, i.e., the micro-level, to promote behavioural changes regarding obesity (Innella et al., 2016). This argument, however, may be too simplistic given how complex structural factors could drive an individual's beliefs and food choices (Otero et al., 2018). For example, income inequalities and societal positioning on body image and beauty influence individuals' obesity-related lifestyle choices (Sim et al., 2010; Amoah, 2003).

Additionally, current agriculture/food value chain disparities further limit individuals from making lifestyle choices devoid of external indicators (Otero et al., 2018). Therefore, centring the individual as the sole agent in obesity causes and prevention may result in stigmatisation and misconceptions, which can affect obesity mitigating policies (Luck-Sikorski et al., 2017). Given these reasons, it is critical that the interventions highlighted by the stakeholders are operationalised at both the population and individual levels, where possible, to reduce the obesity burden in Ghana comprehensively.

The social ecological model also shows how multiple factors/levels, e.g., individual, interpersonal, community, organisation and society, etc., interrelate and influence an outcome, like obesity, and the need for synergistic interventions to address each factor/level (Cassel, 2010; Economos & Irish-Hauser, 2007). For instance, education and awareness interventions targeted at the individual may not guarantee obesity-related healthy lifestyle adoption if community and societal interventions, like laws and regulations, are not considered (Sallis et al., 2015). More practically, education campaigns on the consequences of obesity are no guarantee that people will practice a healthy lifestyle. Similarly, taxation and subsidies on healthy foods may not promise consumption of those foods if the intervention is not complemented with education interventions.

In Ghana, and as evident elsewhere (Swinburn et al., 2011), consumption of an unhealthy diet can be underpinned by sociocultural expectations. For example, individuals may prefer fast foods due to social positioning and elitism, especially when these fast foods are available in high-priced restaurants (Ofori-Asenso et al., 2016). Thus, any increase in the cost of these foods, which could be transferred from the taxation, may not be a deterrent but rather a challenge to raise their purchasing to establish and sustain their social positioning.

The ecological model provides a framework for policymakers to integrate multiple interventions to address the multifactorial and the multi-level obesity influence (Cook & Mueser, 2013). Though the model is unable to determine interventions that are most influential at each population and factorial level, it can delineate interventions specific to each level, unlike single level theories, like the behavioural theories (Sallis et al., 2015; Teixeira et al., 2017). Additionally, implementation of interventions informed by the ecological model can be challenging, especially in resource-constrained settings, given its robustness; however, documented literature on its effectiveness necessitates its adoption in obesity-related policymaking (Sallis et al., 2015).

Concerning strengths and limitations, this study is the first to explore experts' opinions on important interventions to tackle specific determinants of obesity in Ghana. It offers new insight into obesity managing strategies that could guide related policies and drive the tangent of obesity discourses in Ghana. Likewise, the Delphi approach adopted in this study ensured consensus on a larger pool of interventions from broader perspectives. This advantage provides policymakers with several obesity policy menus to confront the menace holistically. Also, the anonymity shield provided by the online approach in this study guided against socially desirable responses that could have potentially biased the study findings. Furthermore, the diverse backgrounds of the stakeholders, especially those from the general public, balanced the obesity prevention narratives by shifting the conversation from the usual obesity 'gatekeepers' debates. The balanced responses could guarantee the adoption of the interventions by the target populations.

Nonetheless, some participants were lost after the first round, resulting in an attrition bias. But this bias may not be pronounced since the Delphi approach relies more on group dynamics and consensus building than sample size and statistical power. Moreover, the final sample size (n=48) was more than the minimum sample size required for Delphi studies (Murphy et al., 1998).

9.4 Conclusion

This chapter identified key interventions to address the association between religion & culture, physical activity & diet, the local food environment, and obesity. These interventions were mainly education strategies, such as mass media and school-based campaigns, government policies, like increased taxation and food regulations, and environmental changes. Though these interventions were similar to those in the literature, they presented with granularities to inform tailor-made policies in Ghana. Finally, the chapter highlighted and discussed the rationale for complementing these interventions to maximise their benefits to reduce the obesity burden. The next chapter, which is the final chapter of this thesis, discusses and summarises the implications of all the findings in this thesis and offers areas for future research.

Chapter 10: Discussion and Conclusion

10.0 Key research findings

The research showed that religion and culture, specifically Muslims and Gas, are associated with an increased risk of obesity in Ghana. It also demonstrated that physical activity and diet are interconnected lifestyle variables associated with increased odds of obesity. Further, it revealed that the higher the number of supermarkets and fast-food joints in an area, the greater the odds of obesity. Additionally, the findings indicated that education and awareness campaigns, environmental changes and government laws and regulations on food businesses must be complemented to address the determinants of obesity in Ghana. Figure 10 shows the new knowledge from this thesis on the determinants of obesity in Ghana.

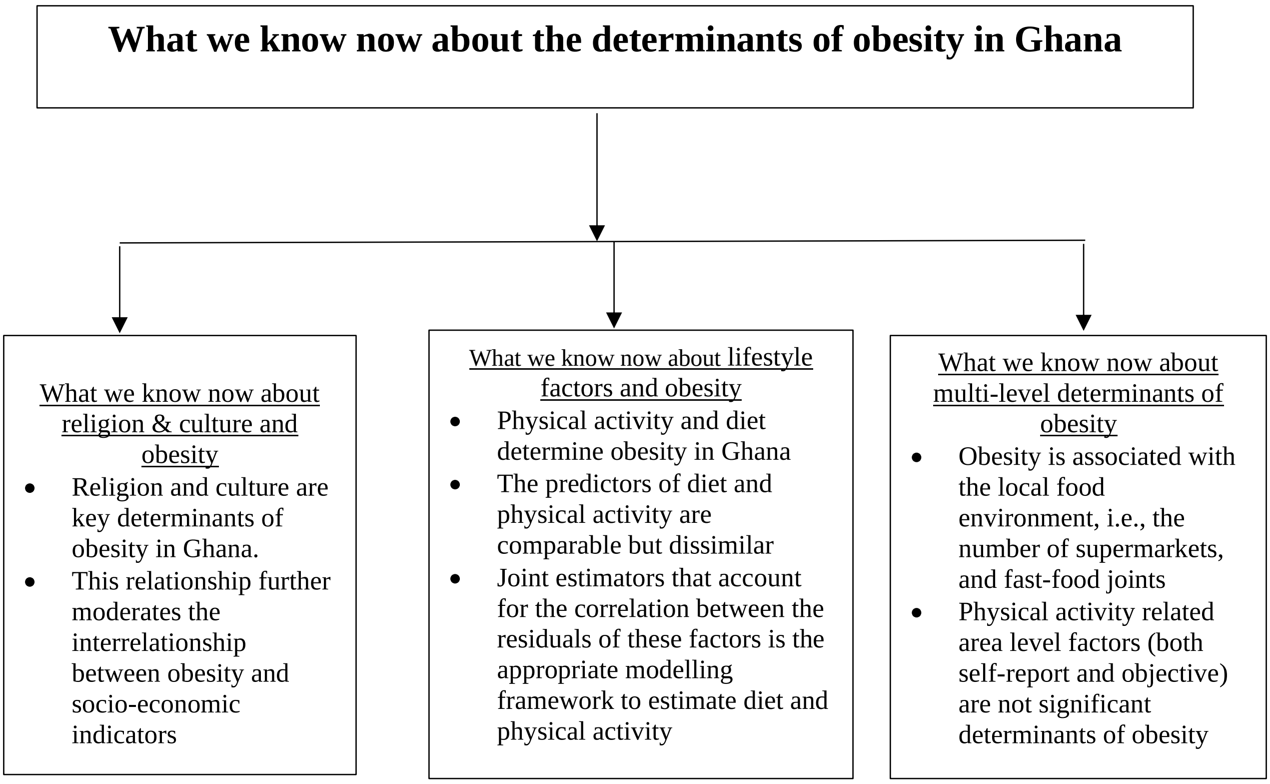


Figure 10: What we now know about the determinants of obesity in Ghana.

The subsequent sections in this chapter discussed how these findings compare to the literature and whether they have contributed new evidence to the body of knowledge on obesity. They also discussed the thesis's contribution to Ghana, their comparison to results from other countries, notably African countries, and how the findings relate to the ecological model. Finally, the chapter explored the policy implications of the findings and the study's limitations.

10.1 Comparison of research findings to the literature

The influence of religion and culture on obesity is widely documented in the literature (Lilo et al., 2020; Higins et al., 2019; Dodor et al., 2018; Sanchez-Johnsen et al., 2017; Delavari et al., 2015; Cline & Ferraro, 2006**)**. For example, Cline & Ferraro (2006) demonstrated that women affiliated with the Baptist religious denomination in America have a higher risk of obesity. This result was consistent with Mason et al. (2013), Bharmal et al. (2013) and Yeary et al. (2017). They also showed that women affiliated with the Latter-Day Saint church were more likely to have a higher risk of obesity and overweight. In their argument, Cline & Ferraro (2006) illustrated that education and race explain the association between the Baptist religious affiliation and obesity, i.e., African Americans with lower education status were more likely to be associated with religious groups and more likely to be obese.

The argument by Cline & Ferraro (2006) was confirmed in this study, particularly as sociodemographic characteristics, like sex and education status, were found to influence the association between religion and obesity in Ghana. Apart from Cline & Ferraro (2016) and Mason et al. (2013), a recent review also found many studies reporting a positive relationship between religiosity and obesity (Dodor et al., 2018). Additionally, Chatham & Mixer (2020) revealed that culture, specifically traditional meals, and family food practices, positively influence the risk of obesity.

Conversely, other studies also indicated that religion or religiosity is not significantly associated with obesity (Spence et al., 2021; Sanchez-Johnsen et al., 2017; Reeves et al., 2012). Similarly, Roff et al. (2005) further highlighted that organised, non-organised and intrinsic religion does not influence obesity. The variations in these studies' findings were probably due to intrinsic sample characteristics, mainly as these studies were from different jurisdictions, including the USA. For instance, Spence et al. (2021)'s study focused on white female nurses, while this current study included black men and women. The apparent social differences between the two samples could influence their religious practice and, subsequently, their risk of obesity. Likewise, the operationalisation of religion and culture was different in the studies. For example, Roff et al. (2015) provided a composite measure of religion (like non-organised, organised, and intrinsic religiosity), while this current study used granular measures of religion. As indicated, these probably account for the difference in findings. Notwithstanding, this study’s findings provided current evidence on the association between religion and culture to inform new related policies in Ghana.

The association between diet and physical activity on obesity is also consistent with the literature (Robinson et al., 2021; Batiha et al., 2021; Myers et al., 2017; Maier & Barry, 2015; Majeed, 2015). However, while these studies used a single-equation estimator to examine these behavioural determinants, this research used joint estimators. Thus, it presents relatively more robust results than those identified in the literature. Furthermore, the finding on the interconnectedness of physical activity and diet and their influence on obesity was also corroborated by a recent systematic review (Chin et al., 2016). Thus, like this study, they also proposed that given the interrelationship between these two factors, combined physical activity and diet interventions may be ideal for reducing the risk of obesity (Chin et al., 2026).

No study was found in the literature that showed that diet and physical activity are not associated with obesity. But an editorial by Malhotra et al. (2015) indicated that despite the enormous evidence, physical activity does not ensure weight loss; instead, an unhealthy diet contributes more to obesity-related health and economic burden than physical inactivity (Malhotra et al., 2015). This report was also documented by Luke & Cooper (2013). However, Blair (2015) argued this assertion by demonstrating that leisure-time physical activity is not a comprehensive measure of physical activity; so, it is not enough to conclude the relationship between obesity and physical activity, as done by the opposing studies.

Additionally, using a large body of evidence from observational, ecological, and experimental studies, they further showed that, like diet, physical inactivity is also a significant indicator of obesity and must be given all the necessary policy and clinical attention it deserves, whilst studies continue to explore their combined influence on obesity. (Blair et al., 2013). Their argument on the policy relevance of including both factors in obesity prevention was consistent with the arguments alluded to in this thesis. But their findings were specific to their study context, thus making this current study the first to provide robust evidence the interrelationship between diet and physical activity in Ghana.

As mentioned in the discussion section of chapter 8 of this thesis, the multilevel finding on food environment and obesity is supported by the literature (Hall et al., 2021; Gonçalves et al., 2019; Backes et al., 2019; Burgoine et al., 2018; Xu et al., 2015; Walker et al., 2020). These studies also demonstrated that the food environment, mainly residential fast-food outlets and supermarkets, increases the odds of obesity among residents. More clearly, Pessoa et al. (2015) showed that when sociodemographic variables are adjusted, residents with more healthy food outlets have higher fruit and vegetable intake than those living distal to healthy food outlets. However, the finding on restaurant location and obesity was inconsistent with the literature. For example, Asirvatham et al. (2019) indicated that the risk of obesity increases with increasing proximity to a restaurant. This difference may be due to varying socio-cultural perceptions of restaurant choices, as argued in chapter 9. It is also possible that different economic characteristics in the two studies account for the different results on restaurant location and obesity (Walker et al., 2020). However, the two studies illustrate that restaurant presence as part of the food environment is associated with obesity.

Finally, the identified interventions to tackle the obesity epidemic in Ghana are supported by the literature (WHO et al., 2018; Dhandevi and Jeewon, 2015; Faulkner et al., 2011; Sahota et al., 2001), except the tax interventions that had varied evidence from the literature (Álvarez-Sánchez et al., 2018; Cawley, 2015; Hemphill, 2018; Nakhimovsky et al., 2016; Lusk, 2014; Swinburn et al., 2011). While Álvarez-Sánchez et al. (2018) and Cawley (2015) argue that taxes on an unhealthy diet could reduce obesity prevalence, the others contend that it could rather trigger increased obesity risk. This contradicting evidence indicates an urgent need for further robust research on food taxation and obesity to direct related policies.

10.2 Comparison of findings to results from other countries

While several studies from different countries, like Togo, Ivory Coast, Benin and Senegal, have explored the determinants of obesity using single estimators, this study used joint estimators to guarantee extensive evidence that captures critical determinants of obesity (Koussoh et al., 2019; Jeoffray Diendéré et al., 2019; Fatai et al., 2015; Doku et al., 2015; Damorou et al., 2013). Additionally, compared to the above-referenced studies, this study provided further evidence on hierarchical determinants of obesity using the ecological model. On the area-level determinants of obesity, the findings of this thesis on food environment and obesity confirm the results of other studies from Nigeria (Osayomi & Orhiere, 2017; Oyeyemi et al., 2012). But the thesis did not confirm Oyeyemi et al. (2012)'s findings on the significant association between obesity and crime. This divergent finding may be due to the type and characteristics of the measured crime in the two studies.

Concerning physical activity and diet, this thesis's result was consistent with findings of similar studies from Nigeria, Togo, South Africa and Cameroon (Aladeniyi et al., 2017; Oyeyemi et al., 2013; Damorou et al., 2013; Tyrovolas et al., 2016; Becquey et al., 2010; Pasquet et al., 2003; Aladeniyi et al., 2017). All these studies agreed that diet and physical activity are significant determinants of obesity. On religion and cultural determinants, this study's result was confirmed by studies from other countries/populations, such as South Asians, Polishes and Zimbabweans (Mangemba et al., 2020; Morawa & Erim, 2018; Bharmal et al., 2018). Nevertheless, while this study identified Muslims to have a higher risk of obesity, Mangemba et al. (2020) showed that Christians rather have higher odds of obesity. Sample characteristics could have accounted for this variation. The association between obesity and Muslim affiliation in this study was, however, confirmed by Bharmal et al. (2018).

Generally, similarities in findings of studies from different countries suggest that effective obesity policies can be triangulated and implemented in other countries to reduce the overall impact of the epidemic globally. But like every intervention, such policies must be subjected to contextual assessment to ensure their acceptability and practicability.

10.3 Situating the thesis findings to the Ghanaian context

This thesis provided current evidence on the influence of religion and culture on obesity in Ghana. Arguably, it is one of the few studies identified in the literature to have examined the relationship between religion & culture and obesity in Ghana (Michgelsen et al., 2021; Clark et al., 2021; Nsiah-Asamoah et al., 2018). Though Nsiah-Asamoah et al. (2018) showed that culture is associated with obesity, their study was mainly descriptive and not empirically supported, as done in this thesis. Thus, comparatively, this study is one of the first to show that culture, especially people of Ga cultural background, influences obesity in Ghana through robust analysis.

Clark et al. (2021) also demonstrated a similar report on culture (Gas) and obesity as reported in this study. But again, this thesis provided a more robust finding, given the higher sample size. Michgelsen et al. (2021) also reported that women affiliated with the Christian religion in Ghana have an increased risk of cardiovascular diseases, including obesity. This evidence is incongruent with the evidence in this thesis since this thesis demonstrated that Muslims have higher obesity odds than Christians. Nonetheless, these studies may not be comparable, given that Michgelsen et al. (2021) focused on only individuals associated with the Christian religion. In contrast, this thesis included all the major religious groups in Ghana.

Similarly, this thesis is the first to provide evidence on the influence of the food environment on obesity in three metropolises in Ghana by accounting for varying levels of accessibility, i.e., 2km, 5km, and 10km radius. This finding is novel because the only other study to examine the food environment and obesity focused on only one metropolis and did not account for varying degrees of accessibility (Dake et al., 2016). It also included only fast-food joints and supermarkets, while this study included restaurants, supermarkets, and fast-food joints. Apart from the food environment, this thesis also contributed new evidence to the arsenal of knowledge on physical activity, diet, and obesity in Ghana by exploring the probability of consuming a healthy diet and engaging in physical activity, and inherently the probability of obesity using joint estimators. Further, it explored factors that could influence the odds of engaging in these two practices. These robust investigations were not observed in similar studies in Ghana (Addo et al., 2015; Atuahene et al., 2017; Ganle et al., 2019).

Finally, this thesis is one of the few studies to conceptualise the determinants of obesity in Ghana using the ecological model, to the best of the researcher's knowledge. Hence, it provides new directions for prioritising obesity interventions in Ghana (Boateng et al., 2017). Specifically, it could direct policymakers on specific levels of the model to prioritise when implementing obesity policies to maximise the expected impact.

10.4 Contribution of thesis findings to the literature

This thesis addressed a critical literature gap by providing new evidence and an in-depth understanding of the determinants of obesity in Ghana using the multi-level approach. The policy relevance of this multi-level approach has been well-documented in other jurisdictions (Siddiqui & Donato, 2016; Moraeus et al., 2012; Shrestha et al., 2020); however, to date, it remains underexplored in Ghana, particularly among heterogeneous groups. Thus, applying this approach in this thesis sets the foundation for new paradigms in analytical estimators for obesity determinants in Ghana. Further, the theses contributed to the obesity knowledge in West Africa by highlighting a critical gap in assessing the interrelationship between obesity and lifestyle behaviours. The existing evidence assumed an independent relationship between obesity and lifestyle behaviours, thus, leading to inaccurate estimates. However, this research demonstrated that accounting for these analytical inaccuracies is robust and could provide precise estimates to inform comprehensive interventions.

The thesis also added new knowledge to the obesity literature by demonstrating the importance of involving stakeholders in obesity to establish key obesity research areas relevant to policymakers in Ghana. This knowledge of stakeholders' involvement was limited in the literature, especially in West Africa, until this thesis' exploration. The inclusion of stakeholders confirmed priority research gaps whose investigation could inform necessary interventions, especially given the prevailing resource constraints in the country. The thesis also demonstrated a lack of current and comprehensive obesity datasets that capture the Ghanaian ecosystem, explaining the paucity of obesity-related research in Ghana. It further addressed this gap by conducting Ghana's most recent obesity survey. This survey could set the pace for more rigorous obesity research in Ghana to ensure up-to-date evidence to address the burden. Unlike the previous datasets identified in chapter 4, this dataset captured Ghana's ecological structure, thus ensuring comprehensive coverage. It also collected variables on religion and culture, key variables missing in the previous datasets. Hence, it filled the crucial gap in obesity dataset inadequacy in Ghana.

Additionally, as mentioned in this chapter, this thesis is one of the few studies to provide robust evidence on religion and culture as crucial obesity determinants. It is also one of the few research projects to show that these determinants moderate the interrelationship between obesity and socio-economic indicators. Previous studies were limited in accounting for this moderating effect. Thus, comparatively, this thesis' findings could inform more robust interventions. The study also addressed one of the critical literature gaps in this study by assessing the interrelationship between physical activity and uptake of a healthy diet using joint estimators. This evidence is relatively new in the literature because most studies apply the conventional single-estimator equation to analyse the influence of diet and physical activity on obesity. It underscored the need for studies to use joint estimators to account for the influence of lifestyle variables on obesity, especially as we advance in research to find mitigation interventions to address this burden holistically.

Furthermore, the thesis demonstrated that the local food environment is a significant determinant of obesity in Ghana based on a multi-level analysis. Though this analysis had been explored by Dake et al. (2016) in Ghana, it did not account for the varying level of accessibility on the risk of obesity. Furthermore, it also included homogenous groups, limiting the external validity of their findings. As such, the inclusion of different access levels and heterogenous groups in this current thesis contributed to new obesity knowledge with considerable policy implications.

10.5 The research findings in relation to the ecological model

The approach and findings of this research align with the ecological model as conceptualised in chapter 4 of this thesis. The ecological model posited that obesity is influenced by an interaction of five primary concentric ecological levels: the individual, household, neighbourhood, sub-metro (subpopulation) and metropolitan (population) levels (refer to figure 5 in chapter 4). This finding is consistent with the arguments of the proponents of the ecological model as a useful tool to investigate factors that influence obesity (Conroy et al., 2018; Pitanga et al., 2016).

As discussed above, though many studies have explored determinants of obesity, most have focused on specific levels of the ecological model, creating gaps that this study address by examining how the combined ecological layers influence obesity. For instance, the study explored how a combination of individual, household and neighbourhood characteristics could determine obesity using a multi-levelling approach (See chapter 9). It also examined the influence of sub-metro and metropolitan factors, like culture/tribe and health policies, on obesity in Ghana (see chapters 6 and 10). Therefore, it provided results that could be valuable in designing setting-specific obesity interventions.

Comparatively, most of the conceptualised ecological layers determined obesity in Ghana. One could argue that the thesis could have explored the incremental contribution of each concentric level to the obesity epidemic in Ghana. While this argument is cogent, it could have led to biased estimates since the levels are not entirely independent of each other (Ohri-Vachaspati et al., 2015). All the same future studies could explore the incremental influence of these concentric levels. Perhaps, it could identify findings that could inform prioritised interventions.

Nonetheless, the thesis identified that at the neighbourhood level of the ecological model, the objective area-level factors significantly predicted obesity more than the self-reported area-level factors (see chapter 9). While this finding could be an outcome of the collected data, since the objective and self-reported measures were mostly diets and physical activity-related variables, respectively, it could also be emanating from nuances around self-perception of diet, like food quality (Ohri-Vachaspati et al., 2015). However, the differences in the degree of significance could have also resulted from the limitations associated with self-report measures, like social desirability bias, discussed in chapter 9.

10.6 Why stakeholders approach in this thesis?

The thesis engaged stakeholders to direct priority obesity research areas for this thesis and provide critical interventions to tackle the findings from those research areas. The basis for this engagement was to ensure the active involvement of key policy actors throughout this thesis to guarantee the usage of identified evidence in obesity policy formulation and implementation. This approach is supported by the literature as it indicates that the transfer of evidence into policy and practice is successful when all key players/actors are involved in the evidence-policy-practice cycle (Bowen & Zwi, 2005). However, as argued by WHO (2020), the evidence herein was aimed to inform obesity-related policies and not necessarily as a sole basis for obesity policies in Ghana. This argument is in recognition that evidence identification is only one of the many inputs/indicators that feed into policy decisions and implementation (WHO, 2020).

As indicated earlier, data suggest that stakeholders' involvement in research can ensure a seamless transfer of knowledge/evidence into policy or practice (Keown et al., 2008). Additionally, such involvement enhances the quality of research outputs due to its tendency to attenuate the possibility of researcher bias (Rees, 2008). But this quality depends on the stakeholders' knowledge base and experience regarding the research area (Belton et al., 2019; Ray & Miller, 2017). It also depends on the engagement process, especially the selection of stakeholders. For example, a skewed stakeholder sample could promote a dominant group's perspectives and bias the research outcomes (Schneider et al., 2017; Tregunno et al., 2004).

Therefore, this thesis employed the purposive sampling technique and used a heterogenous sample to avoid these hypothetical limitations that could have attenuated the quality of the stakeholder approach. Heterogenous samples are sometimes characterised by divergent opinions resulting in time constraints; however, this thesis capitalised on the Delphi consensus approach to maximise the benefits of heterogeneous samples in stakeholder engagements.

Unlike regular theses, including experts or stakeholders in this research maximised the gains of participatory research approaches. First, it helped ascertain the relevance of the research questions to obesity management in Ghana. Second, it allowed the stakeholders to be co-producers of current obesity evidence in Ghana, creating a sense of shared responsibilities and assured efficiency (Roque et al., 2022). Third, it ensured a more effortless knowledge transfer among the participants and the researcher. These advantages tend to accelerate the possibility of the evidence here to inform obesity decisions in Ghana. As demonstrated in this thesis, the robustness of the stakeholders' approach indicates a need for future studies on any given topic to explore its methodologies to enhance research impacts.

10.7 Policy implications of the thesis' findings in Ghana

The findings in this thesis provide numerous policy menus for obesity prevention at individual, sub-population and population levels. For example, the government of Ghana could develop and sponsor obesity awareness campaigns in the local languages of the target populations (cultural groups, in this instance) through documentaries, television & radio commercials and social media. These platforms tend to have a broader coverage with increased potential for public consumption. Thus, their usage could create obesity prevention awareness at the population and subpopulation levels. Moreover, their effectiveness in transmitting obesity prevention messages has been well-documented in the literature (King et al., 2013; Wammes et al., 2005).

On the education campaigns, they must be strategically implemented, given the complexity and cultural/traditional nuances around some indicators of obesity, like food (Sim et al., 2010). For example, educational campaigns on highly caloric traditionally symbolic foods must incorporate strategies on food portioning and sedentary & active lifestyle approaches, as complete abstinence messages may be met with resistance, which could result in an ineffective policy. Essentially, the effectiveness of obesity awareness-based policies targeting specific groups relies on understanding and appreciating the groups' traditions and dogmas (Pretty, 2009).

For the influence of diet and physical activity on obesity, the government could enact laws and provide subsidies to make healthy diets available and affordable, and create enabling environments to promote physical activity participation, as indicated by the stakeholders in the previous chapter. The enabling environment could include:

- Creating recreational centres within communities.
- Ensuring safe neighbourhoods.
- Campaigns to de-commercialise residential areas to promote cycling and walking.
- Tax reduction on the purchase of non-commercial exercise equipment.

However, this policy on diet and physical activity must be augmented with education campaigns on the health and economic costs associated with the consumption of unhealthy diets and physical inactivity.

This supplementation could increase subsidised healthy diets/foods patronage and participation in physical activities. The hybrid nature of this policy could guarantee its operationalisation at both the individual and population levels. For the education aspect of this policy, gatekeepers like health practitioners, traditional & cultural leaders, advocacy groups, teachers and other influential persons could be engaged to champion the campaigns to ensure policy acceptability. Though these policies could be financially demanding, their benefits could be enormous and may provide high returns on investment.

Regarding the local food environment, the government and other appropriate agencies must review existing guidelines and monitor the operations of supermarkets and food-fast vendors religiously to ensure they comply with related regulations. Where necessary, new regulations can be enacted to ensure that supermarkets create higher store visibility of their healthy products. Conclusively, all the outlined policies to address the determinants of obesity must be comprehensive, pragmatic and socio-culturally appropriate to ensure their success.

Several policies to address the obesity burden in Ghana have been discussed individually in the previous text; however, these interventions must be supplemented to address the obesity burden, particularly given the multifactorial complexity of obesity in real-life. All the same, some of these interventions should be prioritised over others because of logistic constraints in Ghana and the documented evidence-based in the literature. For instance, policymakers in Ghana could prioritise education and awareness campaign interventions over other interventions like the provision of recreational centres within communities. This prioritisation is because the former appears more economically viable than the latter, and given Ghana’s chronic fiscal deficiencies, the cost must be considered in the country’s policy implementation.

Apart from cost, the creation of recreational centres in Ghana, particularly in the three metropolises included in this thesis, may be complex due to population congestion. Ghana is currently facing increasing population density concerns due to urban migration. Now, major cities are becoming overcrowded with a steady rise of slums and land encroachments, resulting in space scarcity for recreational development. Moreover, pulling unauthorised structures for such centres may end in societal apprehensions with dire political consequences. Therefore, given their potential adverse social and political implications, such resource-intensive interventions may be shelved by final gatekeepers as opposed to education campaigns. Education campaigns interventions could also be resource-intensive, but the cost could be managed efficiently by using organised group leaders, like heads of religious & cultural groups and opinion & community leaders. Additionally, it could easily be implemented at all population levels than recreational centre interventions.

10.8 Implications for future research

As mentioned earlier, this thesis has provided an in-depth understanding of the determinants of obesity in Ghana. While providing new evidence, it also identified other areas for future studies to further our understanding of obesity in Ghana. First, future studies could examine the determinants of obesity with samples from the other metropolises in Ghana (this study focused on Accra, Kumasi and Tamale). The findings from such studies could complement this thesis result to inform nationally acceptable policies. The survey instrument developed in chapter 5 may be used in such studies to ensure such complementary evidence.

Second, future studies could investigate the relationship between obesity and other lifestyle variables, like sleep, that was not accounted for in this study due to logistic constraints. Such exploration in future studies would provide new evidence and expand our knowledge on the interrelationship between *all* lifestyle variables and obesity in Ghana. Finally, future could also conduct cost-effectiveness analysis of the identified policies in this study to inform less expensive and more effective obesity policies in Ghana.

10.9 Limitations of thesis

This thesis contributed immensely to the obesity literature, particularly in Ghana, as already detailed above. Nonetheless, it was fraught with limitations, which have been highlighted below.

The literature review in chapter 2 identified studies from ten different West African countries; however, there was a significant imbalance in those countries' representation in the review. For instance, most of the studies were conducted in Ghana (n = 22) and Nigeria (n = 19), with only a few from countries like Senegal (n = 2), Benin (n = 1) and Togo (n = 1). This imbalance limits the possibility of exhaustive evidence on the determinants of obesity in underrepresented countries. Also, there were some methodological differences across the studies. For instance, while some determined their effect sizes using odds ratios, others used adjusted odds ratios. These differences limited granular comparisons of the studies. Additionally, the policy relevance of the identified gaps was not explored. Nonetheless, the chapter aimed to identify literature gaps to inform the objectives of the subsequent chapters and not the consequent policies of those gaps.

Chapter 3 reported 18% non-response bias. (10 out of the 55 participants did respond to the questionnaire). However, the effect of this bias on the findings from that chapter may be inconsequential as Delphi relies more on establishing consensus on a given topic. Besides, the minimum sample size for Delphi studies is twelve (n=12) (Murphy et al., 1998); therefore, comparatively, the remaining sample in the chapter was not on the lower side. The analyses in Chapter 5 were mainly descriptive and bivariate explorations of factors associated with obesity in Ghana. Thus, it was limited in indicating the direction and magnitude of the explanatory variables' effect on obesity. Based on this, the interpretation of the findings must be made with caution. But this limitation was addressed in the subsequent sections of the thesis, in specific chapters that sought to understand the determinants of obesity using empirical approaches.

There were two main limitations in chapter 6. First, the use of BMI to estimate obesity presented a challenge, notably as it has been argued to be imperfect in depicting the association between excess weight, fat and connective tissues like muscles and bones (Antonopoulos et al., 2016). Notwithstanding, to date, the BMI measure of obesity is the gold standard for determining obesity, according to WHO (2021). Therefore, its use in chapter 6 aligns with current evidence. Second, the geographic sources of the data used in this chapter could have introduced selection bias. This is because the data was collected from three out of the six metropolises in Ghana, accounting for 50% of the study population. However, the three selected metropolises are the most populous metropolises in Ghana. Additionally, they cover the major religious and tribal groups in Ghana, as evident in the findings of chapter 6.

Since the data used in chapter 6 was the same for chapter 7, the limitation associated with sample representativeness also applies here, and the supporting explanations to assuage the limitation. In addition to the sample representation limitation, the explanatory variables explored in this chapter were not exhaustive. For instance, this chapter did not explore other equally important variables, like education and cost, that could potentially correlate with physical activity and diet. Furthermore, the chapter explored the cross-sectional design to examine factors that influence physical activity and diet, just like the other empirical chapters in this thesis. Therefore, the researcher could not determine any causal association.

Finally, just like chapters 6 and 7, chapter 8 also used samples from only three metropolises; so, the implication of sample underrepresentation, as discussed above, is relevant here. Similarly, like chapter 7, the study design in chapter 8 limited the researcher from establishing causal relationships. In chapter 9, the main limitation was attrition bias which resulted from the loss of participants after the first round of the Delphi approach. However, as discussed earlier in this chapter, this bias may not be consequential since the remaining sample size (n = 48) was not on the lower side regarding the minimum sample size for Delphi studies (Murphy et al., 1998).

10.10 Concluding comments

This thesis aimed to investigate the determinants of obesity in Ghana to contribute to knowledge and advance our understanding of obesity in Ghana using the ecological model. It adopted individual and multi-level approaches with varied regression models to unpack the multifaceted nature of obesity after generating the very first comprehensive obesity dataset in Ghana. The findings suggested that obesity is determined by culture and religion; specifically, Gas and Muslims were more likely to be obese. Likewise, the number of supermarkets and fast-food joints increases the odds of obesity. Also, obesity is influenced by an interrelationship between physical activity and diet. However, the factors that affect the propensity of these lifestyle factors were comparable and sometimes similar. For example, men were more likely to engage in physical activity but less likely to consume a healthy diet.

After exploring determinants of obesity, the thesis further identified and built consensus, through a Stakeholder engagement workshop, on important interventions to address these determinants. Essentially, these interventions bordered on government laws and economic regulations, education and awareness campaigns that target individuals, institutions and organisations. Thus, the thesis suggested that these stakeholders' interventions should be incorporated into current obesity prevention policies to address the identified determinants of obesity in Ghana.

In conclusion, this thesis is the first study to investigate area-level determinants of obesity in Ghana using varying levels of related facilities accessibility through the multi-level approach. It is also the first to analyse the interconnectedness of diet and physical activity using joint estimators. Furthermore, it is the first to explore stakeholders' opinions on important interventions to address the determinants of obesity in Ghana. Therefore, it provides novel evidence on *the cause and solution* to the obesity menace in Ghana. Lastly, it demonstrated that the ecological model is a feasible model for examining the determinants of obesity; thus, its used is encouraged in similar future studies.

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Yang, C. C., & Chiou, W. B. (2010). Substitution of healthy for unhealthy beverages among college students. A health-concerns and behavioral-economics perspective. *Appetite*, *54*(3), 512-516.

Yeary, K. H. C. K., Sobal, J., & Wethington, E. (2017). Religion and body weight: A review of quantitative studies. *Obesity Reviews*, *18*(10), 1210-1222.

Yorke, E., Tetteh, J., Boima, V., & Yawson, A. E. (2021). High BMI: an important health risk factor among older adults in Ghana. *Public Health Nutrition*, *24*(14), 4522-4529.

Zeng X, Zhang Y, Kwong SW et al (2015). The methodological quality assessment tools for preclinical and clinical studies, systematic review and meta-analysis, and clinical practice *Journal of Evidence-Based Medicine.* 8:2–10.

Appendices

Appendix 1: Pilot review

Introduction

This report describes a review of reviews conducted to identify studies on the determinants of obesity. The rationale behind this review was to inform the methods of the main literature review to be conducted as part of the thesis, specifically the choice of databases and search terms. In addition, this study will present an overview of the evidence base and identify any gaps in the literature on reviews on determinants of obesity and potentially inform the type of review (i.e., review of reviews vs review of primary studies).

Methods

Search Strategy

Scopus, the largest database with over 37,000 titles from medicine, technology and social sciences, was searched in February 2020 for relevant systematic reviews. The following search syntax was formulated using thesaurus (Table 1). To produce a manageable set of literature, a number of qualifiers covering year of publication and document type were used. The last five years was considered as appropriate in reflecting the current findings and methodologies in the field.

Table 1: Overview of the search strategy and output

Database	**Syntax**	Hits
SCOPUS	((obesity OR ‘body AND mass AND index’ OR BMI) AND (correlates OR determinants OR factors)) AND DOCTYPE (re) AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015))	2109

Eligibility Criteria

To be selected for full review, a study ought to have the following characteristics:

- A review exploring the determinants of obesity
- Written in English, as there were resource constraints for translation

Following selection, information was collected from the studies using a data extraction form. The questions on the data extraction form reflected the scope of the review (Table 2).

Table 2: Data extraction questions

Type	Question
General features	Authors of study?
	Year of study?
	Study aim?
Methodological features	Which databases were used?
	Search terms used?
Findings	Main findings?

Results

Figure 1 shows the selection of the papers for review. The search produced 2109 hits. Following, the screening of titles/abstracts, 36 papers were selected. A full text screening of the 36 papers led to 8 papers selected for final review. See table 3 for the characteristics of the studies.

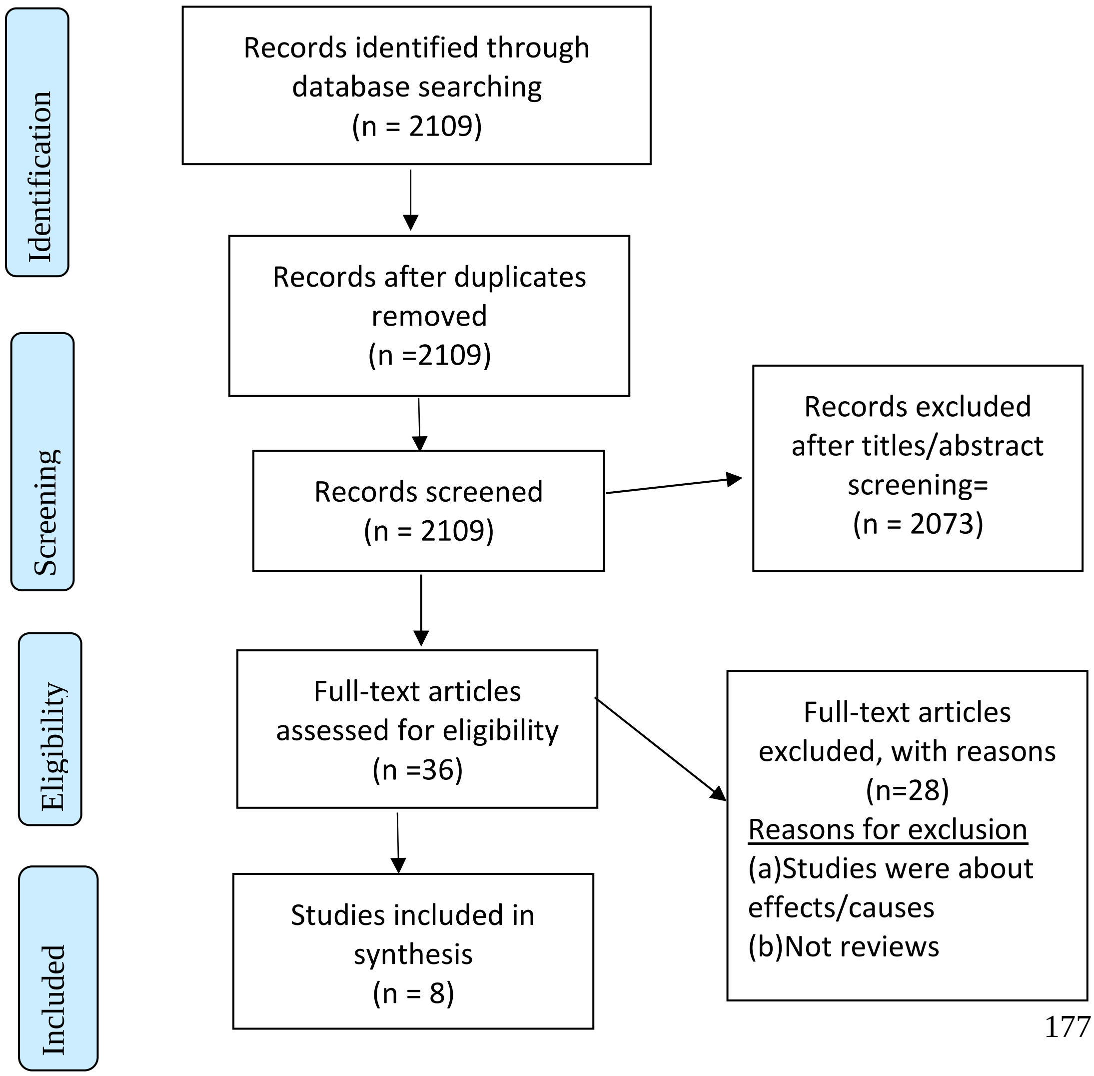

Table 3: Characteristics of the selected studies

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Cameron et al 2015	Assess the evidence relating to socioeconomic patterning of the pre-natal, infant and early childhood determinants of later obesity.	PubMed and Scopus	“socioeconomic” OR “education” AND ‘obesity’	14 modifiable, early-life determinants of later obesity were identified	This review whilst mentioning the determinants of obesity, focussed on early life determinants and even so on their relationship with socio economic patterning. Notably, the scope of this thesis relates to adult population. In addition, this review was conducted in 5 years ago so can be said not be very current
Balhareth et al 2018	Review of correlates of obesity and weight related behaviour in Gulf states	PsychInfo, PubMed	("overweight” OR overweight) OR obesity) OR "body weight changes") NOT "emaciation") OR weight OR "body mass index”) OR "body mass index")	Determinants were socio demographics, lifestyle behaviour, psychological factors	Relevant aim but context area is restrictive, although Gulf states are LMIC, the demographics are different from Africa (scope of the thesis). Having said that some aspects of the Ghanaian culture (particularly Tamale Ghana)

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Weng et al 2012	Determine risk factors for childhood overweight that can be identified during the first year of life to facilitate early identification and targeted intervention.	MEDLINE, EMBASE, PubMed and CAB abstracts	determinants obesity bmi weight gain Overweight Socioeconomic status education Ethnicity	Significant and strong independent associations with childhood overweight were identified for maternal prepregnancy overweight, high infant birth weight and rapid weight gain during the first year of life. Meta-analysis comparing breastfed with non-breastfed infants found a 15% decrease (95% CI 0.74 to 0.99; I2=73.3%; n=10) in the odds of childhood overweight. For children of mothers smoking during pregnancy there was a 47% increase (95% CI 1.26 to 1.73; I2=47.5%; n=7) in the odds of childhood overweight	Population of interest is children. Literature search conducted in 2011

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Varkevisser et al 2018	Synthesized recent literature on determinants of weight loss maintenance for individuals with overweight and obesity.	PubMed and PsycINFO	Obesity and overweight AND Weight loss AND Weight maintenance AND observational studies, randomized controlled trials, systematic reviews AND Determinant AND Physical Activity and Eating Behaviour NOT (<18 years old OR Animal Studies OR Pharmacological Studies OR Bariatric Surgery OR Pregnancy, lactation OR Publication types that are not journal articles OR Cancer OR Mental Disorders OR Diabetes mellitus type 1).	124 determinants were identified of which 5 were demographic, 59 were behavioural, 51 were psychological/cognitive and 9 were social and physical environmental determinants.	Relevant and Went for last 10 years Search conducted in 2016 Excluded cross sectional studies, which is the design the thesis will use. Weight loss maintenance may not be exactly obesity or weight gain

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Mohammadnezha et al 2017	Assess the prevalence of overweight and obesity and also the contributing factors in the Pacific countries	PubMed, Medline, Web of Science and PsychInfo, CINAHL, Scopus, EMBASE and	overweight, obesity, prevalence (determinants OR contributors)	Dietary factors associated with overweight and obesity which followed by physical activity (12.9%) and television viewing (9.68%).	Relevant to my thesis but: Focussed on Pacific. Conducted in 2017 (covering the last 17 years)
Monastaet al 2010	Review the evidence for early-life (from conception to 5 years of age) determinants of obesity. The design is review of published systematic reviews.	Medline, Embase, Web of Science, Cochrane Library, CINAHL, PsycINFO	Weight gain, Obesity OR obese OR obesogenic, 'Weight gain' OR overweight OR 'over weight' OR 'weight change, BMI OR 'body mass index, 'Epidemiological factors' OR 'Risk Factors	Factors associated with later overweight and obesity: maternal diabetes, maternal smoking, rapid infant growth, no or short breastfeeding, obesity in infancy, short sleep duration, <30 min of daily physical activity, consumption of sugar-sweetened beverages. Other factors were identified as potentially relevant, although the size of their effect is difficult to estimate. Maternal smoking, breastfeeding, infant size and growth, short sleep duration and television viewing	Relevant but Infant population, and search was conducted in January 2008

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Gebremariam et al 2017	To summarize existing evidence regarding the factors that mediate or contribute to the explanation of the relationship between socioeconomic position and adiposity among youth	Medline, Embase, Web of Science and PsycINFO	body mass index, overweight, obesity), keywords for SEP (e.g. socioeconomic status, education, income), keywords for mediating factors (e.g. mediat*, attenuat* or indirect*)	The most consistent mediators of the association between socioeconomic position and adiposity identified in this review were as follows: consumption of sugar-sweetened beverages, television viewing, computer use, parental body mass index, breastfeeding duration, breakfast consumption, maternal smoking during pregnancy and infant feeding practices. The mediating role of physical activity as well as fruit and vegetable consumption was found to be indeterminate.	Slightly different research question to the thesis as this study focussed on the relationship between socioeconomic and adiposity and youth

Paper	Aim	Databases	Search terms	Findings	Commentary –choice of a review of reviews or primary review
Samura et al 2016	Discusses factors associated with Excessive gestational weight gain	PubMed	“Maternal weight gain”, “gestational weight gain”, “obesity in pregnancy”, “excessive gestational weight gain”, “pregnancy”, “weight”, “race”, “centering”, “group prenatal”, “diet”, “exercise”, “psychosocial”, and “demographics.”	Pre-pregnancy BMI si the strongest predictor of	Not relevant to the population of interest for the thesis: Gender specific focus (women during pregnancy)

Eight databases were identified in the selected studies. The most frequently used was PubMed, followed by PsycINFO, Medline and EMBASE. Please see table 4 for the databases and their frequency of use by the studies.

Table 4: Databases and frequency of use

Database	**Number of reviews that used it**
PubMed	5/8
PsycINFO	3/8
Medline	3/8
EMBASE	3/8
Web of Science	2/8
Scopus	2/8
CAB Abstracts	1/8
ProQuest	1/8

Conclusion

This pilot review identified databases and search terms used to search for studies on determinants of obesity. The frequent databases were PubMed, PsycINFO, Medline, EMBASE, Scopus and Web of Science. However, since Scopus is known to cover abstracts and citations from PubMed, EMBASE and Medline, it was used in lieu of those databases. So, Scopus, Web of Science and PsycINFO were the databases used in the literature review of this thesis. For the search terms, the common ones included ‘obesity’, ‘obese’, ‘overweight’, ‘BMI’ and ‘weight gain’. These search terms also informed the search strategy of the literature review.

Appendix 2: Quality Assessment Checklists.

If cross sectional study, use AHRQ checklist

Agency for Healthcare Research and Quality (ARHQ) Methodology Checklist for Cross sectional study (http://www.ncbi.nlm.nih.gov/books/NBK35156/)

Item	Yes	No	Unclear
1) Define the source of information (survey, record review)	*		
2) List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	*		
3) Indicate time period used for identifying patients	*		
4) Indicate whether or not subjects were consecutive if not population-based	*		
5) Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants		*	
6) Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)		*	
7) Explain any patient exclusions from analysis	*		
8) Describe how confounding was assessed and/or controlled.	*		
9) If applicable, explain how missing data were handled in the analysis		*	
10) Summarize patient response rates and completeness of data collection	*		
11) Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained		*	

Yes = ⊕; No = -; Unclear = U; Not applicable = NA

If longitudinal study, use NOS checklist

Newcastle-Ottawa Quality Assessment Form for Cohort Studies/longitudinal studies

Note: A study can be given a maximum of one star for each numbered item within the Selection and Outcome categories. A maximum of two stars can be given for Comparability

	Item		Tick as relevant
	1) Representativeness of the exposed cohort	a) Truly representative (one star)	
		b) Somewhat representative (one star)	
		c) Selected group	
		d) No description of the derivation of the cohort	
	2) Selection of the non-exposed cohort	a) Drawn from the same community as the exposed cohort (one star)	
		b) Drawn from a different source	
		c) No description of the derivation of the non-exposed cohort	
	3) Ascertainment of exposure	a) Secure record (e.g., surgical record) (one star)	

Selection		b) Structured interview (one star)	
		c) Written self-report	
		d) No description	
		e) Other	
	4) Demonstration that outcome of interest was not present at start of study	a) Yes (one star)	
		b) No	
Comparability	1) Comparability of cohorts on the basis of the design or analysis controlled for confounders	a) The study controls for age, sex and marital status (one star)	
		b) Study controls for other factors (list) ________________________________ __ (one star)	
		c) Cohorts are not comparable on the basis of the design or analysis controlled for confounders	
Outcome	1) Assessment of outcome	a) Independent blind assessment (one star)	
		b) Record linkage (one star)	
		c) Self report	
		d) No description	
		e) Other	
	2) Was follow-up long enough for outcomes to occur	a) Yes (one star)	
		b) No Indicate the median duration of follow-up and a brief rationale for the assessment above: _____________________	
	3) Adequacy of follow-up of cohorts	a) Complete follow up- all subject accounted for (one star)	
		b) Subjects lost to follow up unlikely to introduce bias- number lost less than or equal to 20% or description of those lost	
		suggested no different from those followed. (one star)	
		c) Follow up rate less than 80% and no description of those lost	

Thresholds for converting the Newcastle-Ottawa scales to AHRQ standards (good, fair, and poor):

Good quality: 3 or 4 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain

Fair quality: 2 stars in selection domain AND 1 or 2 stars in comparability domain AND 2 or 3 stars in outcome/exposure domain

Poor quality: 0 or 1 star in selection domain OR 0 stars in comparability domain OR 0 or 1 stars in outcome/exposure domain

Appendix 3: Characteristics of the studies included in the literature review (n = 63)

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Awudu Abdulai
	2. Year	2010
	3. Aim	To explore the determinants of overweight and obesity in mothers and children
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Weight Household size Mother/ Child's age Mother's marriage status Mother's education Ethnicity Mother's occupation Food consumption TV Viewing
	6. How are these determinants specified in practice?	*Height:* Standard *Weight:* Standard *Household size:* Total number of people in household *Mother's age:* Age of mother in completed years

		Mother marital status: Mother married/ Otherwise *Child's age:* of children between 0 and 6 years in months *Education* No school / Primary / Middle/Islamic/ Secondary Tertiary *Ethnicity* GA or Adangbe/ Ewe/ Akan/Ashanti/Fanti/ Other *Occupation of mother* works on a farm or garden works in a shop, factory or office sells items on the street or in the market *Food Consumption* Daily per head calorie consumption of fruit calories *TV Viewing* If TV present in household, 0 otherwise
	7. How was data on these determinants collected?	Secondary Data (a) Interviews A survey conducted by the International Food Policy Research

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Institute (IFPRI) between January and April 1997. The survey team adopted a two-stage sampling strategy to select 559 households distributed among 16 enumeration areas within the Accra, Ga and Tema districts.
	10. How was obesity specified in practice?	BMI is defined as weight in kilograms divided by height in meters square (kg/m2) and is a commonly used measure to define overweight and obesity in individuals. Optimal BMI levels are generally believed to lie between 20 and 25. BMI below 20 is considered thin, BMI between 25 and 30 is overweight BMI above 30 is obese. Weight of child falls outside the 90th percentile of the sampled children, 0 otherwise
	11. Characteristics of sample	The basic sampling units for the survey were households with children under the age of three. The mean age of overweight women was observed to be 32.8 years whereas that of the non-overweight was 28 years. Overweight and obesity is quite prominent in the age group of 24–40 years.

		The predominant ethnic group is the Ga/Adangbe tribe, who traditionally, are home in Accra and its surroundings.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	576 households The survey team adopted a two-stage sampling strategy to select 559 households distributed among 16 enumeration areas within the Accra, Ga and Tema districts. The survey team made use of the primary sampling units that had been mapped out by the Ghana Statistical Service for the Greater Accra area. This sampling frame included 879 urban and 33 peri-urban enumeration areas. Cluster sampling was then employed to select 36 households in the 16 enumeration areas, for a total of 576 households.
	13. Which sampling method used?	primary sampling Cluster sampling
	15. Which type of statistical method was used?	Descriptive : mean, standard deviation, % Logistic regression
	16 what was the theoretical underpinning used in the study	Household production model in the tradition of Becker (1981). This framework has also been employed by Nayga (2000) to examine the effect of schooling and health knowledge on obesity.

	17. Which statistical model diagnostics tests were reported?	The McFadden R2, an indication of goodness-of-fit and the log-likelihood statistics (indicator of the significance of all covariates)
Empirical findings (objective 5)	18. What are the main findings?	The findings show that mothers' education, employment status and ethnicity significantly exert influence on the generation of body weight. In particular, those who attained secondary and tertiary education had lower body mass indices and were much less likely to be overweight or obese, lending support to the notion that more educated women normally have better health knowledge and are more likely to consume healthy foods and also engage in physical exercises that help to control weight gain. Mother's education was also found to exert a negative and significant impact on the weight status of children. Furthermore, household expenditure was found to exert a positive and significant impact on the probability of a mother being overweight or obese, but no significant impact on the probability of a child being overweight.
	19. What are the author-stated challenges?	None

2.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Addo et al.
	2. Year	2015

	3. Aim	To determine the prevalence of obesity and overweight and associated factors among workers of a financial institution in Accra Metropolis, Ghana.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Ages Sex educational level marital status Years with institution Sedentary work Alcohol intake
	6. How are these determinants specified in practice?	**Sex** Men Women **Age** <25 25–34 35–44 45–54 **Educational level** None Junior high Senior high Tertiary **Marital status** Single Married Cohabiting Divorced **Years with institution** <1 year 1–3 years

		3 years or more **Sedentary work** No Yes **Alcohol** No Yes **Physical activity** Inactive Moderately inactive Moderately active Active
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Age, sex, educational level, marital status, years with institution, alcohol intake and sedentary work were assessed with the help of a structured questionnaire. Level of physical activity was assessed with the help of the General Practice Physical Activity Questionnaire (GPPAQ), developed by the London School of Hygiene and Tropical Medicine. Height measurements were done using a stadiometer while Weight was measured with the help of an electronic bathroom scale with a maximum capacity of 150 kg. The WHO's STEP-wise standardized

		tool for non-communicable disease risk factors was also used.
	10. How was obesity specified in practice?	Body Mass Index (BMI) from weight and height measures and classified according to WHO international classification of adult BMI as follows: Underweight (<18.50 kg/m^2) Normal range (18.50–24.99 kg/m^2) Overweight/Pre-obese (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2). For the analysis, the underweight and normal group of BMI were collapsed into under/normal and the overweight and obese groups were collapsed into overweight/obese.
	11. Characteristics of sample	Sample included men and women aged from 18 years and above and employee from some selected branch of the financial institution in Ghana, working as tellers (cashier), customer service personnel or "back office" staff (managers, supervisors and other supporting staff).
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	180 Sample size of 172 was calculated with Stata 11 software using proportion of obesity and overweight as 30 %, at 95 % confidence interval and a 5 % margin of error. Allowing for a 5 % non-response rate, the effective sample size was adjusted to a total of 180 participants.

	13. Which sampling method used?	Systematic sampling
	15. Which type of statistical method was used?	Bivariate analysis and logistic regression
	16 what was the theoretical underpinning used in the study	Non stated
	17. Which statistical model diagnostics tests were reported?	None indicated
Empirical findings (objective 5)	18. What are the main findings?	Physical activity (OR = 0.34, 95 % CI = 0.13–0.89, p = 0.03), alcohol consumption (OR = 3.00, 95 % CI = 1.35, 6.68, p = 0.007), marital status (OR = 2.74, 95 % CI = 0.96–7.85, p = 0.04), sex (OR = 2.78, 95 % CI = 1.23–6.33, p = 0.01), and age (OR = 1.10, 95 % CI = 1.01–1.20, p = 0.036) were significantly associated with obesity and overweight
	19. What are the author-stated challenges?	Third step (biochemical measurements) of the WHO STEPWISE Approach for Non-Communicable Disease surveillance was not carried out in this study due to inadequate technical staff and insufficient funds to carry out the work involved.

3.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Addo J. and Leon S. D. A.
	2. Year	2009
	3. Aim	To investigate the distribution of obesity and its association with pre-adult wealth and adult socio-economic factors in urban Ghanaian civil servants.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age

		Physical activity Level of education Employment grade Current wealth Pre-adult wealth Alcohol consumption Smoking status Ethnicity Place of birth
	6. How are these determinants specified in practice?	**Age** <35 35 – 44 45 – 54 ≥55 **Physical activity** Light Moderate Intense **Level of education** Primary Secondary Tertiary Missing data **Employment grade** Unskilled Clerical Professional director **Current wealth** Two assets or fewer Three assets Four assets Five assets

		Pre-adult wealth No assets One or two assets Three or five assets Five assets **Alcohol consumption** Never Ex-drinker Once/week Two to three times/week Four or more times/weekSmoking status **Ethnicity** Akan Ga Ewe Northern **Place of birth** Urban Rural
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Questionnaires exploring socio-demographic characteristics, lifestyle and behavioral factors and participants perception of their body weight were administered to participants. Weight was measured to the nearest 0.5kg with mechanical seca floor weighing scale. Height (m) was measured with Seca stadiometer to the nearest millimeter the

		subject standing upright and toes slightly apart at 60 degrees.
	10. How was obesity specified in practice?	BMI was calculated as weight (kg)/height (m^2) and categorized as: Underweight (BMI <18.4kgm^2) Normal weight (BMI> 18.5<24.9 kgm^2) Overweight (BMI>25.0<29.9 kgm^2) Obesity (BMI>30.0 kgm^2) Abdominal was defined as waist circumference of ≥102cm in men and ≥88cm in women.
	11. Characteristics of sample	Sample included 615 men and 400 women civil servants aged 25 years and above employed in seven central government ministries and departments in Accra, Ghana.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1015 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Multivariate Logistic regression analysis
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	There was a positive graded association between pre-adult and adult levels of wealth and the risk of obesity in men (*P* = 0.003), but weak suggestions of an inverse association

		between adult level of wealth and obesity in women under 45 years of age.
	19. What are the author-stated challenges?	Sample was deliberately not representative of general population.

4.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Ajayi et al.
	2. Year	2016
	3. Aim	To show the collective burden of obesity and overweight in sub-Saharan Africa.
	4. Country	Nigeria, South Africa, Tanzania and Uganda
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Sex Age Education level Marital status Cigarette smoking Number of cigarettes in past 24h Wealth status Current smoker
	6. How are these determinants specified in practice?	Sex: men/women Age: 18-34/35-44 / > =45. Education: Low education / high education Marital status: Never married Married/living together Separated, divorced, widowed, other Cigarette smoking: ever smoked / never smoked Number of cigarette in past 254h: <=19 / >=20. Wealth status: High / Middle / Low.

		Current Smoker: Yes / No
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Participants were asked to fill a standardized questionnaire. Some questions were adapted from the WHO STEPS instrument developed for use in resource-limited.
	10. How was obesity specified in practice?	From weight and height using BMI (BMI=weight/height^2)
	11. Characteristics of sample	Participants were 200 nurses from Nigeria, 489 school teachers in South Africa, 276 teachers in Tanzania, 298 village residents in peri-urban and 200 rural location in Uganda. The aged from 18 years and above. The sample included both men and women.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1463 Not indicated
	13. Which sampling method used?	Not stated
	15. Which type of statistical method was used?	Descriptive, Bivariate and binary logistic regression

	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	Chi square goodness of fit test
Empirical findings (objective 5)	18. What are the main findings?	Women sex was a predictor of obesity and overweight in peri-urban Uganda (AOR =8.01, CI =4.02 – 15.96) and obesity in rural Uganda (AOR =11.22, CI =2.27 – 55.40), peri-urban Uganda (AOR =27.80, CI =7.13 – 108.41) and South Africa (AOR =2.17, CI: 1.19 – 4.00). Increasing age was a predictor of BMI> =25kg/m^2 in Nigeria (Age> =45, AOR = 9.11, 1.72 – 48.16) and South Africa (AOR =6.22, CI =2.75 – 14.07), while marital status was predictor of BMI >= 25kg/m^2 only in peri-urban Uganda (Married – AOR=4.49, CI: 1.74 – 11.57).
	19. What are the author-stated challenges?	Sample size was relatively small in each study site Participants were selected groups which may not be a representative sample of the general population.

5.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Akarolo-Anthony et al.
	2. Year	2014
	3. Aim	To examine the correlates of obesity
	4. Country	Abuja, Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age

		Sex Religion Marital status Education Occupation Socio-economic status Sugar sweetened beverages Physical activity Television
	6. How are these determinants specified in practice?	Age: <30/ 30-39/ 40-49/ ≥50 Sex: Men/women Religion: Christianity/Islam Education: None/ primary (elementary school) /≥Tertiary (college). Occupation: self-employed/ unskilled manual/ skilled manual/ professional or executive Socio-economic status: low/ middle/ High. Sugar sweetened beverages: <1month/ ≤1week/ 2-6week/ ≥1day. Physical activity: low/ moderate/ high Television: <6week/ 6-10week/ 11-20week/ >20week.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary

		Participants were approach with self-administered questionnaires at the government worksites in Abuja.
	10. How was obesity specified in practice?	Anthropometric measurements of weight and height to calculate BMI.
	11. Characteristics of sample	Sample included both men and women, aged from 18 years and above. They had varying socio-economic status. They were recruited from a government worksite at the Federal Secretariat Complex in Abuja
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1058 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Log-binomial regression analyses
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	Akaike information criterion.
Empirical findings (objective 5)	18. What are the main findings?	Individuals aged 40 – 49 years to be overweight or obese. The Prevalence rate (PR) for overweight and obesity was 1.45 (CI 1.07 – 1.97 and p=0.002). Compared with the individuals in the lower socio-economic status, the PR of obesity

		among those in the middle and high socio-economic statuses were 1.39, CI =1.13 – 1.72 and 1.24, CI =0.97 – 1.59 respectively. For women compared to men, the PR and CI was 1.24, 1.08 – 1.43 p=0.04 for overweight and 2.54, CI =2.08 – 3.10, p <0.0001 for obesity.
	19. What are the author-stated challenges?	Study is limited by its cross-sectional design and its setting in adult urban population, thus the results cannot to be generalized to rural populations or children. As there were many different ethnic groups, we did not have sufficient power to address the role of this unique ethnic cities on overweight or obesity. Also, dietary carbohydrates intake was assessed over the past year which may not be the best presentation of the participants long-term intake.

6.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Akinyeniju et al.
	2. Year	2016
	3. Aim	To examine the association between socio-economic status (SES) and obesity in Ghana
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Marital status Smoking Alcohol use Health status Education Mother’s education

		Father's education Employment
	6. How are these determinants specified in practice?	Age (years): <21 21 – 39 40 – 64 ≥65 Marital status: Never married Married/cohabiting Separated/Divorced/widow Smoking: Yes/No Alcohol use: Yes/No Health status: Bad/moderate/good Education: Own No formal education Primary school High school College or more Mother's education: Own No formal education Primary school High school College or more Father's education: own No formal education Primary school High school College or more Employment: Own Unemployed Self/informal employment Public sector

		Private sector
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary data Wave 1 of the Ghana study of global ageing and health conducted in 2007.
	10. How was obesity specified in practice?	BMI from the weight and height measured of the participants
	11. Characteristics of sample	Sample consisted of a total of 2341 women aged 18 years and older surveyed as past of the Ghana SAGE study.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2341 None indicated
	13. Which sampling method used?	None
	15. Which type of statistical method was used?	Multivariable linear regression
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	After adjusting for age, smoking, alcohol, health status and marital status, employment status of both parents (p =0.026 and 0.0003 for

		mother and father, respectively) and education status of both the participants and her father (p =0.024 and 0.014, respectively) were each significantly associated with BMI. Participants whose mothers were employed in the public sector had significantly higher BMI compared with those who were unemployed (24.7 vs 22.4); and participants whose fathers were employed in the public sector had higher BMI compared with those whose fathers were unemployed (25.3 vs 19.00). In the adjusted mode, life-course SES based on both maternal (p=0/0339) and paternal (p= 0.0062) education and paternal employment (p<0.0001) were each associated with BMI
	19. What are the author-stated challenges?	We were unable to assess household income directly in the dataset, although we expect that education and employment status will provide a more reliable measure of SES, especially in situations were compensation may be in kind as opposed to cash.

7.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Aladeniyi et al.
	2. Year	2017
	3. Aim	To determine the correlates of obesity among public service workers in Akure
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Sex Age Level of education Marital status

		Grade level Excessive alcohol consumption Engaging in physical activity Spending 8 or > hours in sitting Diabetes mellitus High blood pressure
	6. How are these determinants specified in practice?	Sex: men/women Age: 41 and above Less than or equals 40 Level of education: primary or no formal education Post primary education Marital status: Ever married Never married Excessive consumption of alcohol: Yes/No Diabetes mellitus: Yes/No High blood pressure: Yes/No
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary - Participants completed the previously validated World Health Organization (WHO) STEPwise methodology for the surveillance of

		non-communicable diseases' (NCDs) risk factors at the country level.
	10. How was obesity specified in practice?	BMI measure using Weight and Height (BMI = weight/height^2).
	11. Characteristics of sample	Sample was from Ondo state, Nigeria. It included both men and women, but the women were thrice the number of men. Their ages ranges from eighteen years old and above.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	4, 828 None
	13. Which sampling method used?	Convenient sampling
	15. Which type of statistical method was used?	Descriptive, bivariate and Logistic regression
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
	18. What are the main findings?	Women (AOR= 5.7 CI =4.7-6.9)

Empirical findings (objective 5)		Age (AOR=1.4, CI = 1.1-1.8) Level of education (AOR =0.8, CI=0.7-0.9) Marital status (AOR= 2.1, CI= 1.7-2.8) Alcohol consumption (AOR= 0.7, CI=0.5-0.9) Diabetes mellitus (AOR= 0.7, CI= 0.5-0.9) Hypertension (AOR=0.5, CI= 0.4-0.6). These variables were the significant predictors of obesity.
	19. What are the author-stated challenges?	Cross-sectional study and convenient sampling could not ascertain causal association. Self-reporting of some of the lifestyle measures may have introduced bias.

8.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Reina Engle-Stone1; Martin Nankap; Alex O. Ndjebayi; Avital Friedman; Ann Tarini2; Kenneth H. Brown1; | Lucia Kaiser.
	2. Year	2018
	3. Aim	Examine the prevalence and geographic distribution of overweight and obesity among Cameroonian women; (b) evaluate change in anthropometric indicators among urban

		women between 2009 and 2012; (c) examine associations between household and individual characteristics and overweight and obesity; and (d) examine relationships between body mass index (BMI), abdominal obesity, and inflammation.
	4. Country	Cameroon
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Weight Waist circumference Socio-economic status (SES)
	6. How are these determinants specified in practice?	*Height* Height was measured in duplicate to the nearest 0.1 cm with a portable stadiometer (Seca Leicester Portable Height Measure, Seca Weighing and Measuring Systems), *Weight* Weight was measured in duplicate to the nearest 0.1 kg with an electronic scale (Seca 899, Seca Weighing and Measuring Systems). *Waist circumference* Waist circumference (measured at the navel, over light or no clothing) and hip circumference (measured

		at the widest point over light clothing) were measured to the nearest 0.1 cm using nonflexible measuring tape *Socio-economic status (SES)* Exposure to media Intake of fortified food Consumption of unprocessed food
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary Data Questionnaires used This paper uses data from a 2009 national survey and a 2012 regional survey in Cameroon, conducted for the purpose of designing and evaluating a food fortification program.
	10. How was obesity specified in practice?	BMI (World Health Organization, 2018) underweight was defined as BMI < 18.5; overweight as BMI ≥ 25.0; obese as BMI ≥ 30.0
	11. Characteristics of sample	We limited the analysis to n = 932 (2009) and n = 319 (2012) women for whom

		anthropometric data were available and excluded those who were pregnant On average, women in the North were younger than women in the South and Yaoundé/Douala in the 2009 survey, and women in Yaoundé/Douala were slightly older in the 2012 survey compared with the 2009 survey. Adolescent mothers (15.0–17.9 years) comprised 13% of the sample in 2009 (12% South, 15% North, 11% Yaoundé/Douala) and 5% of the sample in Yaoundé/Douala in 2012. Regional differences in BMI were explained by differences in weight, which varied from a mean of in the North rather than height which did not differ on average by region.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1,251 We limited the analysis to n = 932 (2009) and n = 319 (2012) women for whom anthropometric data were available and excluded those who were pregnant
	13. Which sampling method used?	Simple stratified
	15. Which type of statistical method was used?	Chi square analysis Logistic regression Linear regression
	16 what was the theoretical underpinning used in the study	None

	17. Which statistical model diagnostics tests were reported?	Values represent mean or percent (95% CI) .
Empirical findings (objective 5)	18. What are the main findings?	In 2009, ~8% of women were underweight (BMI < 18.5) and 32% overweight or obese (BMI ≥ 25.0). Underweight was most common in the North (19%) and overweight and obesity in the South (40%) and Yaoundé/ Douala (49%). Prevalence of BMI ≥ 25.0 in Yaoundé/Douala did not differ in 2012 compared with 2009 (55.5% vs. 48.7%; P = 0.16). Residence in urban areas, greater maternal age, and TV ownership were independently related to overweight and obesity in national and stratified analyses. In Yaoundé/Douala in 2012, 48% (waist-to-hip ratio > 0.85) to 73% (waist circumference > 80 cm) had abdominal obesity. Body mass index was positively associated with abdominal obesity and inflammation.
	19. What are the author-stated challenges?	None

9.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Atuahene et al.
	2. Year	2017
	3. Aim	To estimate overweight/obesity, hypertension and diabetes prevalence and associated risk factors among public servants.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Sex

		Marital status Religion Highest education level Alcohol consumption Smoking Most important meal Skipping breakfast Last meal of the day Exercise Leisure time Level of physical activity Means of transport
	6. How are these determinants specified in practice?	Age: Younger (<40yrs)/older (>40) Sex: men/women Marital status: married/unmarried Religion: Christianity/Islam Highest education level: Pre-tertiary/tertiary Alcohol consumption: Yes/No Smoking Yes/No Most important meal: Morning/afternoon/evening Skipping breakfast: Yes/No Last meal of the day: Around 5:30pm/After 7pm Exercise: Don't exercise/exercise often/not too often. Leisure time: Involves physical activity/No physical activity involved. Level of physical activity at work: Sedentary/Non-sedentary. Means of transport: 1. Car/public transport/motorbike 2. Walking/Cycling

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Questionnaires for studying prevalence of overweight/obesity among public servants in Ghana was used to collect data on respondent's demographic characteristics, nutritional knowledge and physical activity.
	10. How was obesity specified in practice?	Calculated from the weight and height measures of the participants using the Body Mass Index (BMI) formula. BMI = weight/ Height^2
	11. Characteristics of sample	Sample was from Nadowli district of Ghana, aged 20 to 59 years. The sample included both men and women. Their religion was Christianity and Islamic.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	257 They used the Public service of creative system survey software: http://www.surveysystem.com to determine the sample size using a

		population size of 775 with a confidence level of 95%.
	13. Which sampling method used?	Proportionate random sampling
	15. Which type of statistical method was used?	Descriptive and logistic regression analysis
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None stated
Empirical findings (objective 5)	18. What are the main findings?	Marital status (p=0.001), leisure time with physical activity (p=0.000) and level of physical activity at work (p=0.035) were significantly associated with BMI. NB: correlation co-efficient were not stated.
	19. What are the author-stated challenges?	Study was cross-sectional, therefore, conclusion between risk factors and overweight was limited. The use of BMI alone was not an accurate predictor of body fat or distribution od adiposity.

10.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Becquey et al.
	2. Year	2010
	3. Aim	To describe dietary patterns of adults in Ouagadougou and to study their relationship with anthropometric status of the subjects.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Snacking score (frequent food consumption outside the main meals) Modern foods score (modernity of the type of foods consumed) Age

		Marital status Religion Ever attended school District
	6. How are these determinants specified in practice?	**Snacking score (frequent food consumption outside the main meals)** Frequency of consuming dégué, milk, sweetened drinks, yoghurt, bread, fruits **Modern foods score (modernity of the type of foods consumed)** Frequency of consuming scrambled eggs, chicken, tomato sauce, pastas, cheese, meat, sodas, soup, French dressing, hamburger **Age (years)** <25 25 – 29 30 – 39 40 and more **Marital status** Single Couple Widowed/divorced **Religion** Muslims Catholics Others **Ever attended school** No yes **District** Non-structured structured

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary A qualitative food frequency questionnaire (q-FFQ) was administered to all subjects of the study to collect data on their dietary habit. Height was measured to the nearest mm with locally-made devices equipped with height gauge and weight (to the nearest 100 g) and body fat percentage (BFP) were measured on scales with a maximum weighing capacity of 130 kg including a foot-to-foot impedance analyzer.
	10. How was obesity specified in practice?	Body Mass Index (BMI) from height and weight measure. Overweight was defined by a (BMI) superior to 25 kg/m^2.
	11. Characteristics of sample	Sample included 1,072 individuals aged 15-65 years: 276 women and 261 men lived in Wemtenga (structured district) and 281 women and 254 men lived in Taabtenga (unstructured district)
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1,072 Not stated
	13. Which sampling method used?	Random sampling

	15. Which type of statistical method was used?	Multiple linear regression and logistic regression
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	A higher "modern foods" score was associated with a higher prevalence of overweight when confounding factors were accounted for (OR = 1.19 [95% CI 1.03-1.36]) but there was no relationship between overweight and the "snacking" score.
	19. What are the author-stated challenges?	First, the sample was not representative of the whole population of Ouagadougou Second, our q-FFQ was pre-tested in a population similar to our study sample but was not validated against another dietary method or biomarkers. Finally, in order to account for the two major co-factors of dietary intake, namely households' economic level and individuals' physical activity, we relied on proxy scores that were not validated as such.

11.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Bishwajit Ghose and Sanni Yaya
	2. Year	2018
	3. Aim	To investigate the time trends in body mass index (BMI) and relationship between media use and body weight status among adult women in Nigeria.
	4. Country	Urban and rural settings in Nigeria

Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Frequency of reading newspapers Listening to radio Television (TV) viewing
	6. How are these determinants specified in practice?	Reading newspaper: Not at all <once a week At least once a week Almost everyday Listening to radio: Not at all <once a week At least once a week Almost everyday TV viewing: Not at all <once a week At least once a week Almost everyday
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary data Nigeria Demographic and Health Surveys conducted in 2013, 2008 and 2013
	10. How was obesity specified in practice?	BMI =weight (kg)/height $(m)^2$
	11. Characteristics of sample	Adult non-pregnant women aged between 15 and 49 years.
	12 a. What was the sample size?	69, 401

	b. what was the statistical basis for sample size used?	Not stated
	13. Which sampling method used?	Not indicated
	15. Which type of statistical method was used?	Multinomial logistic regression
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Watching TV almost everyday and at least once a week were associated with, respectively, 1.6 (CI =1.412 – 1.811) and 1.2 (CI =1.053 – 1.363) times higher odds of being overweight, and 2.7 (CI =2.432 – 3.037) and 1.5 (CI = 1.053 – 1.63) times higher odds of being obese compared with those who never used radio.
	19. What are the author-stated challenges?	Although anthropometric measurements were performed in accordance with WHO guidelines, that of media use status was self-reported and hence subject to reporting bias. Cross-sectional data preclude establishing any temporal relationship between the exposure and outcome variables.

12.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Blankson & Hall
	2. Year	2012
	3. Aim	To describe the anthropometric and physical status of a sample of elderly women in rural

		Ghana and examine factors associated with a low body mass index (BMI).
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight Height Half arm span Mid-upper arm circumference (MUaC)
	6. How are these determinants specified in practice?	*Weight* was measured to a precision of 0.1 kg using a digital electronic scale (Tanita, HD 305, Japan), *Height* was measured to a precision of 0.1 cm using a body meter (sECa, Japan) attached to a straight pole. *Half arm span* was measured to a precision of 0.1 cm from the 'U' bone at the base of each woman's throat to the tip of the middle finger and the value was multiplied by 2 to give arms pan. The value of BMa was classified as: underweight if <17.5, normal if 17.5-23.9, overweight if 24.0-28.9, and obese if ≥29.0 (12).

		Mid-upper arm circumference (MUaC) Was measured to a precision of 0.1 cm using a non-stretch MUaC tape (TalC, Uk). The value of MUaC was classified as severe malnutrition if <22.1cm, moderate if 22.1-23.0cm, mild if 23.10-24.0cm, and normal if >24.0 (10).
	7. How was data on these determinants collected? c. What is the dataset used? (if method of data collection is secondary). d. If primary data, briefly describe method	Primary (B) Interview was used 1. The survey was done in two rural villages in Ashanti. 2. The two villages were selected randomly and taken to be a single unit for statistical purposes. Households were randomly selected by going to the centre of the village and spinning a bottle on a flat surface. Every house in both directions of the bottle was visited, moving from the centre of the village to the perimeter to locate women aged 60y or greater.
	10. How was obesity specified in practice?	*BMI*

		was calculated as weight in kg/(height in m)^2 while body mass armspan (BMa) was calculated as weight in kg/(2xhalfspan in m)$^{)2}$. The value of BMI was classified as underweight if <18.5, Underweight was further classified as mild if 17.0-18.4, moderate if 16.0-16.9 and severe if <16.0 (11). normal from 18.5-24.9, overweight from 25.0-29.9 and obese if ≥ 30.0.
	11. Characteristics of sample	59 women were studied Only 17% were still married; the rest were widowed (59%), divorced (22%) or separated (2%). The women had given birth to a median of 8 children (range 3-13) of whom a median of 2 had died (range 0-8); only one woman had no children alive. less than a half of women reported that they provided their own food; the rest had food provided by their husband or family.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	59 A total of 115 households in both villages were visited 68 elderly women were identified of whom 8 were not interviewed

		because they were either absent or met the exclusion criteria. One woman could not be measured because of a recent snake bite, so was excluded from the analysis.
	13. Which sampling method used?	Simple random & Stratified
	15. Which type of statistical method was used?	Means A linear regression analysis
	16 what was the theoretical underpinning used in the study	a modified version of the Radimer/Cornell food insecurity measure
	17. Which statistical model diagnostics tests were reported?	Fisher's exact test Mantel-Haenzsel risk ratio 95% confidence intervals
Empirical findings (objective 5)	18. What are the main findings?	41% (95%CI 27.8, 53.6) of women were underweight and 16.9% (95%CI 7.18, 26.8) were overweight or obese. Factors associated with a low BMI (<18.5 kg/m2) were age (P=0.001), chewing tobacco (P=0.002), drinking alcohol (P=0.012), a visual acuity score of <30% (P=0.038), using a walking aid (P=0.016) and the number of children who gave the women cash (P=0.005). BMI was strongly positively correlated with BMa (r=0.999, P<0.001) and with MUaC (r=0.91, P<0.001), and a BMI of 18.5 was equivalent to a MUaC of about 23cm.
	19. What are the author-stated challenges?	Due to time constraints and difficulty in travelling

13.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Boua et al.

	2. Year	2018
	3. Aim	To investigate the distribution of BMI and prevalence of obesity in cross-sectional population-based study and to determine the socio-demographic and behavioral correlates with BMI
	4. Country	Burkina Faso
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Ethnicity Marital status Highest level of education Employment Household asset status Smoking status Snuff use Chewing tobacco use Alcohol consumption Diet Physical activity Clinical history Self-reported diabetes status HIV positive TB positive
	6. How are these determinants specified in practice?	Age: 40 to 60 years old Gender: men/women Ethnicity: Mossi Gourounsi Others Marital status: Never married/cohabiting Currently married/ cohabiting Previously married/cohabiting/partner deceased

		Highest level of education: No formal education Primary Secondary Tertiary Employment: Yes/NO Household asset status: Quintile 1 Quintile 2 Quintile 3 Quintile 4 Quintile 5 Smoking status: Never smoked Former smoker Current smoker Snuff use: Yes/NO Chewing tobacco use: Yes/NO Alcohol consumption: Never consumption Ever consumption Current non problematic Current problematic Diet: Serving bread/day Fruit serving/day Vegetable serving/day Eating out/week Sugar sweetened beverage/weak Physical activity: MVPA (mins/week) Sitting (mins/day) Sleep (hours/night) Clinical history: Menopause Pre menopause Peri menopause

		Post menopause Self-reported diabetes status: Yes/NO/ Don't know HIV positive: Yes/NO/ Don't know TB positive: Yes/NO/ Don't know
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary dataset Nanoro Health and Demographic surveillance system (HDSS)
	10. How was obesity specified in practice?	BMI and categorized into underweight, normal weight, overweight and obese
	11. Characteristics of sample	Sample included men and women aged 40 to 60 years and reside in the area of the HDSS
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2,706 None
	13. Which sampling method used?	None
	15. Which type of statistical method was used?	Multivariate hierarchical regression analysis
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None stated

Empirical findings (objective 5)	18. What are the main findings?	Age was inversely associated with MBI in men (β =-.0.09, CI =-0.12 to -0.69). Problematic drinking was associated with a decreased in BMI by 0.89 units (CI = -1.54 to -0.24) compared to those who never consumed alcohol, whereas smoking was found to be associated with a decreased of 2BMI units (β = -2.0, CI = -2.59 to -1.41) compared to those who never smoked. Among women, chewing tobacco was associated with a BMI decrease (β = -0.79, CI = -1.2 to – 0.37).
	19. What are the author-stated challenges?	There were limitations in providing accurate measurement. For example, bread is not a good indicator of carbohydrate intake in Burkina Faso as bread is not a part of usual eating habit as it is rarely part of meals. Aldo, self-reported menopausal status is less accurate that an in-depth analysis, and fruit and vegetable consumption may be inaccurate as the levels were very low. An accurate dietary assessment would have provided a better understanding of several factors associated with BMI

14.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Chigbu et al.
	2. Year	2018
	3. Aim	To explore the prevalence and factors associated with obesity in Enugu state, Nigeria.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Gender

		Age Residence Urban class Marital status Education level Income status Ethnicity
	6. How are these determinants specified in practice?	**Gender** Men Women **Age** ≤40 >40 **Residence** Rural Urban **Urban class** Upper Middle Lower university **ethnicity** Hausa Igbo Yoruba **Marital status** Single Married Divorced Separated Widowed **Education level**

		No Primary Secondary Post-secondary vocational University **Income status** No income Low income class Middle income class High income class
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Structured interviewer administered questionnaire adapted from the Global school health survey questionnaire was used to collect socio-demographic data. Weight was measured with an analogue weight scale to the nearest kg while height was measured with a portable stadiometer. Waist circumference was measured with a tape measure to the nearest 0.1cm
	10. How was obesity specified in practice?	In BMI calculated from the weight and height measures. BMI was classified into four groups according to WHO: Underweight Normal weight Overweight Obese

	11. Characteristics of sample	Sample included men and women adults aged 20 – 60 years form both urban and rural setting in Enugu.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	6459 Sample size formula for cluster representative sample
	13. Which sampling method used?	Multistage stratified cluster randomized sampling
	15. Which type of statistical method was used?	Multinomial regression analysis
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Men were less likely to be overweight (adjusted OR (AOR) 0.79; 95% CI 0.68 to 0.92) and obese (AOR 0.24; 95% CI 0.19 to 0.31) than women. Urban residents were more likely to be overweight (AOR 1.42; 95% CI 1.18 to 1.71) and obese (AOR 2.09; 95% CI 1.58 to 2.76) than rural residents. Each additional 1-year increase in age increased the risk of overweight by 1.012 (AOR 1.012; 95% CI 1.005 to 1.018) and that of obesity by 1.03 (AOR 1.03; 95% CI 1.02 to 1.04). The low-income class was less likely to be overweight (AOR 0.694; 95% CI 0.507 to

		0.951) and obese (AOR 0.44; 95% CI 0.28 to 0.67).
	19. What are the author-stated challenges?	Limited by its cross-sectional design with its inherent response bias.

15.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Innocent Ijezie Chukwuonye; Abali Chuku; Ugochukwu Uchenna Onyeonoro; Ikechi Gareth Okpechi; Okechukwu Ojoemelam Madukwe; Theophilus Ifeanyichukwu Umeizudike; Okechukwu Samuel Ogah
	2. Year	2013
	3. Aim	The objective of this study was to investigate the prevalence of abdominal obesity in Abia State, Nigeria.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	blood pressure height, weight Waist circumference Hypertension Diabetes mellitus
	6. How are these determinants specified in practice?	*blood pressure* Both systolic and diastolic blood pressures were measured thrice in a sitting position using an Omron M2 upper-arm blood-pressure

		monitor (Omron Healthcare, Kyoto, Japan) *height*, Using a stadiometer, respondents' height was measured in centimeters, *weight* weight was measured using a weighing scale in kilograms *Waist circumference* WC was measured using a non-stretchable fibre measuring tape. It was measured to the nearest 0.5 cm at the high point of the iliac crest at minimal respiration. *Abdominal obesity* Abdominal obesity was defined as a WC of 102 cm or more in men and 88 cm or more in women, based on the ATP III criteria.
	7. How was data on these determinants collected? e. What is the dataset used? (if method of data collection is secondary).	Primary Data (b) Interviews were used 1. Dividing the area into administrative units

	f. If primary data, briefly describe method	2. A rural and urban area is further selected randomly from the administrative units The selected areas were further divided into households and people were again randomly selected from each households.
	10. How was obesity specified in practice?	*BMI* BMI was measured with the WHO classification2 as follows: underweight BMI below 18.5 kg/m2, normal weight 18.5–24.9 kg/m2, and overweight BMI 25–29.9 kg/m2. BMI of 30–34.9 kg/m2 defines class I obesity, BMI of 35–39.9 kg/m2 class II obesity, and BMI of 40 kg/m2 and above was used to define class III obesity.
	11. Characteristics of sample	The number of men was 1,378 (49.09%), and the number of women participants 1,429 (50.90%). The mean age of the men was 41.6 ± 18.8 years, while the mean age of the women was 42.3 ± 18.5 years. Education in the study was defined as secondary and above secondary. Most women 209 (18.0%) have secondary education while most men constituting the majority have above secondary education 1029 (94.4%).

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2,807 Calculated using multistage stratified sampling method. This number was arrived at being going through series of sub dividing the study area.
	13. Which sampling method used?	multistage stratified sampling method simple random
	15. Which type of statistical method was used?	Means and standard deviation were calculated for quantitative continuous variables. Qualitative variables were analysed using proportions. Risk factors of obesity and abdominal obesity were estimated using logistic regression analysis.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of obesity using body mass index in the population was 11.12%. In men and women, it was 7.73%, and 14.37%, respectively. The prevalence of abdominal obesity in the population was 21.75%. In men and women, it was 3.2% and 39.2%, respectively. The prevalence of abdominal obesity is higher than the prevalence of obesity. This has some health implications. It implies that some

		people not classified as obese based on the use of BMI are possibly at higher cardiovascular risk
	19. What are the author-stated challenges?	None

16.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Emmanuel Cohen, Philippe Jean-Luc Gradidge, Amadou Ndao, Priscilla Duboz, Enguerran Macia, Lamine Gueye, Gilles Boëtsch, Patrick Pasquet, Michelle Holdsworth and Nicole Chapuis-Lucciani.
	2. Year	2018
	3. Aim	To determine the impact of bio-cultural factors on the nutritional status of Senegalese adults.
	4. Country	Senegal
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Dietary intake Physical activity Health status perception Anthropometry variables Perceptions of corpulence
	6. How are these determinants specified in practice?	*Dietary intake* To assess dietary intake, first the Dietary Diversity Score (DDS) – a qualitative 24-hour recall to assess the diversity of food group composition – was used. Secondly,

		obesogenic eating practices was also evaluated by assessing among other things the frequency of snacking in the last 24 hours. *Physical activity*: To assess the duration of physical activity, four items from the International Physical Activity Questionnaire (IPAQ) were used. *Health status perception:* Using the BSS, a body self-satisfaction index was calculated to identify subjects as either satisfied with their body weight or wanting to gain or lose weight. *Anthropometry* **Height** was measured to the nearest millimetre using a portable stadiometer (Siber Hegner, Zurich, Switzerland). **Weight** was measured with participants in very light clothing, to the nearest 100 g, using a digital beam scale (Tanita, Tokyo, Japan). **Hip circumference and waist circumference** were measured to the nearest millimetre in a standing position using a non-stretchable tape-measure, according to standard procedures. The waist-to-hip ratio (WHR) was calculated to assess body fat distribution (WHO, 2000). *Perceptions of corpulence* To accurately assess body weight perceptions and identify the potential social valorization of overweight/obesity, the Body Size Scale (BSS) and Body image assessment guide (BIAG) were used.

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Data The study sample comprised 393 adults from the agglomeration of Dakar and 204 adults from the rural Kaolack region. For both areas, a quota sampling strategy was used, according to three criteria (age, sex and neighbourhood) from the 2002 National Senegalese Census.
	10. How was obesity specified in practice?	Overweight was defined as BMI ≥25 and <30 kg/m2 and obesity by a BMI ≥30 kg/m2.
	11. Characteristics of sample	In all areas, men overestimated their body size and perceived themselves to be in the normal weight category/ All women perceived their partners to be in the overweight category; however, only rural women indicated that they wanted them to gain weight to be overweight. Both urban and suburban women showed a slight preference for their partner to lose weight. Concerning women's perceptions only suburban and rural groups overestimated their own weight. Women in the urban and suburban groups perceived themselves to be in the overweight category, whereas rural women perceived themselves to be in the normal weight category and wanted to gain weight.
	12 a. What was the sample size?	597

	b. what was the statistical basis for sample size used?	For both areas, a quota sampling strategy was used, according to three criteria (age, sex and neighbourhood) from the 2002 National Senegalese Census.
	13. Which sampling method used?	Quota sampling
	15. Which type of statistical method was used?	Analysis of variance and covariance (ANOVA/ANCOVA) t-tests (post-hoc analyses) χ 2 and Fisher's exact Two Principal Component Analyses (PCA) one multiple Factorial Correspondence Analysis (FCA) binary logistic regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	adjusted odds ratios (OR), 95% confidence intervals (CI)
Empirical findings (objective 5)	18. What are the main findings?	Middle-aged and older Senegalese women were found to value overweight/ obesity more than younger Senegalese in all regions. In addition, young urban/suburban adults had a tendency for daily snacking whilst urban/suburban adults tended to be less physically active and had higher anthropometric means. A binary logistic regression model showed that being women, older, living in urban/suburban areas and valuing larger body size were independently associated with being overweight/obese, but not high-calorie diet. Univariate analyses showed that lower physical activity and higher socioeconomic status were associated with

		being overweight/obese. Finally, overweight/obesity, which is low in men, is associated with hypertension in the total sample.
	19. What are the author-stated challenges?	None

17.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Corsi et al.
	2. Year	2010
	3. Aim	To explore the extent to which body mass index (BMI) varies between small areas or neighborhoods in low- to middle-income countries.
	4. Country	Benin, Burkina Faso, Ghana, Guinea, Liberia, Niger, Togo, Senegal, Mali, Sierra Leone, Cameroon, Ivory Coast, Nigeria, Gabon
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Education Household wealth Neighborhood of respondent
	6. How are these determinants specified in practice?	Age (years) 20 – 49 **Education** – specification not indicated **Household** wealth - specification not indicated **Neighborhood of respondent** The area-based primary sampling unit (PSU) which corresponds to census enumeration area
	7. How was data on these determinants collected?	Secondary dataset Demographic and health surveys from participating countries from 1994 to 2008

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	
	10. How was obesity specified in practice?	BMI and was modelled as a continuous variable
	11. Characteristics of sample	Sample included non-pregnant women aged from 20 to 49 years both with or without children from participating countries.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	451,321 Not indicated
	13. Which sampling method used?	Area based probability sampling
	15. Which type of statistical method was used?	Multilevel analysis
	16 what was the theoretical underpinning used in the study	Not explicitly stated
	17. Which statistical model diagnostics tests were reported?	Linear and multinomial models*
Empirical findings (objective 5)	18. What are the main findings?	Of the total variation in BMI 17.6% was attributable to countries (Standard Deviation [SD] 2.0, 95% credible interval [CI] 1.7, 2.4) and 10.6% (SD 1.56, 95% CI 1.54, 1.58) was attributable to neighbourhoods in age-adjusted models. Adjusting for individual- and neighbourhood-level covariates reduced the SD attributable to countries and neighbourhoods to 1.9, and 1.17, respectively. Between-country variation was 13.4% (SD

		0.75, 95% CI 0.62–0.90) for underweight and 18.9% (SD 0.92, 95% CI 0.76-1.10) for overweight, and between-neighbourhood variation was 7.7% (SD 0.57, 95% CI 0.55-0.58) for underweight and 7.1% (SD 0.56, 95% CI 0.55-0.58) for overweight in the fully-adjusted multinomial model Of the total variation in BMI 17.6% was attributable to countries (Standard Deviation [SD] 2.0, 95% credible interval [CI] 1.7, 2.4) and 10.6% (SD 1.56, 95% CI 1.54, 1.58) was attributable to neighbourhoods in age-adjusted models. Adjusting for individual- and neighbourhood-level covariates reduced the SD attributable to countries and neighbourhoods to 1.9, and 1.17, respectively. Between-country variation was 13.4% (SD 0.75, 95% CI 0.62–0.90) for underweight and 18.9% (SD 0.92, 95% CI 0.76-1.10) for overweight, and between-neighbourhood variation was 7.7% (SD 0.57, 95% CI 0.55-0.58) for underweight and 7.1% (SD 0.56, 95% CI 0.55-0.58) for overweight in the fully-adjusted multinomial model
	19. What are the author-stated challenges?	Neighbourhood units in this study were derived from country specific census definition, as such there is possibility of misclassification. Cross-sectional nature of the study meant individual covariates may have different meaning across countries and this could have influenced the finding of this study.

		BMI is unable to distinguish body fat and lean body mass

18.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Dake et al.
	2. Year	2011
	3. Aim	To examine the sociodemographic correlates of obesity among Ghanaian women
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age place of residence region of residence level of education ethnicity religion occupation marital status parity household wealth quintile
	6. How are these determinants specified in practice?	Age (years) 15 – 19 20 – 24 25 – 29 30 – 34 35 – 39 40 – 44 45 - 49 place of residence urban rural region of residence Western

		Central Greater Accra Volta Eastern Northern Upper west Upper East Ashanti Brong Ahafo level of education no education primary secondary higher ethnicity Akan Ga-Dangme Ewe Mole-Dagbani other religion Roman catholic Orthodox Christian Other Christian Moslem other occupation Not working Formally employed Sales/services Agric-self employed Unskilled/skilled marital status

		never married married living together formerly married parity 0 1 – 3 4 – 6 ≥7 household wealth quintile poorest poorer average richer richest
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Data from the 2003 and 2008 Ghana Demographic and Health Survey.
	10. How was obesity specified in practice?	Specified in BMI, which was computed by dividing weight in kilograms by height in meters squared (kg/m2). It was then classified into: underweight (<18.5 kg/m2) normal weight (18.5– 24.9 kg/m2) overweight (25.0–29.9 kg/m2) obese (≥30.0 kg/m2).

	11. Characteristics of sample	Sample included only women aged from 15 to 49 years living in any of the ten regions of Ghana.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	5,279 Not indicated
	13. Which sampling method used?	Two-stage stratified sampling
	15. Which type of statistical method was used?	Multinomial logistic regression
	16 what was the theoretical underpinning used in the study	None indicated
	17. Which statistical model diagnostics tests were reported?	-2log-likelihood was used to determine the fit of the model.
Empirical findings (objective 5)	18. What are the main findings?	The likelihood of a woman being overweight or obese increased with increasing age; older women were thus more likely to be overweight or obese compared to the youngest age group. In 2003, women who resided in regions other than the Greater Accra region were less likely to be overweight or obese, whereas in 2008, women from the Eastern region had a 42% higher chance of being overweight compared to those from the Greater Accra region. Women who had higher education were about two times more likely to be overweight compared to non-educated women.

		Women from richer households were twice as likely to be overweight and about five times as likely to be obese compared to women from households of average wealth status.
	19. What are the author-stated challenges?	The study uses secondary data from the demographic and health survey; the limitations of those data therefore apply to the present study as well. For example, most postpartum weight retention studies measure weight at 12 months after delivery and this makes comparison to these studies more difficult. Data on the dietary practices and the physical activity levels of the women were not available; therefore, these variables were not included in the analysis. Including these variables in the analysis could have given slightly different results or could have mad

19.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Dake et al.
	2. Year	2016
	3. Aim	to examine the characteristics of the local food environment in an urban poor setting in Accra and the associated risk of obesity for residents
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	**Independent variable** Characteristics of the food environment: **Control variables** Age Sex Marital status

		Education level Type of occupation Length of stay in the community Social cohesion Crime level Trust among community members Lifestyle behaviors
	6. How are these determinants specified in practice?	**Characteristics of the food environment:** 1. the number of out of home cooked food resources 2. the number of convenience stores 3. the number of fruit and vegetables stand in each enumeration area (EA) 4. the presence of physical activity space **Age (years)** 15 – 49 **Sex** Men Women **Marital status** Never married Married Cohabiting Formerly married **Education level** No education Primary Middle/junior high Secondary/middle high Tertiary **Type of occupation** No occupation

		Professionals Sales/services Manual other **Length of stay in the community** Since birth ≤10 years >10 years **Lifestyle behaviors** Physical activity Sedentary behavior Alcohol consumption Smoking
	7. How was data on these determinants collected? g. What is the dataset used? (if method of data collection is secondary). h. If primary data, briefly describe method	Primary data Data on socio-demographic and lifestyle behaviors of respondents were collected using a semi-structured questionnaire through interviewer administered face to face interviews. Global physical activity questionnaire was used to collect data on physical activity of respondents. Weight was recorded to the nearest 0.1kg with a calibrated Seca scale while height was measured to the nearest 0.1cm.
	10. How was obesity specified in practice?	BMI from the weight and height measured of the respondents and categorized into

		underweight, normal, overweight and obesity according to the WHO standard. Respondents who were underweight were excluded from the data analysis.
	11. Characteristics of sample	Sample included men aged from 15 – 59 and women from 15 – 49 and residents James town, Ussher town and Agbobloshie. Participants had an average of 25.58kg/m^2 and the women had a higher BMI on the average than men.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	657 Not stated
	13. Which sampling method used?	Household listing was used as a sampling frame for selection of households into study
	15. Which type of statistical method was used?	Multilevel analysis, bivariate ordinary least squares regression analysis.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Multilevel analysis
Empirical findings (objective 5)	18. What are the main findings?	The results of the multilevel analysis reveal a 0.2 kg/m^2 increase in BMI for every additional convenience store and a 0.1 kg/m^2 reduction in BMI for every out-of-home cooked food place available in the study area after controlling for individual socio-demographic characteristics, lifestyle behaviors, and community characteristics

	19. What are the author-stated challenges?	Study cannot establish causation due the use of cross-sectional study design. Study area is fairly homogenous, thus there may not be large variations among the EAs. The number of level 2 unit is small and may not be large enough to detect significant effects.

20.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Fidelia A.A. Dake
	2. Year	2012
	3. Aim	To investigate spatial autocorrelation in BMI using the cluster as the spatial unit of observation.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Women GPS data (Spatial location)
	6. How are these determinants specified in practice?	*Women* Aged between 15 and 49 years *GPS data file* had longitude and latitude co-ordinates and valid BMI values for the women belonging to these clusters.

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary (a) This study makes use of secondary data from the 2008 Ghana Demographic and Health Survey (GDHS).
	10. How was obesity specified in practice?	*BMI* BMI based on the standard WHO BMI cut-off points normal weight (BMI; 18.50-24.99 kg/m2), overweight (BMI; 25.00-29.99 kg/m2) obese (BMI≥30.00 kg/m2).
	11. Characteristics of sample	Women: Aged between 15 and 49 years arranged in clusters. Eastern 29.45 Overweight Eastern 30.25 Obese Greater Accra 30.17 Obese Central 30.30 Obese Ashanti 33.36 Obese Upper West 30.87 Obese

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	4454 Applied exclusion criteria
	13. Which sampling method used?	None
	15. Which type of statistical method was used?	ArcMap in ArcGIS Histogram, a box plot, and a cartogram. The presence of spatial clustering was determined using the local spatial autocorrelation (LISA) statistic.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	The analysis revealed that overweight among women is a more common phenomenon in southern Ghana than in northern Ghana. However, there were a few clusters in the northern half where the women were overweight on average. One of these clusters in the Upper West region had its mean BMI value falling in the obese category of the WHO BMI classification. The results indicate that almost a quarter of the clusters in Ghana contain women who are mostly overweight on average.

		Overweight and obesity are more common in urban areas of developing countries including Ghana.
	19. What are the author-stated challenges?	None

21.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Damorou et al.
	2. Year	2013
	3. Aim	To determine the prevalence of obesity and its risk factors among workers in Lome
	4. Country	Togo
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Education level Dietary habits Total cholesterol Fasting blood sugar Blood pressure
	6. How are these determinants specified in practice?	Age (years) 18 and above Gender Men women Education level University or higher Secondary school Primary school illiterate Dietary habits Smoking Lipids and fatty foods

		Regular exercise Total cholesterol Fasting blood sugar Blood pressure Normal Prehypertension Hypertension 1 Hypertension 2
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Questionnaire on socio-demographics were administered to respondents to fill.
	10. How was obesity specified in practice?	BMI and waist circumference. BMI was categorized into overweight, normal, overweight and obese. Waist circumference (WC) measured as >88cm for women and >102cm for men.
	11. Characteristics of sample	Sample included men and women workers aged 18 years and above in Lomé, Togo.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	510 Not stated
	13. Which sampling method used?	Simple random sampling

	15. Which type of statistical method was used?	ANOVA, linear regression
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Low education level (OR =2.45, 95%CI =1.78 – 4.55, p =0.001) and lack of physical activity (OR =3.57, 95%CI =2.34 – 9.67, p =0.001) were the main factors significantly associated with obesity.
	19. What are the author-stated challenges?	Study was limited to only workers in Lomé. As such, findings cannot be generalized to adult population in Lomé.

22.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Dickson et al.
	2. Year	2016
	3. Aim	To (a) assess the association between dietary diversity (DD) score, socioeconomic status (SES) and maternal body mass index (BMI), and (b) the variation of the effects of DD and SES at different points of the conditional distribution of the BMI.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Maternal DDS Maternal parity Maternal age (in years) Number of household members Number of children under 5 years Education Employment status Household wealth

		Sex of household head Presence of co-wives
	6. How are these determinants specified in practice?	**Maternal DDS** grain, tubers, root: Yes/No flesh meat: Yes/No dairy products: Yes/No legumes: Yes/No eggs: Yes/No organ meat: Yes/No dark green vitamin A rich leafy vegetables: Yes/No vitamin A rich fruits and other vitamin A vegetables: Yes/No Other fruits: Yes/No. **Maternal age (in years):** 15 – 59 **Household wealth** Poorest Poorer middle richer richest **Education level** No education Primary Secondary+ **Employment** Not working Agriculture and others White collar

		Presence of co-wives No co-wives There are co-wives **Sex of household head** Men women
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary dataset Demographic and Health Surveys (DHS) from Ghana
	10. How was obesity specified in practice?	BMI and was derived by dividing weight in kilograms by the square of height in meters. It was measured a continuous variable
	11. Characteristics of sample	Sample included women from 15 – 59 years and their partners from 15 to 49 years old. Sample was from both rural and urban settlements.
	12 a. What was the sample size?	2038 No

	b. what was the statistical basis for sample size used?	
	13. Which sampling method used?	Systematic sampling with probability proportional to size
	15. Which type of statistical method was used?	Quantile regression analysis
	16 what was the theoretical underpinning used in the study	None indicated
	17. Which statistical model diagnostics tests were reported?	None indicated
Empirical findings (objective 5)	18. What are the main findings?	Women who consumed an additional unit of dietary diversity (DD) achieved an increase of 0.245 in BMI for those in the 90th quantile in Ghana. The effect of household wealth increases for individuals across all quantiles of the BMI distribution. A unit change in the household wealth score was associated with an increase of 0.038 units increase in BMI for individuals in the 5th quantile in Ghana. Also, 0.237 units increased for those in the 90th quantile in Ghana.
	19. What are the author-stated challenges?	Study is cross-sectional surveys; therefore, the analyses have not been able to disentangle potential reciprocal causations. The DD score used in the analysis had its limitation because the individual may not be able to report their food consumption accurately due to cognitive challenges such as lack of knowledge, forgetfulness and interview situations. Another limitation is that QR in its current form and implementation in STATA does not

		incorporate the complex survey design of DHS

23.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Jeoffray Diendéré, Jean Kaboré Jérôme Winbetourefa Somé, Gauthier Tougri, Augustin Nawidimbasba Zeba, Halidou Tinto.
	2. Year	2019
	3. Aim	To determine the prevalence and factors associated with overweight/obesity among women living in rural and urban Burkina Faso
	4. Country	Burkina Faso
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Demographic information Anthropometric data Biological data Urbanization
	6. How are these determinants specified in practice?	*Demographic information:* age (ranging from 25 to 64 years), marital status (groups: i. married or cohabitating, ii. never married, iii. divorced or separated, iv. widowed), residence environment (i. urban, ii. rural), education levels (groups: i. no formal schooling, ii. primary or more), occupation (groups: i. public or private formal employment or self-employed, ii. student or homemaker or retired or unemployed or volunteer).

		Anthropometric data: weight (kg), height (m), waist circumference (cm). *Biological data* **: total cholesterol** (mmol/l), high density lipoprotein cholesterol (HDL-cholesterol in mmol/l, a cut-off of >1.2 mmol/l was defined as a high level) and fasting blood sugar (mmol/l, having a level ≥6.1 mmol/l was defined as high blood sugar). **Blood pressure** (systolic and diastolic values in mmHg) was measured three times, and we used the mean of the three values for each indicator. High blood pressure was defined as a mean value of SBP/DBP ≥140/90 mmHg or actively undergoing anti-hypertension treatment. Current (past month) **alcohol use** were recorded by the self-reported alcohol consumption technique. Current (past year) **smoking tobacco use** considered manufactured cigarette smoking, hand-rolled tobacco smoking, and pipe smoking.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary).	Secondary Data We used data from the Burkina Faso first national survey conducted in 2013, based on the WHO STEPwise approach to Surveillance (STEPS)

	b. If primary data, briefly describe method	
	10. How was obesity specified in practice?	BMI (weight/height², kg/m²) Overweight/obesity as BMI ≥25 kg/m².
	11. Characteristics of sample	Age range (years) 25-34 1,009 35-49 774 >49 408 Marital status Married/cohabitating 1,910 Singles 281 Education level No formal education 1,787 school or more 404 Occupation Employed/Self-employed 1,222 Others 969
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2191 Complete data from 2438 participating women were available and included data on nutritional status, biological features, and alcohol and tobacco consumption conducted the analysis using the data for 2191 women, after excluding those who were pregnant.

	13. Which sampling method used?	None
	15. Which type of statistical method was used?	multivariate logistic regression univariate analyses
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	For all statistical analyses, a p-value <0.05 was considered significant.
Empirical findings (objective 5)	18. What are the main findings?	The overall prevalence of overweight/obesity was 19.6% (13.1% and 44% in rural and urban women respectively, p=0.0001). Common factors positively associated with overweight/obesity in both rural and urban women were being a resident of a region in the highest urbanization rate quartile, having a high level of total cholesterol (alone or via an interaction with age) and having a high DBP. In urban women only, overweight/obesity was also associated with a high SBP
	19. What are the author-stated challenges?	None

24.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Doku Teye David and Subas Neupane
	2. Year	2015
	3. Aim	To explore trends in overweight/obesity and underweight and associated factors were explored among 15 to 49 years old women in Ghana.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Education Parity

		Marital status Wealth index Place of residence Survey year
	6. How are these determinants specified in practice?	**Wealth index** Richest Richer Middle Poorer Poorest **Place of residence** Urban Rural **Survey year** 1993 1998 2003 2008
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary dataset Data was taken from the 1993 (N = 4562), 1998 (N = 4843), 2003 (N = 5691) and 2008 (N = 4916) Ghana Demographic and Health Surveys (GDHS).
	10. How was obesity specified in practice?	It was calculated by dividing body weight (kg) by height squared (m^2). It was then

		categorized into three namely; underweight-18.5 kg/m^2, normal weight-18.5–24.9 kg/m^2 and overweight/obesity ≥25.0kg/ $m^{2.}$
	11. Characteristics of sample	Sample included women aged from 15 to 49 years from four demographic and health surveys conducted in Ghana in 1993, 1998, 2003 and 2008
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	20,012 Not stated
	13. Which sampling method used?	Multi-stage sampling
	15. Which type of statistical method was used?	Descriptive, Bivariate and multinomial logistic regression
	16 what was the theoretical underpinning used in the study	Non stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	In the multivariate analysis, Older age was found to be associated with overweight/obesity among both rural (OR = 2.21; 95 % CI = 1.74 -2.82) and urban residents (OR = 2.57; 95 % CI = 2.03 – 3.25). However, the association was stronger among urban residents. Women with primary (OR = 0.44; 95 % CI = 0.22 – 0.88) or no education (OR = 0.22; 95 % CI = 0.11 – 0.44) had lesser likelihood of being overweight/obese, especially among rural residents. Women with no education

		(OR = 0.48; 95 % CI = 0.32 – 0.72) were also less likely of being overweight/obese among urban residents.
	19. What are the author-stated challenges?	There was no data on waist circumference which would have allowed examination of trends in abdominal obesity. Additionally, no data were available on behavioral or other factors that could have explained the observed changes in the prevalence of overweight among women.

25.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Fatai A. Maruf and Nwannedimma V. Udoji
	2. Year	2015
	3. Aim	To explored prevalence of overweight and obesity and their associations with socio demographic variables in a Nigerian population.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Weight SES - occupational and educational indices.
	6. How are these determinants specified in practice?	*Height* was measured to the nearest 1 cm using a height meter. Participants were barefoot and stood on the platform of the height meter while

		the height was read from the meter at the level of the vertex of the head. *Weight* was measured to the nearest 1 kg using a weighing scale (Model BR9011, 120 × 0.01 kg) SES - occupational and educational indices. *Occupation:* class I (SC I; professional), social class II (SC II; managerial and technical), social class III (SC III; skilled-manual and non-manual), social class IV (SC IV; partly skilled), and social class V (SC V; unskilled). *Educational attainment*: pre-primary (0), primary (1), lower secondary (2), upper secondary (3), post-secondary non-tertiary (4), first stage of tertiary education (5), and second stage of tertiary education (6)
	7. How was data on these determinants collected? i. What is the dataset used? (if method of data collection is secondary).	Primary Data (B) Questionnaires 1. Study area divided into four administrative quarters 2. Three churches were randomly selected from the list of churches from

	j. If primary data, briefly describe method	each of the quarters, giving a total of 12 randomly selected churches. Out of the churches respondents were randomly selected.
	10. How was obesity specified in practice?	*Body mass index (BMI)* was calculated from their respective height and weight as weight (kg) divided by height (m) squared. Based on BMI, participants were categorised as underweight, normal weight, overweight, or obese using the World Health Organization criteria.
	11. Characteristics of sample	*Age (years)* 18–40 M= 54.9 F= 42.3 41–60 M= 31.6 F= 41.7 >60 M= 13.5 F=16.0 *Education* None/primary M= 11.8 F=14.5 Secondary M= 60.6 F= 57.8 Tertiary M= 27.6 F= 27.7 *Occupation* Professional M= 4.8 F=4.1

		Skilled M= 26.6 F=39.0 Unskilled M=68.5 F=56.9
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1521 Respondents were selected from 12 selected churches that were derived from 4 administrative units.
	13. Which sampling method used?	Simple random & simple stratified methods
	15. Which type of statistical method was used?	Mean, standard deviation, frequency Multinomial logistic regression was used to determine risk estimates for overweight and obesity, with age group, gender, highest educational attainment, and occupational status as factors.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Statistical level of error was set at 0.05.
Empirical findings (objective 5)	18. What are the main findings?	Prevalence of overweight was higher in men(32.3%; 95% CI, 29.5%–35.2%) than in women (29.8%; 95% CI, 26.8%–33.0%); the reverse was the case for prevalence of obesity in menthan in women. Higher odds ratios (ORs) for overweight and obesity were observed in participants aged 41–

		60 years (OR 2.03; 95% CI, 1.57–2.61 for overweight and OR 4.29; 95% CI, 3.25–5.67 for Obesity) and those >60 years (OR 1.72; 95% CI, 1.21–2.43 for overweight and OR 4.21; 95% CI, 2.86–6.19 for obesity) compared to those aged 18–40 years. Women sex was associated with higher ORs for overweight (OR 1.20; 95% CI, 0.96–1.51) and obesity (OR 2.21; 95% CI, 1.73–2.83). Participants with secondary education had marginally higher ORs for overweight (OR 1.15; 95% CI, 0.88–1.51) and obesity (OR 1.17; 95% CI, 0.86–1.59) than those with tertiary education, and so were those with primary education for obesity (OR 1.19; 95% CI, 0.74–1.89) but higher OR for overweight (OR 1.44; 95% CI, 0.98–2.13). Unskilled participants had about the same OR for overweight and obesity as professionals, and while skilled participants had about the same OR for overweight as professionals, their OR for obesity (OR 1.27; 95% CI, 0.67–2.43) was fairly higher than that for professionals.
	19. What are the author-stated challenges?	None

26.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Fezeu at al.
	2. Year	2005
	3. Aim	To determine the association between socio-economic status (SES) and adiposity in urban Cameroon

	4. Country	Cameroon
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Household amenities quartile Occupation level Alcohol consumption Tobacco smoking Educational level Physical activity quartile
	6. How are these determinants specified in practice?	**Age (years)** 25 – 34 35 – 44 45 – 54 55+ **Sex** Men Women **Household amenities quartiles** First (poorest) Second Third Fourth (richest) **Occupation level** Low Middle High **Alcohol consumption** Non drinker <5g/day 5 – 30g/day >30g/day **Tobacco smoking** Non smokers

		smokers **Educational level** None Primary Secondary University **Physical activity quartile** First quartile Second quartile Third quartile Fourth quartile
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Participants responded to a questionnaire on their socio-demographic characteristics. Information on household amenities and annual family income was obtained from the head of each household. Body weight and height were measured with the subjects wearing light clothes, and waist circumference was measured midway between the lowest rib and the iliac crest. The Sub-Saharan Africa Activity Questionnaire (SSAAQ), was used to assess the leisure time physical activity during the past month. Frequency and duration were computed for each reported activity, and the energy expenditure was calculated using Ainsworth compendium. Energy expenditure

		related to leisure time physical activity was calculated by multiplying the ratio of the exercise to resting metabolic rate (MET, Metabolic equivalent) score by the number of hours spent in each activity.
	10. How was obesity specified in practice?	BMI was calculated from weight and height measure. It was categorized into: normal weight ($18.5 \leq BMI < 25$ kg/m^2) overweight ($25 \leq BMI < 30$ kg/m^2) ($BMI \geq 30$ kg/m^2). Abdominal obesity was defined using waist ≥94 cm for men and ≥80 cm for women
	11. Characteristics of sample	Samples were recruited from Biyem-Assi, an urban area of Yaoundé, the capital city of Cameroon. The participants included civil servants, businessmen, and students. It included men and women aged 25 years and over.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2,831 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Logistic regression model
	16 what was the theoretical underpinning used in the study	Non indicated
	17. Which statistical model diagnostics tests were reported?	None

Empirical findings (objective 5)	18. What are the main findings?	After adjusting for age classes, quartiles of leisure time physical activity, alcohol consumption, and smoking, the prevalence of obesity and abdominal obesity were higher in the third (odds ratios, 2.0, 95% CI: 1.3–3.0 and 1.3, 1.0–1.8) and fourth (1.8, 1.2–2.8 and 1.7, 1.2–2.4) quartiles of household amenities compared with the first quartile in women. In men, the odds ratios of overweight + obesity, obesity, and abdominal obesity were higher in the third (1.6, 1.1–2.3; 2.1, 1.1–4.2; and 3.3, 1.8–5.8, respectively) and fourth (odds ratios, 2.3, 1.6–3.2; 2.4, 1.5–6.0; and 4.1, 2.3–7.3, respectively) quartiles of household amenities compared with the first quartile. Also, in men, after adjusting for confounding variables, the odds of overweight + obesity (1.6, 1.2–2.3), obesity (3.8, 1.8–7.8), and abdominal obesity (2.2, 1.3–3.6) were significantly higher for those in the high compared with the low occupational level.
	19. What are the author-stated challenges?	None stated

27.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Leopold K. Fezeu1, Felix K. Assah, Beverley Balkau, Dora S. Mbanya1, André-Pascal Kengne, Paschal K. Awah and Jean-Claude N. Mbanya
	2. Year	2008

	3. Aim	To compare the 10-year changes in the distribution of adiposity in rural and urban Cameroonian populations
	4. Country	Cameroon
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight Waist circumference Socio-demographic variables
	6. How are these determinants specified in practice?	*Weight* was measured using Seca scales, height with calibrated adult Leicester stadiometers, *Waist circumference* measured mid-way between the lower rib and the iliac crests, with a constant tension tape. *Socio-demographic variables* age classes alcohol consumption tobacco smoking, educational level.
	7. How was data on these determinants collected?	Secondary Data (a) Interviews was used

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Surveys were carried out in 1994 and 2003 in Cameroon, in the same settings, using similar methodology.
	10. How was obesity specified in practice?	*The BMI* was calculated Overweight + obesity, BMI ≥25 kg/m2, Central obesity WC ≥80 cm for women and 94 cm for men
	11. Characteristics of sample	Women recruited in 2003 were significantly older than those recruited in 1994, in both rural and urban areas. The education level was significantly higher in 2003 in urban women and rural men. During the study interval, the prevalence of alcohol consumption increased in both genders and places of residence, while tobacco smoking increased in women and decreased in men in rural area only. Changes in BMI and WC differed significantly according to the place of residence: in the rural population.
	12 a. What was the sample size?	3,160 Data available in the dataset used

	b. what was the statistical basis for sample size used?	1994 (1,762 subjects) 2003 (1,398 subjects)
	13. Which sampling method used?	None
	15. Which type of statistical method was used?	Comparison of percentages used $\chi 2$ or Fisher's exact tests, and means, Student *t*-tests. Multivariate logistic regression models used
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	odds ratios and 95% confidence intervals
Empirical findings (objective 5)	18. What are the main findings?	Between 1994 and 2003, the age-standardized prevalence of BMI ≥25 kg/m^2 increased significantly only in the rural area (+54% for women and +82% for men), while the age-standardized prevalence of central obesity (WC ≥80 cm (women), ≥94 cm (men)) increased significantly only in the urban population (+32% for women and +190% for men). These differences persisted after adjustments for age group, alcohol consumption, tobacco smoking, and level of education, and within almost all the strata of the studied risk factors.
	19. What are the author-stated challenges?	None

28.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Goryakin et al.
	2. Year	2015

	3. Aim	To assess the impact of globalization on overweight and obesity on 56 selected countries
	4. Country	Ghana, Gabon, Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Guinea
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	**Total globalization** Social globalization Political globalization Economic globalization Education Occupation Age Number of children
	6. How are these determinants specified in practice?	**Total globalization:** measured using the KOF total globalization indicator which is an aggregation of three sub-components below: 1. Social globalization: measured with the social KOF globalization index, based on the following variables: telephone traffic transfers (percent of GDP); international tourism foreign population (in percent of total population); international letters (per capita); internet users (per 1000 people); TVs (per 1000 people); trade in newspapers (percent of GDP); number of McDonald's restaurants (per capita); number of Ikea (per capita); trade in books (percent of GDP). 2. Political globali0zation: measured the political KOF index, a composite measure including information on the following four components: number of

		foreign embassies in a given country; membership in International Organizations; participation in U.N. Security Council missions; number of signed international treaties. This component is designed to measure the degree of a country's international political engagement 3. Economic globalization: measured with the economic KOF sub-index, which is a composite measure comprising trade (in percent of GDP); foreign direct investment (FDI) stocks (in percent of GDP), portfolio investment (in percent of GDP), income payments to foreign nationals (in percent of GDP), hidden import barriers, mean tariff rate, taxes on international trade (in percent of current revenue) and capital account restrictions. Total globalization was then categorized into 4 quartiles: **Total globalization quartile 1** **Total globalization quartile 2** **Total globalization quartile 3** **Total globalization quartile 4** **Age (years)** 15-49 **Number of children** 0 1 – 2

		3 – 5 **Education** No education Incomplete primary education Complete primary education Incomplete secondary education Complete secondary **Occupation** service occupation manual occupation agriculture occupation
	7. How was data on these determinants collected? k. What is the dataset used? (if method of data collection is secondary). l. If primary data, briefly describe method	Secondary data Demographic and Health surveys from the participating countries from the year 1991 to 2009
	10. How was obesity specified in practice?	In BMI greater or equal to 25 kg/m^2. The BMI was calculated by dividing weight in kilograms by height squared in meters. Women whose BMI was above 50 kg/m^2, or whose weight was either greater than or equal to 220 kg, were excluded.

	11. Characteristics of sample	Sample included only women from 15 to 49 years in some selected low and middle income countries.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1,225,816 Not stated
	13. Which sampling method used?	Not stated
	15. Which type of statistical method was used?	Ordinary least squares (OLS) regression
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Economic globalization quartile 2 (r =0.117, p =0.003), economic globalization quartile 3 (r =0.147, p =0.003) and economic globalization quartile 4 (r =0.139, p =0.003) were significantly associated with overweight in women.
	19. What are the author-stated challenges?	The sample was necessarily restricted to women only, and mostly of child-bearing age. Therefore, generalizing our findings to women of all age groups, let alone to both genders, is not possible. Drawing major causal claims about our findings, especially in relation to 19 countries that were only present in the sample for one

		year, and thus could not provide any within-variation for the fixed effects analysis. Most sampled women were mothers with at least one child under 5 years of age, which is potentially problematic in that such women may more likely be overweight, although the reverse may be true in the lowest income countries, where both pregnancy and breastfeeding may lead to large energy needs relative to family resource

29.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	M Siervo, P Grey, OA Nyan and AM Prentice
	2. Year	2006
	3. Aim	To investigate the distribution of overweight and obesity and its relationship with socio-economic and behavioural factors in a developing-country population undergoing rapid nutritional transition.
	4. Country	Gambia
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight and height Waist (WC) and hip circumferences (HC) Socio-economic status score Educational level score Healthy lifestyle score Western influences score

	6. How are these determinants specified in practice?	*Weight and height* were measured to the nearest 0.1 kg and 0.5cm with subjects wearing light clothes *Waist (WC) and hip circumferences (HC)* were measured to the nearest 0.1cm with a flexible tape. WC was measured at the level of the upper margin of the iliac crest and HC at the hip's visible largest point. *Socio-economic status score*: Employment/ Possession of social amenities *Educational level score:* Reading magazines, newspapers/ Education *Healthy lifestyle score:* Physical activity/ Smoking *Western influences score:* Reading magazines, newspapers/ Radio & TV ownership
	7. How was data on these determinants collected?	Primary Data (b) Questionnaires were used

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	In total, 200 subjects voluntarily agreed to participate in the study and signed the informed consent after the project was fully explained by the fieldworkers. We stopped the recruitment in each group as soon as we reached 50 subjects.
	10. How was obesity specified in practice?	Body mass index (BMI) The BMI growth charts proposed by Cole et al. (2000) and by Centre of Disease Control (2000) BMI was utilized to classify each adult subject as underweight (BMIo18.5kg/m2), normal weight (18.5pBMIo25 kg/m2), overweight (25pBMIo30 kg/m2) and obese (BMIX30 kg/m2).
	11. Characteristics of sample	The subjects were divided by gender (men–women) and by age (14–25 and 35–50 years). Each group I made up of 50 respondents Number of subjects 50 50 50 50 Illiteracy 10% 56% 0% 34% Primary school 4% 26% 10% 18% Secondary school 86% 18% 90% 48%

		Married 6% 78% 8% 84% Not married 92% 4% 92% 12%
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	200 In total, 200 subjects voluntarily agreed to participate in the study and signed the informed consent after the project was fully explained by the fieldworkers. We stopped the recruitment in each group as soon as we reached 50 subjects
	13. Which sampling method used?	Simple stratified method
	15. Which type of statistical method was used?	Data were expressed as absolute and relative frequencies (Categorical variables) and mean and standard deviation (Continuous variables). Chi Square test was used to explore statistical differences between categorical variables. One-way ANOVA was used to analyse continuous variables And Kruskall–Wallis ANOVA was utilized to analyse variables not normally distributed. Spearman-rank correlation analysis was used to explore the association between BMI and the composite scores.
	16 what was the theoretical underpinning used in the study	None

	17. Which statistical model diagnostics tests were reported?	Scheffe´s test in order to obtain more precise information on the significant differences among the single variables
Empirical findings (objective 5)	18. What are the main findings?	There were highly significant gender and age differences in overweight (YM¼0%, YW¼10%, OM¼6% and OW¼34%) and obesity (YM¼0%, YW¼4%, OM¼6% and OW¼50%). Only 16% of OW were neither overweight nor obese compared to 88% of OM. OW had a higher fat mass percent (38.4%) than other groups, while fat-free mass (kg) was significantly higher in menthan women with YW having the lowest value. Young generations were more educated and more influenced by western ideals than OM and OW. Weight gain was not always associated with weight concern and many overweight/obese subjects did not perceive themselves as overweight.
	19. What are the author-stated challenges?	None

30.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Koussoh Simone Malik, Anicet Adoubi, Kouamé Kouadio, Jérôme Kouamé, Annita Hounsa, Julie Sackou
	2. Year	2019
	3. Aim	This study assessed selected correlates of overweight and obesity among women in a

		sub-urban population of Abidjan, Côte d'Ivoire.
	4. Country	Côte d'Ivoire
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Abdominal obesity The level of physical activity Blood pressure (BP) The level of education The socioeconomic level Demographic variable
	6. How are these determinants specified in practice?	*Height:* was measured by a tape measure and weight by a Camry® brand scale model scal160 that can support up to 160 kg. *Abdominal obesity:* was measured by a tape measure and defined as a waist circumference (WC) to hip circumference (TH) ratio greater than 0.80 (18). *The level of physical activity* was assessed by the IPAQ questionnaire which defined 3 categories of persons: category 1 (inactive or insufficiently active) category 2 (sufficiently active) category 3 (very active). *Blood pressure (BP)* Systolic blood pressure below 90 mmHg and/or diastolic blood pressure below 60 mmHg were considered low blood pressure.

		systolic blood pressure greater or equal to 140 mmHg and/or diastolic blood pressure greater or equal to 90 mmHg with or without treatment were considered to have high blood pressure. *The level of education* was categorized into four: no education, primary level secondary level, & higher level *The socioeconomic level* the poverty score or wealth index calculated on the basis of asset ownership (e.g. televisions, bicycles, cars, materials used for housing construction, types of access to water and sanitation). The relative wealth scale was then classified into five categories: Poorest, Poor, middle, rich richest *Demographic variable* age Marital status
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Data (b) The neighbourhood of Anonkoi 3 is a village in the commune of Abidjan. The area contains 668 households. Therefore, we conducted a random sample, we calculated a sampling interval of two (668/336 = 1.98).

		The sample size was calculated using the formula: n = p (1-p) Z2/i2 with n: sample size; p: prevalence of overweight and obesity 32.2%; Z=1.96 for a 5% risk of error and i: accuracy (5%)/
	10. How was obesity specified in practice?	Body Mass Index Overweight is defined as having a BMI greater than or equal to 25 and lower than 30 kg/m2; obesity is defined as having a BMI greater than or equal to 30.
	11. Characteristics of sample	Age 15-30 128 (39.14) 31-45 129 (39.45) >45 70 (21.41) Marital status Married 184 (56.27) Single 143 (43.73) Level of study None 127 (38.84) Primary 68 (20.8) Secondary 106 (32.41) Higher 26 (7.95)
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	327 The sample size was calculated using the formula:

		n = p (1-p) Z2/i2 with n: sample size; p: prevalence of overweight and obesity 32.2%; Z=1.96 for a 5% risk of error and i: accuracy (5%)/
	13. Which sampling method used?	Simple random
	15. Which type of statistical method was used?	Univariate analysis using the Pearson KHI Logistic regression model.
	16 what was the theoretical underpinning used in the study	Physical activity was assessed by the IPAQ questionnaire
	17. Which statistical model diagnostics tests were reported?	The adjusted odds ratio and the confidence intervals at 95% were calculated.
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of overweight was 27.2% and that of obesity was 19.6%; 72.2%of women had abdominal obesity. The prevalence of abdominal obesity was 90.6% among obese people. Age (p=0.006), marital status (p=0.002) and blood pressure (p=0.004) were significantly associated with obesity. With regard to abdominal obesity, there was a significant association of educational level in addition to the above factors.
	19. What are the author-stated challenges?	None

31.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Lartey et al.
	2. Year	2019

	3. Aim	To examine recent changes in obesity prevalence and associated factors for older adults in Ghana between 2007/08 and 2014/15.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity	Age Sex Education level Marital status Residence/location household wealth smoking status alcohol consumption Fruit and vegetable intake Physical activity
	6. How are these determinants specified in practice?	**Age (years)** 50–59 60–69 ≥ 70 **Sex** Men Women **Educational Status**

		Low High **Marital status** Single Married/ cohabiting Widow/divorce **Location** Rural Urban **Wealth Index** Lowest Low Moderate High Higher

		Smoking status Never Smoked Quitter Currently smoke **Alcohol Consumption Status** Never drunk alcohol Quitter Currently Drinks **Fruit & Vegetable Intake** Below requirement Met requirement
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary dataset Secondary data from the World Health Organization's (WHO) 2007/8 (Wave 1) and

		2014/15 (Wave 2) Study on global AGEing and adult health (WHO-SAGE).
	10. How was obesity specified in practice?	BMI was calculated as a person's weight in kilograms divided by the square of their height in meters and obesity was defined using cut-offs following the WHO classification. BMI was classified into four categories: underweight, BMI<18.50 kg/m^2 normal/healthy weight BMI≥18.50<25.00 kg/m^2 Overweight 25.00<30.00 kg/m^2; obese as BMI≥30.00 kg/m^2 From the measured waist circumference, high central adiposity was determined using sub-Saharan Africa standards as waist circumference ≥81.2 cm for men, and ≥80.0 cm for women
	11. Characteristics of sample	Sample included adults aged 50 years and older in Ghana were drawn from the WHO SAGE 2007/08 (Wave 1; n = 4158) and 2014/15 (Wave 2; n = 1663).
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	5,821 Not stated
	13. Which sampling method used?	Stratified multistage cluster sampling
	15. Which type of statistical method was used?	Multinomial and binomial logistic regression
	16 what was the theoretical underpinning used in the study	Ecological framework

	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Women between the age of 50–59 years had a significantly higher odds of obesity (OR = 2.67; 95% CI: 1.34–5.30) in 2007/08. Also, significantly higher odds of high central adiposity among women aged 50–59 years (OR = 1.69; 95% CI: 1.10–2.58) and 60–69 years (OR = 1.54; 95% CI: 1.06–2.25) only in 2007/08. Not meeting the recommended physical activity level among women was associated with higher odds of obesity (OR = 3.23; 95% CI: 1.13–6.23) and high central adiposity (OR = 2.19; 95% CI: 1.32–3.63).
	19. What are the author-stated challenges?	First, study was cross-sectional, thus results focused on associations and not causality. Second, the study focuses only on those who were 50 years and above and does not cover the entire population. Therefore, conclusions from this study is limited to the population of 50 years and above. Finally, although the data is representative of the population aged 50 years and over, the analysis omits observations with missing data (13% in 2007/08 and 4.8% in 2014/15) on variables such as weight, height and waist circumference. Hence, there is a chance for selection bias to be introduced that might have affected external validity.

32.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Luke et al.
	2. Year	2014
	3. Aim	To examine whether low levels of PA are associated with excess weight and adiposity.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Physical activity Age Gender Employment Education participant and significant other's occupation parental education household assets and amenities.
	6. How are these determinants specified in practice?	**Physical activity** sedentary <100 counts per minute (cpm), moderate 1535–3959 cpm vigorous ≥3960 cpm **Age (years)** 25 – 45 **Gender** Men women **Employment status** worked for pay in the previous month education was coded as a continuous variable **occupations** manual (technical, service, manual, agriculture or fishing) non-manual (managerial, professional or clerica

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Demographic data and basic health history information, with a focus on cardiovascular conditions and diabetes, including age of first diagnosis and medication and dietary supplement use were collected with a questionnaire. Self-reported physical activity was assessed using the Global Physical Activity Questionnaire. Participants recorded the number of days per week and amount of time per day engaged in moderate and vigorous activities during work, number of days per week and amount of time per day engaged vigorous recreational activities, number of days per week and amount of time per day spent walking or bicycle riding (i.e., travel), and amount of time spent daily in sedentary activities
	10. How was obesity specified in practice?	BMI calculated from the weight and height of participants. BMI was analyzed as a continuous variable.
	11. Characteristics of sample	Sample included young men and women adults aged 25 to 45 years recruited from suburb of Chicago, Illinois, USA; urban Jamaica; rural Ghana; peri-urban South Africa; and the Seychelles.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2, 500. (500 from Ghana). Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Univariate, bivariate, multiple linear regression
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	In the ecological analysis time spent in moderate-to-vigorous activity was inversely associated with BMI (r = -0.71), and inversely associated with waist circumference in Ghana (r =-0.15).
	19. What are the author-stated challenges?	the cross-sectional nature of the data limits the ability to make causal inferences and determine the direction of association.

33.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Macia et al.
	2. Year	2010
	3. Aim	To determine the prevalence of obesity in Dakar
	4. Country	Senegal
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender

		Marital status Education level Ethnicity
	6. How are these determinants specified in practice?	**Age** 20 – 29 30 – 39 40 – 49 ≥50 **Gender** Men Women **Marital status** Single Married Widowed/divorced **Education level** Illiterate Primary Intermediate Secondary University **Ethnicity** Wolof Peul Serer Diola Mandingue others
	7. How was data on these determinants collected?	Secondary data Data from the 2002 census in Dakar

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	
	10. How was obesity specified in practice?	BMI from the weight and height measures of participants, Waist to hip ratio (WHR) from the waist hip circumference measure and waist circumference (WC) at the thinnest point of the abdomen at the end of a normal expiration. BMI was classified into: underweight, normal, overweight and obesity per WHO standard. WHR: ≥0.9 in men and ≥0.8 in women WC: ≥102cm in men and ≥88 in women
	11. Characteristics of sample	Sample included men and women from living in the department of Dakar. Their age ranged from 20 years and above.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	600 Quota method *
	13. Which sampling method used?	Not clearly stated
	15. Which type of statistical method was used?	Logistic regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
	18. What are the main findings?	Ages 30 – 39 (OR =8.02, CI =3.57 – 18.02, P <0.001), 40 – 49 (OR =22.51, CI =8.88 –

Empirical findings (objective 5)		57.06, P <0.001) and ≥50 (OR =24.4, CI =9.03 – 65.91, P <0.001) were significantly associated with obesity compared to age 20 – 29. Similarly, women was significantly associated with obesity (OR =17.91, CI =9.39 – 34.15, P <0.001) compared to men.
	19. What are the author-stated challenges?	Did not state

34.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Chidozie E. Mbadaa Rufus A. Adedoyinb Olusola Ayanniyic
	2. Year	2009
	3. Aim	The aims of this study were to examine relationships between SES and BMI, investigate whether variations in BMI are influenced by differences in SES, and estimate the prevalence of overweight and obesity in a semi-urban population in Nigeria.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Body weight Socioeconomic strata
	6. How are these determinants specified in practice?	Height was measured with a height meter calibrated from 0 to 200 cm. Body weight was measured in kilograms to the nearest 1.0 kg, with the participant standing and not wearing shoes. SES = Socioeconomic strata

		subjects' highest educational attainment, level of income, occupational status This was used to classify the subjects into the 3 different socioeconomic groups. Based on the summative score, the participants were categorised into lower (<9), middle (10–18), or upper socioeconomic class (19–27).
	7. How was data on these determinants collected? m. What is the dataset used? (if method of data collection is secondary). n. If primary data, briefly describe method	Primary data (B) Questionnaires used Selected out of the 11 political wards into which the Ife central local government area was divided were randomly chosen. In each ward, 3 census enumeration areas were randomly selected and houses with odd numbers were selected for survey. The study design intended to recruit a total of 1,500 adults. Each enumeration area was expected to include 100 adults aged 20 years and older. All eligible adults were recruited until approximately 100 participants were available in an enumeration area.
	10. How was obesity specified in practice?	BMI was calculated by dividing weight in kilograms by height in metres squared (kg/m2). WHO criterion was applied: normal ≥18.5–24.9 kg/m2; overweight ≥25–29.9 kg/m2;

		obesity ≥30–39.9 kg/m2.
	11. Characteristics of sample	1,067 adults (552 men (51.7%); 515 women (48.3%)) whose ages ranged between 30 and 60 years The mean age, height, weight, and BMI of all the participants were 44.33 ± 6.78 years, 166 ± 8.58 cm, 64.41 ± 11.46 kg, and 23.45 ± 3.89 kg/m2, respectively. Socioeconomic Strata Lower SES 319 Middle SES 460 Higher SES 288
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1,067 adults 1. Dividing the sample area into small administrative units 2. Conducting census to identify households with odd numbers 3. Selected using age criterion
	13. Which sampling method used?	Simple random
	15. Which type of statistical method was used?	*Pearson's product-moment correlation analysis* was used to determine the relationship among total SES scores and each score of weight, height, and BMI of the participants. *Multivariate linear regression analysis* was used to test the relationship between SES and

		age as independent variables and BMI as dependent variable. *Least significance difference* (LSD) post hoc analysis was used to probe the specific differences found in the F ratio of the *ANOVA.*
	16 what was the theoretical underpinning used in the study	SES questionnaire used by Balogun et al.1990 SES ladder of 9 rungs adopted from the MacArthur, 2000
	17. Which statistical model diagnostics tests were reported?	The confidence level was set at $p < 0.05$.
Empirical findings (objective 5)	18. What are the main findings?	SES was found to be inversely related ($p < 0.010$) to weight and BMI, respectively. The odds ratio (OR) and 95% confidence interval (CI) for obesity among lower SES individuals were OR 2.4 and CI 1.91–2.88 compared with OR 2.9 and CI 2.42–3.39 in those of the middle and higher socioeconomic strata. Among men, the OR and 95% CI for obesity among lower SES individuals were OR 1.9 and CI 1.21–2.59 compared with OR 1.7 and CI 1.00–2.39 in those of the middle and higher socioeconomic strata. Among women, the OR and 95% CI for obesity among lower SES individuals were OR 3.0 and CI 2.32–3.68 compared with OR 4.7 and CI 4.02–5.38 in those of the middle and higher socioeconomic strata.
	19. What are the author-stated challenges?	None

35.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Mogre et al.

	2. Year	2015
	3. Aim	To investigate the influence of socio-demographic, dietary habits and physical activity levels on general and abdominal obesity among a sample of university students in Ghana
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Sex Food group Physical activity
	6. How are these determinants specified in practice?	**Age** (years): ≥30 years) **Sex**: men/women **Food group** Cereals and grains >3 days/week Roots and tubers >3 days/week Beans and nuts >3 days/week Fruits and vegetables >3 days/week Animal products >3 days/week Alcoholic and Non-Alcoholic beverages >3 days/week Fats and oils >3 days/week **Physical activity levels** Vigorous Moderate Light
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary).	Primary data

	b. If primary data, briefly describe method	Self-administered questionnaires were given to respondent to collect the required data for this study
	10. How was obesity specified in practice?	BMI was calculated as weight (kg)/height^2 (m^2) and used to categorize *BMI-measured* weight status: underweight (BMI ≤ 18.5) normal weight (BMI 18.5–24.9) overweight (BMI 25.0–29.9) obese (BMI ≥ 30) Abdominal obesity was deduced from the waist to hip ratio determined as a waist circumference >102 cm in men and >88 cm in women
	11. Characteristics of sample	Sample included participants men and Female populations aged 18–36 years attending the University for Development Studies, School of Medicine and Health Sciences (UDS-SMHS), Tamale, Ghana
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	552 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Multinomial logistic regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None

Empirical findings (objective 5)	18. What are the main findings?	General overweight/obesity (BMI) was less likely in students who engaged in vigorous physical activity (Adjusted Odds Ratio (AOR) = 0.3, 95 % CI = 0.1 – 0.7, p = 0.004), but more likely in students who consumed fruits and vegetables > 3 days per week (AOR = 2.6, 95 % CI = 1.2 – 5.4, p = 0.015). Abdominal obesity was also less likely in men students (AOR = 0.0, 95 % CI = 0.0 – 0.5, p = 0.017) but more likely in students who consumed roots and tubers > 3 times per week (AOR = 8.0, 95 % CI = 2.2 – 10.1, p = 0.017) and in those who consumed alcoholic and non-alcoholic beverages > 3 times per week (AOR = 8.2, 95 % CI = 2.2 – 31.1, p = 0.002)
	19. What are the author-stated challenges?	Study is cross-sectional and causality cannot be inferred from cross-sectional analyses because the data was collected at a single point in time and the direction of the association cannot be determined. Another limitation is that, all dietary data were obtained by means of a food frequency questionnaire. Food frequency questionnaires do not collect detailed information on the preparation or physical form of foods consumed which have been shown to affect the energy density of foods. This could have influenced the information relating to dietary habits and their association to other variables in the study. This study was conducted among a sample of university students who are highly educated.

		Participants may have had better recall of dietary intakes than the general population. Even though the sample population may be a true reflection of the urban population, it might not be representative of young rural Ghanaian adults who are not highly educated.

36.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Subas Neupane, Prakash K.C. David Teye Doku
	2. Year	2016
	3. Aim	To explore the prevalence of overweight and obesity in the region. Furthermore, the study explores disparity in the phenomenon by place of residence, level of education and wealth quintile.
	4. Country	Sub-Saharan Africa
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight Height Place of residence Socio-economic Status Maternal education
	6. How are these determinants specified in practice?	*Weight* was measured using solar-powered scales with accuracy of 0.1 kg *Height*

		was measured using standardized measuring boards with accuracy to 0.1 cm. *Place of residence* The participants' place of residence was designated as rural and urban according to country specific definitions. *Socio-economic Status* The wealth index was calculated using easy-to-collect data on a household's ownership of selected assets (e.g. televisions, bicycles, cars, materials used for housing construction and types of water access and sanitation facilities). Continuous scale of relative wealth was then categorized into five (poorest, poorer, middle, richer, and richest) according to the quintile of the sample. *Maternal education* no education primary secondary, or higher

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary Data (a) Thirty-two nationally representative cross-sectional data from the most recent Demographic and Health survey (DHS) conducted between January 1, 2005, and December 31, 2013 in Sub-Saharan Africa were used.
	10. How was obesity specified in practice?	*Body mass index (BMI)* was calculated by dividing body weight (kg) by squared height (m2). Overweight and obesity were defined as recommended by World Health Organization overweight 25.0–29.9 kg/m^2 obesity ≥30.0 kg/m^2.
	11. Characteristics of sample	Data from a total of 250651 women from 32 countries in Sub-Saharan Africa were analysed in this study The mean age of the studied women varied from 27.68 years (Comoros) to 29.43 years (Liberia). The overall mean age of the study participants was 28.46 years. Only 10.5 % of women were urban residents in Burundi which is the least among countries studied whereas Congo (Brazzaville) had the highest number of urban residents (66.8 %).

		On the average, 36.6 % of the women resided in urban areas. According to wealth index, Lesotho had the fewest poorest (14.6 %) and the highest number of poorest women were found in Burundi (20 %). The largest number of women who had no education (80.7%) were found in Niger compared to only 1.2 % in Lesotho. Similarly, women in Lesotho also had the lowest mean number of children (1.82) compared to 4.42 % in Chad.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	Data from a total of 250651 women In this study, all together 366885 women from 32 countries responded to the surveys with the response rates varying from 86.2 to 100.0 %. However, the present analysis is based on all women who had information on weight and height (N = 250651).
	13. Which sampling method used?	No stated
	15. Which type of statistical method was used?	Descriptive figures of the study participants are reported The pooled prevalence for the region was also estimated.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Odds ratios (ORs) and their 95 % confidence intervals (CIs)

Empirical findings (objective 5)	18. What are the main findings?	The pooled prevalence of overweight for the region was 15.9 % (95 % CI, 15.7–16.0) with the lowest in Madagascar 5.6 % (95 % CI, 5.1–6.1) and the highest in Swaziland 27.7 % (95 % CI, 26.4–29.0). Similarly, the prevalence of obesity was also lowest in Madagascar 1.1 % (95 % CI, 0.9–1.4) and highest in Swaziland 23.0 (95 % CI, 21.8–24.2). The women in urban residence and those who were classified as rich, with respect to the quintile of the wealth index, had higher likelihood of overweight and obesity. In the pooled results, high education was significantly associated with overweight and obesity.
	19. What are the author-stated challenges?	None

37.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Ngianga-Bakwin Kandala and Saverio Stranges
	2. Year	2014
	3. Aim	To examine the geographic variation of overweight and obesity prevalence at the state-level among women in Nigeria
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Geographic location (State of residence at the time of survey) – main determinant Covariates: Age Education level

		Religion Wealth index Ethnicity Place of residence
	6. How are these determinants specified in practice?	State of residence: Akwa Ibom Anambra Bauchi/Gombe Edo Benue Borno Cross-river state Adamawa Imo Kaduna Kano Katsina Kwara Lagos Niger Ogun Ondo/Ekiti Oye Nassarawa/Plateau Rivers/Bayelsa Sokoto/Zamfara Abia Delta Enungu/ Ebonyl Jigawa Kebbi Kogi Osun

		Taraba Yobe Abuja Age: 15 – 49 years Education: No education Primary education Secondary education Higher education Religion: Catholic Other Christian Islam Traditionalist Other Wealth index: Poorest Poorer Middle Richer Richest Ethnicity: Ekoi Fulani Hausa Ibibio Igala Igbo Ijaw/Izon Kanuri/Beriberi Tiv Yoruba others Place of residence: Urban population Rural population

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary data 2008 Demographic and Health Survey datasets for Nigeria
	10. How was obesity specified in practice?	Body Mass Index (BMI) = weight (kg)/height $(m)^2$
	11. Characteristics of sample	Sample included only women aged from 15 – 49 years old.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	34,596. However, some participants had missing data, thus data analysis included 27, 967. Not indicated
	13. Which sampling method used?	Not indicated
	15. Which type of statistical method was used?	Multivariate Bayesian geo-additive regression models.
	16 what was the theoretical underpinning used in the study	Not indicated
	17. Which statistical model diagnostics tests were reported?	Not stated
Empirical findings (objective 5)	18. What are the main findings?	Higher education level (odds ratio (OR) =1.68 and 95% credible region (CR) =1.38 – 2.00), higher wealth index (OR =3.45, CR =2.98 - 4.05), living in urban settings (OR =1.24, CR =1.14 – 1.36) and increasing age were all

		significantly associated with higher prevalence of overweight and obesity. There was also a striking variation in overweight/obesity prevalence across ethnic groups and state of residence, the highest being in cross-river state, in south Eastern Nigeria (OR =2.32, CR =1.62 – 3.40), the lowest in Osun state in south western Nigeria (OR =0.48, CR =0.36 – 0.61).
	19. What are the author-stated challenges?	The cross-sectional nature of the present study does not allow for establishing temporality and causality of the observed associations. The analysis was based on a nationally representative sample of Nigerian women, therefore, the generalizability and applicability of these findings to Male populations or other sub-Saharan African countries warrant further investigations. There was limited or lack of information for variables such as dietary habits, physical activity, and biomarker data, which are relevant to metabolism and overweight/obesity aetiology. Therefore, the possibility that our findings might have been somewhat biased by the lack of this important confounders cannot be ruled out.

38.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Nonterah et al.
	2. Year	2017
	3. Aim	The study characterized the socio-demographic and behavioral factors

		influencing body mass index (BMI) among adults in rural Northern Ghana.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age groups in years Ethnicity Partnership status Highest level of education Employment status People-to-bedroom density Household SES categories
	6. How are these determinants specified in practice?	**Age groups in years** 40–44 45–49 50–54 55–60 **Ethnicity** Kassena Nankana Others **Partnership status** Never married Currently married Divorced/separated **Highest level of education** No formal education Primary education Secondary education Tertiary education **Employment status** Unemployed

		Employed **People-to-bedroom density** **Household SES categories** Poorest Very poor Poor Less poor Least poor
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Trained research assistants conducted all interviews using a pretested comprehensive AWI-Gen questionnaire and carried out all measurements in this study. Weight was measured to the nearest 0.1 kilograms (Kg) using a calibrated standardized Seca GmbH & Co. KG, Hamburg, Germany weighing scale and according to standard practice. Their standing height was recorded to the nearest 0.1mm using a stadiometer.
	10. How was obesity specified in practice?	The BMI was calculated from weight and height using the formula BMI = weight in kg/ (height in m^2) and subsequently categorized into underweight, normal weight, overweight and obesity according to World Health Organization (WHO) recommendation.
	11. Characteristics of sample	Study recruited both men and women aged 40–60 years who had been resident within the study area for at least 10 years.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2014 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	hierarchical linear regression analysis
	16 what was the theoretical underpinning used in the study	Study developed conceptual framework
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Participants with the highest level of education and a high household socio-economic status had higher BMIs than those in the lowest strata in both men ($\beta = 0.074$, $p = 0.028$ and $\beta = 0.072$, $p < 0.001$, respectively) and women ($\beta = 0.174$, $p = 0.001$ and $\beta = 0.109$, $p < 0.001$, respectively). Men ($\beta = -0.050$; $p < 0.001$) and women ($\beta = -0.073$; $p < 0.001$) of the Nankana ethnic group had a lower BMI than the Kassena ethnic group. Among men, alcohol consumption ($\beta = -0.021$; $p = 0.001$) and smoking ($\beta = -0.216$; $p < 0.001$) were associated with lower BMI. Smokeless tobacco was associated with lower BMI

		among women. Pesticide exposure was associated with higher BMI ($\beta = 0.022$; $p = 0.022$) among men
	19. What are the author-stated challenges?	The behavioral data was collected based on self-reported responses from the participants and these could not be independently verified and may lead to biased estimates of our observed associations. The cross-sectional nature of this study comes with inherent limitations as causality cannot be established.

39.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Nuertey et al.
	2. Year	2017
	3. Aim	To determine the prevalence of obesity and overweight and its associated factors amongst registered pensioners in Ghana
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Sex Age Marital status Ethnicity Education level Social class Region of residence Religion Hypertension Diabetes
	6. How are these determinants specified in practice?	**Sex** Men Women

		Age (years) Less than 65 65–69 70–74 75–79 ≥ 80 **Religion** Christianity Islam Traditional Others **Education level** None Basic/ MSLC Secondary Tertiary Others **Social class** I [Professional] II [Managerial/technical] III [(N) Skilled non-manual] III [(M) Skilled Manual] IV [Partly skilled] V [Unskilled] **Marital status** Never Married Married Widow/Widower Divorced Separated **Ethnicity** Ga-Dangme Akan

		Ewe Guan Mole-Dagomba Grusi Others **Region of residence** Ashanti Brong Ahafo Central Eastern Greater Accra Northern Upper East Upper West Volta Western **Hypertension** Yes No **Diabetes** Yes No
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Study questionnaires were made to record socio-demographic data of participants. Weight was measured with the weighing scale to the nearest one-kilogram while the height to the nearest one millimeter.

	10. How was obesity specified in practice?	BMI was calculated from weight and height measures and categorized into two groups: Normal/underweight Overweight/obesity
	11. Characteristics of sample	Sample included men and women members of the National pensioners association (NPA) in all the ten regional capitals in Ghana. Their ages ranged from sixty years and above.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	4813 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Logistic regression
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Hypertensive pensioners had 2.6 times the odds of being obese/overweight compared to non-hypertensive pensioners (95% CI = 2.3–2.9). Diabetics were associated with higher odds of being obese/overweight, OR = 2.5 (95% CI = 2.0–2.0) compared to non-diabetics. Women pensioners were associated with three times the odds of being obese/overweight compared to the men pensioners

	19. What are the author-stated challenges?	In the 2010 population and housing report on the elderly in Ghana, women elderly population was 56% as opposed to 44% of men which was attributed to higher life expectancy of women than men. However, in this study, men constituted 68.3% while women constituted 31.7% of pensioners. This could introduce a bias when generalizing the results of the study on the pensioners to include the whole elderly population of Ghana

40.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Nwodo et al.
	2. Year	2017
	3. Aim	This study investigated the body weight distribution amongst sexes and different age groups in educational institutions in Ota, Southwest Nigeria.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Sex
	6. How are these determinants specified in practice?	**Age (years)** 2 – 5 6 – 12 13 – 19 20 – 39 40 – 49 60 - 75 **Sex** Men Women

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data The age and sex data were collected from participants. Weight (kg) was measured to the nearest 0.01kg using ProduexTM digital balance, Springfield, USA. Height (m) was measured to the nearest 0.001 m using a standard meter rule with the subject standing upright, barefooted and without a cap or headgear.
	10. How was obesity specified in practice?	BMI was calculated as weight (kg)/height (m^2). Obesity was specified as: Underweight (BMI <18.4kgm^2) Normal weight (BMI> 18.5<24.9 kgm^2) Overweight (BMI>25.0<29.9 kgm^2) Obesity (BMI>30.0 kgm^2)
	11. Characteristics of sample	Sample included 609 men and 785 women aged from 2 to 75 years. The participants were randomly selected amongst pupils, students and staff of four educational institutions in Canaanland, Ota: Kingdom Heritage Model School (Crèche, Nursery and Primary), Faith Academy (Secondary), Covenant University Secondary School (Secondary) and Covenant University (Tertiary).
	12 a. What was the sample size?	1394

	b. what was the statistical basis for sample size used?	Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Pearson correlation and linear regression analyses
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Linear regression analysis showed that age (r =0.612, p =0.000) influenced BMI of the subjects.
	19. What are the author-stated challenges?	Did not state

41.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Y. Obirikorang, C. Obirikorang, O.A. Enoch, E. Acheampong, P. Tuboseiyefah, A.A. Miriamand N.B. Emmanuella
	2. Year	2016
	3. Aim	To determine the prevalence and risk factors of obesity among practicing nurses in three selected hospitals in the Kumasi metropolis.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight and Height

		Waist Circumference and Hip Circumference Physical activity Alcohol intake Working under stressful hours
	6. How are these determinants specified in practice?	*Waist circumference*: WC <94 cm, 94-101.9 cm and ≥102 cm defined as normal, overweight and obese respectively for men, and <80 cm, 80-87.9 cm, and ≥88 cm defined as normal, overweight and obese respectively for women. *Waist Hip Circumference:* WHR was also de-fined for both men and women with WHR <0.90, 0.90-0.99 and ≥1.0 defined as normal, overweight and obese respectively for men and <0.80, 0.80-0.84, and ≥0.85 defined as normal, overweight and obese respectively for women. WHtR was also de-fined for both men and women with WHtR < 0.5 and ≥.0.5 defined as normal and obese. Physical activity *Not defined* Alcohol intake *Not defined* Working under stressful hours *Not defined*

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary **(b)** Structured questionnaire was used to obtain information from all study respondents. All study participants were recruited spanning a period of 3 weeks. 825 practicing nurses out 120,143 practicing nurses in the region.
	10. How was obesity specified in practice?	BMI (kg/m2) was categorized, using the current World Health Organization definitions (WHO, 2000). BMI of <18.5 kg/m2, 18.5-24.9 kg/m2, 25-29.9kg/m2 and 30kg/m2 were used to define under-weight, normal, overweight and obese respectively
	11. Characteristics of sample	The average age of the study participant was 31.6 ± 9.7 years. Majority of the nurses (59.4%) were between the ages of 20-29 years. Women comprised 83.9% (692/825) while men made up the remaining 16.1% (133/825). More than half of the participants were single (60.8%). Majority of the nurses (59.4%), Majority of the respondents (49.7%) hold diploma as educational qualification.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	825 practicing nurses were recruited from a population of 120,143 Arbitrarily selected
	13. Which sampling method used?	Simple randomized sampling technique
	15. Which type of statistical method was used?	Independent sample t-test was employed to compare two groups of continuous variables. Categorical data were analysed using Chi-Square test logistic regression was employed to assess the associated risk factors of obesity
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	2- tailed and statistical significance was defined by a p value < 0.05.
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of obesity among nurses was 55.9% by WHtR, 35.7% by WC, 29.4% by BMI classification and 27.3% by WHR classification. The pattern of increased prevalence was higher among women nurses and nurses with high professional rank

		irrespective of the an-thropometric parameters used. Logistic regression model indicates that taking meals late at night [odds ratio (OR) = 2.5 (1.1 to 5.7), p=0.0398], taking meals at stressful hours [OR=7.9 (2.1 to 29.8); p=0.0009], and fast food intake [OR=2.6 (1.1 to 6.0), p=0.0370) were independent risk factors of obesity classified by BMI. Taking meals at stressful hours [OR=3.33 (1.4 to 8.2); p=0.0091] and being women [OR=26.8 (3.5 to 207.7); p<0.0001] were significant independent risk factors of obesity classified by WC. Using WHR, being a fe-men [OR=22.1 (1.31 to 380.0); p=0.0009] was an independent risk factor for obesity. Taking meals late at night [OR=2.4 (1.2 to 4.7); p=0.0121], taking meals at stressful hours [OR=3.1 (1.3 to 7.4); p=0.0148], and physical inactivity [OR=2.2 (1.0 to 4.5); p=0.0478] and being a women [OR=4.6 (1.7 to 12.4), p=0.0024] were independent risk factors of obesity using WHtR. Obesity among nurses in the Kumasi metropolis is on a rise and of public health significance.
	19. What are the author-stated challenges?	None

42.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Christian Obirikorang, Derick Nii Mensah Osakunor1, Enoch Odame Anto, Samuel Opoku Amponsah, Opei Kwafo Adarkwa
	2. Year	2015
	3. Aim	This study described differences in prevalence of obesity and cardio-metabolic risk factors between urban and rural settlements in the Ashanti Region of Ghana.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Biochemical Assays Anthropometric measurements Blood pressure Occupation Type of family
	6. How are these determinants specified in practice?	*Biochemical Assays:* **Plasma glucose** levels were determined using the glucose oxidase method. Serum lipid levels; total cholesterol (TC), triglycerides (TG) and HDL-**cholesterol** (HDL-c) were determined by enzymatic methods on the Selectra Pro "S" System (Elitech Clinical Systems Elitech Group). LDL- *Anthropometric measurements:* **Body weight** (to the nearest 0.1 Kg) in light clothing was measured with a mechanical scale (Hospibrand ZT-120, England). **Heigh**t (to the nearest 0.1 cm) without shoes was

		measured with a commercial stadiometer (SECA, Germany). **Waist circumference (WC)** (to the nearest 0.1 cm) was measured using a measuring tape (Gay Mills, WI), midpoint between the last palpable rib and the suprailiac crest, with the subjects standing and breathing normally. **The hip circumference (HC)** was measured at the outermost points of the greater trochanters . The waist and hip circumferences were measured with the tape parallel to the floor. *Blood pressure*-Hypertension was defined as a systolic blood pressure of _ 140 mmHg and/or diastolic blood pressure was _ 90 mmHg on two occasions, after initial screening (also with newly detected cases). *Occupation:* Formal" jobs were defined as that which encompasses all jobs with normal hours, regular wages. Any such contrary to this was classified as "informal". *Type of family*: individual, nuclear and extended
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary).	Primary Data (B) Interviews were used A total of 672 participants, consisting of 312 urban and 360 rural settlers were recruited via simple random sampling technique. Kumasi consists of 50 towns, of which 10

	b. If primary data, briefly describe method	neighbourhoods were selected at random and 16 households selected at random from each neighbourhood. We selected at least one (1) eligible participant from each household
	10. How was obesity specified in practice?	The body mass index (BMI) was calculated using the formula; weight (Kg) / height (m2). Overall obesity was defined as a BMI of _ 30 Kg/m2 obesity class I, II and III as a BMI of 30–34.9, 35–39.9 and _ 40 Kg/m2 respectively. Percentage body fat (BF%) was estimated using the following formula Adult body fat% = (1.20 × BMI) +(0.23 × Age)-(10.8 × sex) -5.4. The cut-offs for BF% for men and women were _ 25% and _ 30%, respectively
	11. Characteristics of sample	Median age was 50 years and there was no significant difference in age distributions between participants in the urban and rural areas. The majority (62.5%) of families lived in the nuclear family system with a majority average income. There were significant differences between urban and rural participants with respect to gender distribution, marital status, employment, education, average income, type of family, and alcohol intake.
	12 a. What was the sample size?	672

	b. what was the statistical basis for sample size used?	No Based on the division of area into household and the number to pick from each households
	13. Which sampling method used?	Simple random
	15. Which type of statistical method was used?	Categorical variables were expressed as frequencies and proportions. As continuous variables were not normally distributed, a non-parametric tests, the Mann-Whitney test The Chi-square or Fisher's test was used to compare categorical variables as appropriate. Multivariate logistic regression was used Spearman's rho (Rank) correlation was used
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Rank sum test
Empirical findings (objective 5)	18. What are the main findings?	Significant differences in diastolic blood pressure (80.0 mmHg vs 79.5 mmHg; p = 0.0078), and fasting blood sugar (5.0 mmo/l vs 4.5 mmol/l; p < 0.0001) between the two groups. Further differences in anthropometric measures suggested greater adiposity amongst participants in the urban area. Participants in the urban area were more likely than rural participants, to have high total cholesterol and LDL-c (p < 0.0001 respectively). Risk factors including BMI _ 25 (p < 0.0001), BMI _ 30 (p < 0.0001), high waist circumference (p < 0.0001), high waist-toheight ratio (p < 0.0001)

		and alcohol consumption (p 0.0186) were more prevalent amongst participants in the urban area. Markers of adiposity were higher amongst women than men in both areas (p < 0.05). In the urban area, hypertension, diabetes and lifestyle risk factors were more prevalent amongst menthan women. Differences in risk factors by urban / rural residence remained significant after adjusting for gender and age. Obesity and cardio-metabolic risk factors are more prevalent amongst urban settlers, highlighting an urgent need to avert the rise of diet and lifestyle-related chronic disease
	19. What are the author-stated challenges?	None

43.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Mathew Okoh
	2. Year	2013
	3. Aim	To explore the social and demographic factors associated with overweight and obesity among adult women of reproductive age in Nigeria and as such provide information that could help identify the most at-risk group for targeted intervention.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Ethnicity

		Educational status Marriage status frequency of watching television.
	6. How are these determinants specified in practice?	Not specifically defined other than the literal meanings of these variables.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary data **(a)** 2008 NDHS (collected through Questionnaire) Data collection took place over a four-month period from June to October 2008. In the interviewed households, a total of 34,596 women were identified to be eligible for the individual interview, and 33,385 of them were successfully interviewed. For men, 16,722 were identified as eligible in half the households, and 15,486 of them were successfully interviewed. Analysis for this report focused only on women.
	10. How was obesity specified in practice?	BMI of less than 18.5 kg/m2 was defined as underweight, 18.5 to 24.9 kg/m2 was defined as normal weight, 25 to 29.9 kg/m2 was defined as overweight and a BMI of 30 kg/m2 and above was defined as obesity.

	11. Characteristics of sample	Eighteen thousand one hundred and seven women aged 20 to 49 years were included in the analyses. Mean age was 33.5 years and women less than 30 years of age constituted the majority (36%) of the study population. The Hausa/Fulani, Yoruba and Igbo ethnic groups accounted for almost 60% of the study population. Half (50.2%) of the women were of the Islamic faith while 47% practiced the Christian religion. Twenty three percent of the study population had a primary education, 22% had a secondary education and only 7% reported that they received a tertiary education. Seventy percent of the women reported that they were employed. Nine out of ten women were married and median number of childbirth among this study population was four.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	18,107 out of the 33,385 interviewed and captured in the dataset. Exclusion criteria was used to eliminate some of the respondents.

	13. Which sampling method used?	Stratified & simple random method
	15. Which type of statistical method was used?	Chi-square test was use to compare categorical variables for associations multi-nominal logistic regression was used to examine correlates
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Statistical significance was set at p< 0.05 and 95% confidence interval.
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of overweight (BMI 25 to 29.9kg/m2) and obesity (BMI 30kg/m2 and above) in this population were 18.1% and 7.1% respectively. The prevalence of overweight/obesity was highest among Igbo women. Multivariable logistic regression revealed increased frequency of watching television, belonging to a particular ethnic group, having a tertiary education and increased parity as risk factors for increased BMI.
	19. What are the author-stated challenges?	None

44.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Olatunbosun et al.
	2. Year	2010

	3. Aim	To explore the prevalence of obesity and overweight in an urban setting in Ibadan, Nigeria.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Marital status Salary grade Physical activity Smoking Alcohol Family history of hypertension Family history of diabetes
	6. How are these determinants specified in practice?	**Age (years)** 19 – 70 **Gender** Men Women **Marital status** Single Married Divorced Widowed **Salary grade** 1 2 3 **Physical activity** Low High **Smoking** Yes

		No **Alcohol** Yes No **Family history of hypertension** Yes No Not sure **Family history of diabetes** Yes No Not sure
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Structured questionnaire were administered to respondents to collect data on socio-demographics.
	10. How was obesity specified in practice?	Specified in BMI, which was calculated from the weight and height measures of the participants. BMI was categorized according to WHO standard into; Underweight Normal weight Overweight Obese
	11. Characteristics of sample	Sample included men and women civil servants aged from 19 -70 years in Ibadan.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	998 Not stated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Multivariate analysis of variance (ANOVA), logistic regression
	16 what was the theoretical underpinning used in the study	Not indicated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Higher salary grade levels (OR =6.67, p =0.001), alcohol use ≥60g/week (OR =2.78, p =0.001), family history of diabetes (OR =0.38, p =0.001) and hypertension (OR =2.68, p =0.001) were predictive of obesity and overweight in men. Only age (OR =1.04, p =0.008) and higher salary grade levels (OR =4.13, p =0.002) were predictive of obesity and overweight for women.
	19. What are the author-stated challenges?	Study population belongs to occupational group; thus, findings cannot be generalized to the wider population. Widely used International criteria for estimating adiposity are largely based on studies carried out predominantly in Caucasian populations

45.

Headings	Review questions	Responses

General Information (objective 5)	1. Authors	IkeOluwapo O. Ajayi1, Clement Adebamowo, Hans-Olov Adami, Shona Dalal, Megan B. Diamond, Francis Bajunirwe, David Guwatudde, Marina Njelekela, Joan Nankya-Mutyoba, Faraja S. Chiwanga, Jimmy Volmink, Robert Kalyesubula, Carien Laurence, Todd G. Reid, Douglas Dockery, David Hemenway, Donna Spiegelman and Michelle D. Holmes
	2. Year	2016
	3. Aim	To show the collective burden of obesity in sub-Saharan Africa and to determine the differences between urban and rural populations and other socioeconomic factors.
	4. Country	Nigeria; South Africa; Tanzania & Uganda
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Weight Smoking habit Education
	6. How are these determinants specified in practice?	*Height* Measured through standard procedure *Weight* Measured through standard procedure *Smoking habit*

		Old smoker New smoker *Education* Low: secondary level education or less High: university education or above
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Data (b) Questionnaires used These 1463 participants included nurses in two hospitals in Nigeria, school teachers in South Africa and Tanzania, and village residents in one peri-urban and one rural location in Uganda. All sites used random selection for participants. Participants were adults aged 18 years or older.
	10. How was obesity specified in practice?	*Body mass index (BMI) as* We calculated weight in kilograms divided by height in meters squared, and used the standard definitions of Underweight 18.5 Kg/m2 normal weight 18.5–24.9 Kg/m2 overweight 25–29.9 Kg/m2 obese 30 Kg/m2

	11. Characteristics of sample	We enrolled 1463 participants comprising 489 teachers in South Africa (33 %), 276 teachers in Tanzania (19 %), 200 nurses in Nigeria (14 %), 298 community members in peri-urban Uganda (21 %) and 200 in rural Uganda (14 %). The response rates were between 96 % and 99 % across the sites. Out of the 498 in the Uganda sites, two thirds (322, 65 %) of the participants were self-employed, 123 (25.0 %) were unemployed while 49 (9.9 %) were either in government or private employment. All the respondents in Nigeria were employed as nurses and those in South Africa and Tanzania as teachers. Overall, two thirds were women (927, 65 %), 976 (70 %) were currently married/living together and 856 (66.0 %) were classified to have high education. Only 134 (10 %) of the participants mentioned they ever smoked a cigarette. A quarter (351, 25 %) of the participants were in the low socio-economic group while 522 (37 %) were in the high socio-economic group. The mean age of the participants was 41.0 ± 11.1 years and ranged from 18– 80 years. South African and Tanzanian participants were older than those from the other sites.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1463 No These 1463 participants included nurses in two hospitals in Nigeria, school teachers in South Africa and Tanzania, and village residents in one peri-urban and one rural location in Uganda. All sites used random selection for participants.
	13. Which sampling method used?	Simple random
	15. Which type of statistical method was used	Descriptive statistics such as means, standard deviation, median and range for continuous variables and proportions for categorical variables. We then performed univariate and multivariate analyses using binary logistic regression to examine the associations between potential correlates.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	Odds Ratio and 95 % confidence intervals were presented Chisquare goodness of fit test
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of overweight and obese (combined) was 46%, 48 %, 68 %, 75 % and 85 % in rural Uganda, peri-urban Uganda, Nigeria, Tanzania and South Africa (SA), respectively. Rural

		Uganda, Peri- urban Uganda, Nigeria, Tanzania and SA had obesity prevalence of 10 %, 14 %, 31 %, 40 % and 54 %, respectively ($p < 0.001$). Overall, prevalence of overweight was 374 (31 %) and obesity, 414 (34 %). Women sex was a predictor of overweight and obesity (combined) in peri-urban Uganda [AOR = 8.01; 95 % CI: 4.02, 15.96) and obesity in rural Uganda [AOR = 11.22; 95%CI: 2.27, 55.40), peri-urban Uganda [AOR = 27.80; 95 % CI: 7.13, 108.41) and SA [AOR = 2. 17; 95 % CI: 1.19, 4.00). Increasing age was a predictor of BMI > =25 kg/m2 in Nigeria [Age > =45 - AOR = 9.11; 95 % CI: 1.72, 48.16] and SA [AOR = 6.22; 95 % CI: 2.75, 14.07], while marital status was predictor of BMI > =25 kg/m2 only in peri-urban Uganda. [Married - AOR = 4.49; 95 % CI: 1.74, 11.57]. Those in Nigeria [AOR = 2.56; 95 % CI: 1.45, 4.53], SA [AOR = 4.97; 95 % CI: 3.18, 7.78], and Tanzania [AOR = 2.68; 95 % CI: 1.60, 4.49] were more likely to have BMI > =25 kg/m2 compared with the rural and peri-urban sites.
	19. What are the author-stated challenges?	None

46.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Osayomi T. and Orhiere
	2. Year	2017
	3. Aim	Thus, the focus of the study was to determine the small-area variations in the prevalence of overweight and obesity in an urban area of Nigeria and its association with socio-economic, environmental, dietary and lifestyle risk factors.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Sex Age Occupation Education status Ethnicity Marital status Household and neighborhood characteristics (spatial risk factors)
	6. How are these determinants specified in practice?	**Sex** Men women **Age (years)** 18 – 27 28 – 37 38 – 47 48 – 57 58 and above **Occupation** Student Business

		Civil service Unemployed Others **Education status** No formal education Primary education Secondary education Tertiary education **Ethnicity** Yoruba Ibo Hausa Ohers **Marital status** Single Married Divorced/separated/widowed **Household and neighborhood characteristics** vehicle ownership housing tenure (tenants) availability of sidewalks proximity of fast food outlets availability of physical fitness recreational centers
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Information on the demographic, socio-economic, lifestyle, household and

		neighborhood characteristics of respondents was obtained from respondents with the aid of a structured questionnaire. Weight and height measures were self-reported by respondents.
	10. How was obesity specified in practice?	BMI was calculated from the self-reported weight and height measures of participants. It was then categorized into two groups; overweight and obesity.
	11. Characteristics of sample	Sample included men and women from Ibadan North LGA, Nigeria aged from 18 years and above.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	234 Not stated
	13. Which sampling method used?	Systematic sampling technique
	15. Which type of statistical method was used?	simple linear regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Physical proximity to fast food outlets was the only significant factor driving the spatial pattern of obesity (b = 0.645; R2 = 0.416).
	19. What are the author-stated challenges?	The Ibadan North LGA might not be representative of Nigerian urban areas because of differences in cultural, demographic and geographical backgrounds

		Secondly, overweight and obesity were computed based on self-reported height and weight of respondents. Sometimes, these pieces of information are under- or over reported. Furthermore, the BMI formula, though cheap and easy to compute, has its limitations

47.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Hermann Z Oue´draogo, Florence Fournet, Yves Martin-Pre´vel, Jean Gary, Marie C Henry and Ge´rard Salem
	2. Year	2008
	3. Aim	To document the prevalence and the socio-spatial variations of obesity and to identify individual and household characteristics, lifestyles and dietary practices contributing to obesity and its socio-spatial distribution.
	4. Country	Burkina Faso
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Anthropometric measurements Dietary practices Lifestyles
	6. How are these determinants specified in practice?	*Anthropometric measurements* were performed using SECA_R instruments, in accordance with the WHO Recommendation

		Dietary practices Micronutrient-rich food consumption Low/ Middle/ High Sugar-rich food consumption Low/ High Protein-rich food consumption Low /Middle/ High Place of breakfast yesterday Home/ Outside Place of lunch yesterday Home / Outside Place of diner yesterday Home/Outside *Lifestyles* Usual transport with motor vehicle (No/Yes) Walk at least 30 min per day (Yes/ No) Water fetching (Yes /No) Regular participation in sport (Yes/ N0) Physically active (Yes/ No) Social integration (No/ Yes) Current smoking (No/ Yes) Current chewing-tobacco (No/ Yes) Current cola-nut chewing (No/ Yes) Coffee drinking (No/ Yes) Alcohol consumption (No/ Yes)

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Data (b) Questionnaires used In structured areas, parcels were randomly selected using cadastral data and a generated set of random numbers. In unstructured areas, starting points were selected using aerial photographs of Ouagadougou and pairs of generated random numbers, which corresponded to Global Positioning System (GPS) data points. To assess obesity, a sample size of 384 individuals for each stratum was calculated to be adequate for measuring the prevalence of obesity, assuming an expected prevalence of 10% with a precision of 3%.
	10. How was obesity specified in practice?	BMI Obesity was defined as BMI$30 kg/m2.
	11. Characteristics of sample	Age (years) 35–44 911 45–54 510 55–64 343 ≥65 235 Gender

		Men 885 Women 1114 Schooling level Unschooled 1046 Primary 424 Secondary/ more 431
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2022 adults To assess obesity, a sample size of 384 individuals for each stratum was calculated to be adequate for measuring the prevalence of obesity, assuming an expected prevalence of 10% with a precision of 3%.
	13. Which sampling method used?	Simple random method
	15. Which type of statistical method was used?	Principal Components Analysis the Chi-square test bivariate analysis
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	P <0.10. Odds ratios with 95% confidence intervals Wald's $\chi2$ test.
Empirical findings (objective 5)	18. What are the main findings?	The overall prevalence of obesity was 14.7% (men5.5% and women 21.9 %). Age, gender, household equipment index, usual transport with motor vehicles and micronutrient-rich

		food consumption were associated with obesity. After adjustment for these factors, obesity remained associated with the area of residence: residents from SHBD areas were more likely to be obese than those from ULBD areas (OR=51.41; 95% CI 2.59, 4.76
	19. What are the author-stated challenges?	None

48.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Bakare Oyebisi and Motunrayo Funke Olumakaiye
	2. Year	2016
	3. Aim	To assess fast food consumption pattern and body weight status among the undergraduates of Obafemi Awolowo University, Ile-Ife, Nigeria
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Fast food consumption Socio-economic characteristics: Age Sex Education base Length of stay in school Upkeep allowance
	6. How are these determinants specified in practice?	Fast food consumption: Once/week Twice/week Thrice/week Occasionally Everyday

		Age: <18 18-25 ≥26 Sex: men /women Education base: Arts Science Technology Social science Length of stay in school: <1 1 -3 4 and above Upkeep allowance: low <N5,000/month Medium N5,000 – N10,000 Higher >N10,000
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data A 40-item protested self-administered questionnaire consisting of questions relating to the sociodemographic characteristics and knowledge about fats food consumption pattern were responded to by participants. Other items included one week diet recall and the anthropometric measurement of weight and height.

	10. How was obesity specified in practice?	Specified in BMI form the weight and height measures. The BMI was categorized into: Underweight Normal weight Overweight Obese 1 Obese 2 Obese 3
	11. Characteristics of sample	The sample included men and women students aged below 18 years and above from the Obafemi Awolowo University, Ile-Ife, Nigeria during the rain semester in 2011/2012 session.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	360 Not indicated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Descriptive bivariate and regression analysis
	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None indicated
Empirical findings (objective 5)	18. What are the main findings?	There was a significant relationship between fast food consumption and obesity (r=0.47, p =0.0001).
	19. What are the author-stated challenges?	Did not state any limitations or challenges

49.

Headings	Review questions	Responses

General Information (objective 5)	1. Authors	Adewale L. Oyeyemi; Benedicte Deforche; James F. Sallis; Ilse De Bourdeaudhuij; Delfien Van Dyck.
	2. Year	2013
	3. Aim	This study investigated the mediating effects of PA and sedentary time on the associations of neighbourhood environmental factors and body mass index (BMI) among Nigerian adults.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Height Weight PA (Physical Activity) and Sitting Time Environmental Assessment. Socio-demographic Characteristics
	6. How are these determinants specified in practice?	***Height*** was measured to the nearest .1 cm with participants barefoot and standing upright against a Holtain portable stadiometer (Crymych, United Kingdom). ***Weight*** Was measured to the nearest kilogram, with participants lightly dressed using a portable digital scale calibrated from 0 to 120 kg. ***PA (Physical Activity) and Sitting Time*** The seven-item short version of the International Physical Activity Questionnaire

		(IPAQ-SF) was used to assess participants' self-reported PA. Four independent variables—the total minutes of walking, MVPA, total PA in a week (MET-min/wk), and sitting time per day—were used in analyses. ***Environmental Assessment***. An adapted version of the Physical Activity Neighbourhood Environment Scale (PANES) was used to assess participants' perception of neighbourhood environmental factors. Neighbourhood environmental variables assessed by the adapted included (1) residential density (2) access to destinations, (3) connectivity of the street network, (4) infrastructures for PA and walking, (4) social environment, (5) aesthetics, and (6) neighbourhood safety ***Socio-demographic Characteristics*** *Educational level* was classified as: more than secondary school education, secondary school education (middle and high school), and less than secondary school education. *Employment status* was classified into: employed (government/ private and self-employed) unemployed (homemaker, student, retired, or unable to find a job).
		Primary Data

	7. How was data on these determinants collected? o. What is the dataset used? (if method of data collection is secondary). p. If primary data, briefly describe method	Questionnaire used 1. Localities in Maiduguri were categorized into high and low socioeconomic status (SES). 2. The planning expert made summary judgments based on direct observation, local knowledge and professional background. 3. Fifteen neighbourhoods of each type were randomly selected (lottery method). In each of the randomly selected neighbourhoods, households were enumerated on site, and all adults living in every odd numbered house were invited through home visits to participate in the study.
	10. How was obesity specified in practice?	BMI was calculated as weight (kg) divided by the square of the height (m2). The World Health Organization principal cut-off points for BMI were used to create the categories: underweight (,18.5 kg/m2), normal weight (18.5 to ,25 kg/m2), overweight (25 to ,30 kg/m2), obese (.30 kg/m2)

	11. Characteristics of sample	The participants' mean age and BMI were 35.9 ±6 9.6 years and 24.3± 6 4.2 kg/m2, respectively, and the sample consisted of 43.1% women and 56.9% men. There was slight overrepresentation of unemployed adults (36.8%) and adults with at least a secondary school education (39.8%) 59.2% of the participants in the present study walk 150 minutes per week. The participants reported a mean sitting time of about 5 hours per day.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1411 1. 2970 individuals contacted for the study 2. 2057 agreed to participate. Among the individuals who agreed to participate, 1411 provided full information on PA behaviours and environmental variables. only 1411 participants provided complete survey data and were included in the analysis.
	13. Which sampling method used?	Simple random Simple stratified
	15. Which type of statistical method was used?	The product-of-coefficient test of McKinnon and colleagues

		Generalized Linear Models
	16 what was the theoretical underpinning used in the study	The seven-item short version of the International Physical Activity Questionnaire (IPAQ-SF) An adapted version of the Physical Activity Neighbourhood Environment Scale (PANES)
	17. Which statistical model diagnostics tests were reported?	For all analyses, 95% confidence intervals (CIs) were reported. All analyses were controlled for possible confounders: gender, age, working status, and educational attainment
Empirical findings (objective 5)	18. What are the main findings?	Walking and total PA significantly mediated the association between BMI and perception of higher residential density (ab ¼_.025 and _.037, respectively), absence of garbage (ab ¼_.046 and _.076, respectively), and more safety from crime at night (ab ¼ _.044 and _.083, respectively). In addition, walking, moderate to vigorous PA, and total PA significantly mediated the association between BMI and perception of better aesthetics (ab ¼ _.035, _.022, and _.071, respectively). Sedentary time was not a significant mediator of any associations between environmental factors and BMI.
	19. What are the author-stated challenges?	None

50.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Adewale L. Oyeyemi and Babatunde Adegoke

	2. Year	2012
	3. Aim	To examine associations between neighborhood environment variables and overweight in Nigeria adults.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	**Sociodemographic characteristics:** age, gender, marital status, ethnic group, educational level, employment status, monthly income (naira). **Environmental factors:** Residential density, Access to commercial places, Access to non-residential places, Access to public transport, Presence of recreational centers, Presence of pedestrian pathways, Maintenance of pathways, Presence of beautiful things, Absence of unattended animals, Absence of garbage and foul odors, Seeing people active, Connectivity of street, Traffic safety for bicycling, Traffic safety for walking, Crime Safety during the day, Crime safety at night.
	6. How are these determinants specified in practice?	**Socio-demographic variables** Age (years): 25 – 65 Gender: men/women Marital status: married/single Ethnic group: Hausa/Fulani/ Kanui/shuwa Others Educational level: >secondary school Secondary school <secondary school Employment status: Employed/ unemployed Monthly income: <N15,000

		N16,000 – N45,000 N46,000 – N90,000 >N90,000. **Environmental variables** **Residential density** Low High **Access to commercial places** Disagree Agree **Access to non-residential places** Disagree Agree **Access to public transport** Disagree Agree **Presence of recreational centers** Disagree Agree **Presence of pedestrian pathways** Disagree Agree **Maintenance of pathways** Poor Good **Presence of beautiful things** Disagree Agree **Absence of unattended animals** Disagree Agree **Absence of garbage and foul odors** Disagree

		Agree **Seeing people active** Disagree Agree **Connectivity of street** Poor Good **Traffic safety for bicycling** Not safe Safe **Traffic safety for walking** Not safe Safe **Crime Safety during the day** Not safe Safe
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data An adapted self-administered version of the Physical Activity Neighborhood Environment Scale (PANES) was used to assess participants' perception of neighborhood environmental factors. The 17-item PANES was originally designed by the International Physical Activity Prevalence Study group for brief assessment of variables believed to be

		related to the activity-friendliness of neighborhoods.
	10. How was obesity specified in practice?	BMI calculated as weight (kg) divided by the square of the height (m^2). BMI was categorized into underweight (< 18.5 kg/m^2) normal weight (18.5- < 25 kg/m^2) overweight (25- < 30 kg/m^2) obese (> 30 kg/m^2)
	11. Characteristics of sample	Samples included men and women from age 25 to 65 years systematically recruited from 38 neighbourhoods categorized into high and low socioeconomic status (SES) by the ministry of urban planning and development in Maiduguri, Nigeria.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1818 Not stated
	13. Which sampling method used?	Not stated
	15. Which type of statistical method was used?	Descriptive, Bivariate and logistic regression analysis
	16 what was the theoretical underpinning used in the study	The ecological model
	17. Which statistical model diagnostics tests were reported?	Not stated
Empirical findings (objective 5)	18. What are the main findings?	After adjustment for sociodemographic variables, overweight was associated with distant access to commercial facilities (odds ratio [OR], 1.49; 95% confidence interval [CI], 1.02- 2.18), poor neighbourhood

		aesthetics (OR, 1.58; 95% CI, 1.16-2.09), perceiving garbage and offensive odours in the neighbourhood (OR, 1.41; 95% CI, 1.05-1.89) and feeling unsafe from crime at night (OR, 1.47; 95% CI, 1.13- 1.91) and unsafe from traffic (OR, 1.56; 95% CI, 1.17-2.07) in the total sample. Significant interactions regarding overweight were found between gender and four environmental variables, with low residential density (OR, 1.39; 95% CI, 1.02-1.93) and poorly maintained pedestrian pathways (OR, 1.89; 95% CI, 1.13-3.17) associated with overweight in men only, and absence of beautiful things (OR, 2.23; 95% CI, 1.42-3.50) and high traffic making it unsafe to walk (OR, 2.39; 95% CI, 1.49-3.83) associated with overweight in women only.
	19. What are the author-stated challenges?	Perceived, as opposed to objective, measures of neighbourhood environments were used. This limited the study because previous studies have reported limited agreement between perceived and objective measures of neighbourhood characteristics, but it is not known which is more important to overweight and obesity. Also, the study did not include measures of the food environment, which may be important in explaining obesity. Adjustment was made for neighbourhood SES in the analysis, and the interactions of neighbourhood SES with environmental variables for overweight were explored, however, neighbourhood SES

		variables may cofound the outcome variables in this study. In addition, participants were younger on the average and were recruited from a single city, which may compromise environmental variability and limit generalization of findings to other African countries. Finally, the cross-sectional design utilized does not allow for causal relationships to be determined.

51.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Pasquet et al.
	2. Year	2003
	3. Aim	To examine the current prevalence of overweight and obesity in Yaoundé, the capital city of Cameroon and search for possible causal factors
	4. Country	Cameroon
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Sex Age Education level Occupation length of residence in Yaoundé Ethnicity Parity Smoking practice Physical activity pattern
	6. How are these determinants specified in practice?	**Sex** Men Women **Age (years)**

		20 – 29 30 – 39 40 – 49 50 – 59 ≥60 **Education level** Illiterate Primary Secondary High **Occupation** No activity Agriculturalist Trader Executive/professional Other occupation **length of residence in Yaoundé** <5 years ≥ 5years **Ethnicity** Beti-Fang Bamileke Other ethnicities **Parity** <4 ≥ 4 **Smoking practice** Never smoked Stopped smoking Currently smoking **Physical activity pattern** Regular sport and/or more than 2h walking per day

		No sport and less than 2h walking per day
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Interviewer-administered questionnaires on socio-demography, smoking habits, physical activity, self-perception of body weight and health status were filled by participants. Their weight was measured with a digital scale to the nearest 100g, and their height was measured with a stadiometer to the nearest millimetre. Waist and hip circumference were measured with a tape measure.
	10. How was obesity specified in practice?	BMI calculated from the weight and height measures of the participants and categorized as Overweight: BMI $\geq 25kg/m^2$ Obesity: BMI $\geq 30kg/m^2$
	11. Characteristics of sample	Sample included all men and women 20 years and above. Pregnant and lactating mothers were excluded from sample.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	771 Not indicated
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Logistic regression model

	16 what was the theoretical underpinning used in the study	Non stated
	17. Which statistical model diagnostics tests were reported?	None indicated
Empirical findings (objective 5)	18. What are the main findings?	The length of residence in Yaoundé (OR =2.0, 95%CI = 1.1 – 3.8) increasing education level (OR =2.7, 95%CI = 1.3 – 5.6), occupation (OR =1.9, 95%CI = 1.1 – 3.6), ethnicity (OR =2.4, 95%CI = 1.3 – 4.4) physical inactivity (OR =1.5, 95%CI = 1.1 – 2.2) and smoking practices (OR =0.5, 95%CI = 0.3 – 0.8) appear to influence early overweight and/or obesity
	19. What are the author-stated challenges?	Study design is cross-sectional; thus no causal inferences can be drawn.

52.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Peltzer et al.
	2. Year	2014
	3. Aim	To determine the prevalence of overweight/obesity and its associated factors among university students in 22 low- and middle-income countries and emerging economy countries
	4. Country	Ivory Coast, Nigeria.
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Wealth Country income classification Organized religious activity Social support Dietary variables Health risk behavior

	6. How are these determinants specified in practice?	Age: 16-19/ 20-21/ 22 or more Gender: Men/women Wealth: Wealthy/ quite well off/ not well off/ poor Country income classification: Low income, lower middle income, upper middle income, high income. Organized religious activity: low/ medium/ high Social support: Low/ medium/ High. Dietary variables: Eats red meat at least once a day Try to eat fiber Avoids fat and cholesterol Fruits and vegetables (<5 times/day) Skipping breakfast Number of meals a day Number of in-between snacks Health risk behavior: Physical activity (low/ moderate/high) Current tobacco use Binge drinking (past month)
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary).	Primary

	b. If primary data, briefly describe method	Participants responded to anonymous self-administered questionnaires. Research assistants helped participating students to respond to questionnaires in selected universities.
	10. How was obesity specified in practice?	BMI
	11. Characteristics of sample	Samples were selected from 22 universities. They were aged from 16 to 30 and above. Participants were both men and women.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	396 from Ivory Coast 439 from Nigeria Not indicated
	13. Which sampling method used?	Stratified random sampling
	15. Which type of statistical method was used?	Multivariate logistic regression
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Women who are 22years or more are significantly associated with obesity (AOR =1.38, CI: 1.18-1.60). Women in high organized religious activity are significantly associated with overweight and obesity (AOR =1.22, CI =1.03-1.47).
	19. What are the author-stated challenges?	Study population (university students) are not representative of young adults in general. Study is cross-sectional and the temporal relationships between health behavior

		practices and social and health status cannot be established in such studies.

53.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Ramsay et al.
	2. Year	2009
	3. Aim	To compare regional and sex-specific body mass index (BMI) distributions, using a cross-sectional study design, in adults aged 40–60 years across six study sites in four sub-Saharan African (SSA) countries and to compare the determinants of BMI at each.
	4. Country	Ghana, Burkina Faso
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age sex ethnicity socio-economic status household crowding education level marital status physical activity sedentary time night-time sleep duration smoking use of smokeless tobacco dietary intake alcohol intake pesticide use HIV and TB status Parity Menopausal stage

	6. How are these determinants specified in practice?	**Age** 40 – 60 years **Sex** Men Women **The study did not specify the variables below** Ethnicity socio-economic status household crowding education level marital status physical activity sedentary time night time sleep duration smoking use of smokeless tobacco dietary intake alcohol intake pesticide use HIV and TB status Parity Menopausal stage
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Questionnaires were used to collect the demographic variables while the weight and height of the participants were measured with

		a weighing scale and a stadiometer respectively.
	10. How was obesity specified in practice?	Calculated from the weight and height measures of the participants. It was categorized into four categories; underweight, lean, overweight and obesity, according to WHO standard.
	11. Characteristics of sample	The sample included men and women adult population aged 40 – 60 years from Navrongo in Ghana and Nanoro in Burkina Faso.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1,968 Not stated
	13. Which sampling method used?	Not stated
	15. Which type of statistical method was used?	Descriptive, bivariate and multiple linear regression (Sex-stratified hierarchical models)
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	
Empirical findings (objective 5)	18. What are the main findings?	Across Navrongo (R^2 = 0.20) and Nanoro (R^2 = 0.20), men with higher socioeconomic and educational level were associated with higher BMI.
	19. What are the author-stated challenges?	There is limitation in the generalizability of the findings of thus study

54.

Headings	Review questions	Responses

General Information (objective 5)	1. Authors	Fahad Razak; Daniel J. Corsi; Arthur S. Slutsky; Anura Kurpad; Lisa Berkman; Andreas Laupacis; S. V. Subramanian
	2. Year	2015
	3. Aim	To determine the prevalence and distribution of BMI lower than 16 and its change in prevalence over time in women in LMIC.
	4. Country	West Africa and beyond (LMIC)
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Weight Height Demographic variables Socioeconomic variables
	6. How are these determinants specified in practice?	*Weight* weighed wearing light-fitting clothing and without shoes using digital scales (seca 874 digital floor scale, seca) with precision to 0.01 kg. *Height* Standing height was measured without shoes using adjustable measuring boards (ShorrBoard) designed for use in survey settings and recorded to the nearest 0.1 cm. *Demographic variables* Age

		Area of residence (urban or rural, using country-specific definitions), Education was divided into 3 ordinal categories: none or incomplete primary, primary, or secondary or higher. *Socioeconomic variables*: Wealth was defined using an asset index developed for the DHS program. This index was developed within each country using a standardized list of assets and utilities, with creation of a score via factor analyses. Wealth was divided into quintiles and treated as an ordinal variable.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary (a) Data were obtained from the Demographic and Health Surveys (DHS) program. This study used 2 data sets and analyses. The first was a cross-sectional data analysis across countries where at least 1 survey was completed. The second was

		a repeated cross-sectional analysis of data from countries that had at least 2 surveys. If a country had more than 2 surveys available, the first and last survey year were used to construct this data set.
	10. How was obesity specified in practice?	*BMI* BMI lower than 16 were age-standardized to the World Health Organization's standard population for 2000-2025 using the direct method. BMI, body mass index (calculated as weight in kilograms divided by height in meters squared)
	11. Characteristics of sample	Age 20-29 206, 396 30-39 166, 067 40-49 128, 298 Education None 139, 242 Primary 135, 848 Secondary or more 225, 671 Area of residence Urban 226, 674 Rural 274, 087
	12 a. What was the sample size?	7948

	b. what was the statistical basis for sample size used?	Estimates of the total population of women with a BMI lower than 16 were constructed using United Nations' country population estimates22 of the total number of women aged 20 through 49 years. The weighted prevalence of BMI lower than 16 was multiplied against the total population of women aged 20 through 49 years for the matching survey year.
	13. Which sampling method used?	Simple stratified
	15. Which type of statistical method was used?	A logistic regression analysis was conducted on the pooled data set to examine factors associated with BMI lower than 16. Fixed-effects model to account for between-country differences, including year of survey. Pearson product-moment correlation coefficient was calculated between last survey year and change in prevalence of BMI lower than 16 to detect whether there was an association between these variables.
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	$\chi 2$ test significant (*P* <.05) 95% CIs
Empirical findings (objective 5)	18. What are the main findings?	BMI lower than 16 remains a critically important public health entity. BMI lower than 16 was associated poverty and low education. Second, the prevalence of BMI lower than 16

		was not decreasing in most countries. The prevalence and total population burden of individuals with BMI lower than 16 remains high globally. The highest prevalence rates of BMI lower than 16 were found across multiple regions of South Asia and Sub-Saharan Africa. The increased risk of mortality among those with a BMI lower than 16 exceeds the increased risk associated with being overweight or obesity.
	19. What are the author-stated challenges?	×This cross-sectional analysis is based on survey data spanning 2 decades.

55.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Smith et al.
	2. Year	2017
	3. Aim	To determine the association between ABO blood group and BMI in a Ghanaian population
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender ABO Blood groups Rhesus factor
	6. How are these determinants specified in practice?	**Age (years)** ≤20 21 – 25 26 – 30 >30

		Gender Men Women **ABO blood group** A AB B O **Rhesus** Negative Positive
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary data Blood samples were collected for ABO group analysis while weight and height were measured with a weight measuring scale and a Shahe stature meter respectively.
	10. How was obesity specified in practice?	BMI =weight (kg)/height (m)^2. BMI categorization Underweight Normal weight Overweight obese
	11. Characteristics of sample	Sample included 238 men and 174 women students from KNUST university in Ghana. They aged from 18 – 46 years.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	412 A total of 412 participants were recruited from a population of 40,000 students at KNUST using an assumed distribution response rate among the respondents at 50%, at 95% confidence interval (*z*-score 1.96). Using the Cochran formula [41], the minimum size required was 381; however, to accommodate a nonresponse rate of 10.0% and stronger statistical power and effect size, the sample size was projected to 412 students.
	13. Which sampling method used?	Simple random sampling
	15. Which type of statistical method was used?	Bivariate analysis (Pearson chi square)
	16 what was the theoretical underpinning used in the study	Not stated
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	The study did not observe any significant difference by association of ABO blood group with gender (p= 0.973), BMI (p= 0.307), or Rhesus status (p =0.723)
	19. What are the author-stated challenges?	Being an institutional-based cross-sectional study, we recognize that making generalization of our findings to the Ghanaian population may be inappropriate.

56.

Headings	Review questions	Responses

General Information (objective 5)	1. Authors	Roger Sodjinou, Victoire Agueh, Benjamin Fayomi, Hélène Delisle
	2. Year	2008
	3. Aim	To assessed the rate of obesity and other cardiovascular disease (CVD) risk factors in a random sample of 200 urban adults in Benin and explored the associations between these factors and socio-economic status (SES)
	4. Country	Benin
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Diet quality score Alcohol consumption score Smoking score Household amenities Physical activity score
	6. How are these determinants specified in practice?	*Diet quality score:* Dietary intake was assessed through three non-consecutive 24-h food recalls conducted over an average period of one month. *Smoking Score*: smoking status and number of cigarettes smoked daily. Four categories were identified: current smokers ≥10 cigarettes/day, current smokers <10 cigarettes/day

		Alcohol consumption score: Alcohol consumption was assessed by questioning the subjects about their habitual drinking patterns. Subjects were asked about the average daily amount of alcoholic beverages. A standard unit of one drink was used to assist respondents: 1 bottle of beer (33cl), 1 glass of wine (11cl) or 1 shot of distilled spirit (3.5cl). *Physical activity score:* Data on physical activity was collected with three 24-hour recalls of activities. A physical activity score was computed taking account of both the intensity (light, moderate or vigorous) and the duration of physical activity. *Household amenities:* Household asset ownership was used as a proxy measure for income because in developing country settings it better reflects economic status than income. Ten variables deemed appropriate for the Benin context were used: type of latrine, floor, roof, and sidewalls; type of fuel used for cooking; presence in the home of a paid domestic helper, electricity, television set, house phone, and fridge.
	7. How was data on these determinants collected?	Primary Data **(b)** Cotonou is divided into 140 neighbourhoods of approximately equal population size. Ten

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	neighbourhoods were picked at random. The administrative maps of the selected neighbourhoods allowed the random selection of 20 households in each of them. One subject was randomly selected among the eligible members of every household during home visits. We alternated men and women to have an equal number of subjects for each sex. Overall, 100 men and 100 women participated in the study. Data collected through Interviews
	10. How was obesity specified in practice?	BMI was calculated as weight in kilograms divided by height in meters square. Overall obesity was defined as a BMI ≥ 30 Abdominal obesity was defined as a waist circumference of ≥ 102 cm in men or ≥88 cm in women according to WHO
	11. Characteristics of sample	Men (n = 100) Women (n = 100) Birthplace (%) Rural 35.5 Urban 64.5 Education level (%) None A= 17 M= 6 F= 28 Primary A= 29.5 M=24 F=35 Secondary/ A= 53.5 M=70 F=37 Occupation (%)

		Unskilled A=62 M=57 F=67 Semi-skilled A =12.5 M=13 F=12 Skilled A=25.5 M=30 F=21 Household amenities (%) Low A=23.5 M=18 F=29 Medium A= 47 M=54 F=40 High A=29.5 M=28 F=31
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	200 *Not mathematically selected The study was conducted in the city of Cotonou, with an estimated population of one million inhabitants. Eligible participants were born-Beninese adults aged 25 to 60 years Cotonou is divided into 140 neighbourhoods of approximately equal population size. Ten neighbourhoods were picked at random. The administrative maps of the selected neighbourhoods allowed the random selection of 20 households in each of them.
	13. Which sampling method used?	Simple Random Cross sectional
	15. Which type of statistical method was used?	Two-tailed t-test. The chi-square test

			Logistic regression Multiple linear regression analyses
	16 what was the theoretical underpinning used in the study		lifestyle index as developed recently by Kim et al 2004
	17. Which statistical model diagnostics tests were reported?		Holsmer-Lemshow test
Empirical findings (objective 5)	18. What are the main findings?		The most prevalent CVD risk factors were overall obesity (18%), abdominal obesity (32%), hypertension (23%), and low HDL-cholesterol (13%). Diabetes and hypertriglyceridemia were uncommon. The prevalence of overall obesity was roughly four times higher in women than in men (28 vs. 8%). After controlling for age and sex, the odds of obesity increased significantly with SES, while a longer exposure to the urban environment was associated with higher odds of hypertension. Of the single lifestyle factors examined, physical activity was the most strongly associated with several CVD risk factors. Logistic regression analyses revealed that the likelihood of obesity and hypertension decreased significantly as the OLS improved, while controlling for potential confounding factors.
	19. What are the author-stated challenges?		None

57.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Silvia Stringhini, Terrence E. Forrester, Jacob Plange-Rhule, Estelle V. Lambert4, Bharathi Viswanathan,Walter Riesen6, Wolfgang Korte; Naomi Levitt, Liping Tong, Lara R. Dugas, David Shoham, Ramon A. Durazo-Arvizu, Amy Luke and Pascal Bovet.
	2. Year	2016
	3. Aim	TO examine the association of education and wealth with several NCD-RFs (smoking, physical activity, alcohol abuse, obesity, hypertension, high cholesterol and high blood glucose) in young adults (25–45 years) in five populations of African descent.
	4. Country	Ghana, South Africa, Jamaica, Seychelles, United States
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Smoking Physical activity Weight Height Hypertension Socio-economic indicators
	6. How are these determinants specified in practice?	*Smoking* was assessed by an administered structured questionnaire. Current smokers refer to participants reporting smoking at least one cigarette per day. *Physical activity*

		was measured using an accelerometer (Actical, Phillips Respironics, Bend, OR, USA), with participants wearing the accelerometer at all times during 8 days Data were obtained based on six complete days of activity. *Weight* was measured to the nearest 0.1 kg using the same standard calibrated weighing scale at all 5 sites (Seca 770, Hamburg, Germany). *Height* was measured to the nearest 0.1 cm using a stadiometer (Invicta Stadiometer, Invicta, London, UK) with the participant's head held in the Frankfort plane. *Socio-economic indicators* Two indicators of SES were used: education and a proxy measure of wealth several questions assessing the household's ownership of a number of assets (iron, fridge, cable, etc.).
	7. How was data on these determinants collected?	Primary Data (b) 500 participants were enrolled in each of five study sites: rural Ghana, urban Jamaica, urban South Africa, the Seychelles and Maywood

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	(suburb of Chicago, IL, USA). For recruitment; a simple random sample and age-stratified random sample was used.
	10. How was obesity specified in practice?	*BMI* Weight and height to calculate body mass index (BMI,kg/m2). Obesity was defined as BMI ≥ 30 kg/m2. Systolic and diastolic blood pressures were measured using an automatic digital blood pressure monitor in all sites. Hypertension was defined as systolic/diastolic BP ≥ 140/90 mmHg.
	11. Characteristics of sample	55 % of the participants are women 26.2 % were current smokers overall, the prevalence of smoking being highest in the USA sample and lowest in the Ghanaian sample. The same pattern was observed for obesity. About 40 % of participants were physically active. The prevalence of physical activity was higher among individuals with low education in most sites apart from South Africa. Obesity was more prevalent among individuals with middle education in all sites; hypertension among individuals with low education in the USA, Ghanaian and Jamaican samples and among those with high education in the South African and Seychelles samples.

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	2180 500 participants were enrolled in each of five study sites: rural Ghana, urban Jamaica, urban South Africa, the Seychelles and Maywood (suburb of Chicago, IL, USA). For recruitment; a simple random sample and age-stratified random sample was used.
	13. Which sampling method used?	Simple random sample and age-stratified random sample was used.
	15. Which type of statistical method was used?	Least squares linear regression Descriptive analysis : Mean, percentages and Standard deviation
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	The prevalence of NCD-RFs differed between these populations from five countries (e.g., lower prevalence of smoking, obesity and hypertension in rural Ghana) and by sex (e.g., higher prevalence of smoking and physical activity in men and of obesity in women in most populations). Smoking and physical activity were associated with low SES in most populations. The associations of SES with obesity, hypertension, cholesterol and

		elevated blood glucose differed by population, sex, and SES indicator. For example, the prevalence of elevated blood glucose tended to be associated with low education, but not with wealth, in Seychelles and USA. The association of SES with obesity and cholesterol was direct in some populations but inverse in others.
	19. What are the author-stated challenges?	None

58.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Derek Anamaale Tuoyire
	2. Year	2018
	3. Aim	To explore the association between TV exposure and overweight/obesity among Ghanaian women.
	4. Country	Ghana
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Presence of TV Frequency of viewing TV Demographic variables
	6. How are these determinants specified in practice?	*Presence of TV* TV in the household of respondents Yes No *Frequency of viewing TV*

		not at all (No exposure) less than once a week (Moderate Exposure) at least once a week (High Exposure) *Educational level* No education, primary, middle/junior secondary school /junior high school (JHS), and secondary/higher *Marital status* never married/ married & cohabiting/ divorced/widowed/separated *Occupation* not working/ professional/managerial/ sales/trade, agricultural/ manual labour *Wealth quintile* poorest, poorer, middle, rich and richest *Type of locality* Rural urban
	7. How was data on these determinants collected?	Secondary Data (a) 2014 GDHS by Ghana Statistical Service (GSS), Ghana Health Service (GHS), and

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Inner-City Fund (ICF) International. Specifically, the women's dataset was used given that they constituted the population of interest in this study.
	10. How was obesity specified in practice?	BMI World Health Organisation's (WHO) BMI cut-off points underweight, < 18.5 kg/m2; normal weight, 18.5–25 kg/m2; overweight, 25.0–29.9 kg/m2; obese, ≥ 30.0 kg/m2
	11. Characteristics of sample	All Women *Age* 15–24 1445 25–34 1242 35–44 1062 45+ 410 *Education* No education 794 Primary 765 Middle/JHS 1710 Secondary/higher 2 889 *Marital status* Never married 1408 Married 1699 Cohabiting 585 Wid/div/sep 466

	12 a. What was the sample size? b. what was the statistical basis for sample size used?	4158 The GDHS collected the data using a two-staged stratified random sampling procedure. At the initial stage, clusters were selected using systematic random sampling. The sampling frame for selection of the clusters was an updated list of enumeration areas used in the 2010 Ghana.
	13. Which sampling method used?	stratified random sampling procedure
	15. Which type of statistical method was used?	The descriptive analysis used percentages to estimate the prevalence of TV exposure and overweight/obesity in relation to the characteristics of women in the study. In the second level of analysis, two binary logistic regression models were conducted
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	OR Odds Ratios; 95% confidence intervals
Empirical findings (objective 5)	18. What are the main findings?	Despite controlling for other factors (age educational level, marital status, wealth quintile, occupation, type of locality, and parity), the results show that women with TV in their households, and with high TV exposure were significantly (P < 0.05) more likely (OR = 1.39, 95% CI = 1.002, 1.923) to be overweight/obese compared to those with

		no TV in their households, and no TV exposure.
	19. What are the author-stated challenges?	None

59.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Tyrovolas et al.
	2. Year	2016
	3. Aim	To evaluate the factors associated with low skeletal muscle mass (SMM), sarcopenia and sarcopenic obesity using nationally representative samples of people aged >65years from diverse geographic regions of the world
	4. Country	Ghana, South Africa, Russia, Spain, China, Mexico
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Sex Education Wealth Current drinker Current smoker Physical activity Number of chronic conditions
	6. How are these determinants specified in practice?	Age (years): 65 -69 70 – 74 75 – 79 >80 Sex: Women/men Education: ≤primary Secondary ≥Tertiary

		Wealth: poorest Poorer Middle Richer Richest Current drinker: Yes/NO Current smoker: Yes/NO Physical activity: High Middle Low Number of chronic conditions: 0/ 1/ 2/ ≥3
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary data COURAGE and SAGE surveys
	10. How was obesity specified in practice?	BMI from weight and height measures.
	11. Characteristics of sample	Sample included both men and women aged 65 years old and above from 6 countries: Ghana, China, Russia, Mexico, Spain and South Africa.
	12 a. What was the sample size?	1,975 (Ghana) Not indicated

	b. what was the statistical basis for sample size used?	
	13. Which sampling method used?	None
	15. Which type of statistical method was used?	Descriptive, bivariate and multivariable regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	Compared to high levels of physical activity, low levels were related with higher odds for sarcopenia (OR =1.36, 95%CI= 1.11 – 1.67) and sarcopenic obesity (OR =1.80, CI =1.23 – 2.64) in the overall sample.
	19. What are the author-stated challenges?	Cross-sectional study limits the potential for etiological conclusion. Also, estimates of %body fat and appendicular skeletal muscle mass were based on population equations and not direct assessment. Also, the use of indirect assessment of lean mass is common in population-based studies as most of these direct methods are too costly or impracticable for community-based research. Next, we used fast walking speed rather than usual walking speed as an indicator of muscle performance whereas most previous research has used the latter. Finally, despite the fact that nutrition and specific food consumption, such as protein in-take, are strongly associated with muscle mass, the survey did not include detailed dietary assessment.

60.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Ukegbu et al,
	2. Year	2017
	3. Aim	To assess prevalence of overweight and obesity and associated factors in a group of university undergraduates in south-east Nigeria
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Gender Level in school Monthly allowance Number of meals Consumption of unhealthy snack foods Soft drink consumption Weekly alcohol consumption Hypertension
	6. How are these determinants specified in practice?	Age: 18-22, 22-25, 25-30 Gender: men/women Level in school: 100 level, 200 level, 300 level, 400 level, 500 level Monthly allowance: <N5,000/ N5, 000 – N10,000, N10,001 – N15,000, N15, 001 – N20,000, >N20,000. Number of meals: one/two/three/ >3 Consumption of unhealthy snack foods: ≤3times/week, ≥3times/week, not at all. Soft drink consumption: ≤3times/week, ≥3times/week, not at all. Weekly alcohol consumption: Yes/No Hypertension: systolic and diastolic pressure.

	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Primary Structured questionnaire designed to obtain information on socio-demographic characteristics, dietary habits and lifestyles pattern.
	10. How was obesity specified in practice?	Anthropometric measure for BMI (weight (kg)/height (m)^2) Waist(cm) to hip(cm) ratio (WHR)
	11. Characteristics of sample	Sample were selected from five tertiary institutions in south-eastern states of Nigeria. It included both men and women. Sample excluded pregnancy or lactation in women, presence of any form of physical disability and suffering from any form of chronic illness.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	1610 Sample size was calculated with the Araoye formula: $N = z^2 \times P\ (100 – p) / x^2$.
	13. Which sampling method used?	Multistage sampling.
	15. Which type of statistical method was used?	Descriptive and Bivariate analysis (chi square test (X^2)

	16 what was the theoretical underpinning used in the study	None stated
	17. Which statistical model diagnostics tests were reported?	None stated
Empirical findings (objective 5)	18. What are the main findings?	Consumption of unhealthy snack foods (X^2 =13.39, p=0.037), being women (X^2 =47.91, p =0.000), first year student (X^2 =41.82, p=0.000) and having high systolic (X^2 =88.18, p=0.000) and diastolic (X^2 =10.17, p=0.000) pressure were associated with obesity
	19. What are the author-stated challenges?	There was limitation with the blood pressures measures because they were measured only on a single visit and using an oscillometric device, rather than measurements on three separate visits using the auscultation protocols which is the gold standard methods of assessing blood pressures.

61.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Kolawole W Wahab, Mahmoud U Sani, Bashir O Yusuf, Maruf Gbadamosi, Akeem Gbadamosi, Mahmoud I Yandutse
	2. Year	2011
	3. Aim	The aims of this study were therefore to determine the prevalence of overweight and obesity and also determine the factors that would independently predict obesity among

		apparently healthy adult Nigerians in the north western city of Katsina.
	4. Country	Nigeria
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	age, sex, current history of alcohol or tobacco use, hypertension and diabetes mellitus
	6. How are these determinants specified in practice?	BMI of 18.5-24.9 kg/ m^2 was used as the reference (normal BMI), 25-29.9 kg/m^2 was used to define overweight while ≥30 kg/m^2 was used for definition of obesity. Obesity was further sub classified into class 1 (30-34.9 kg/m2), class 2 (35- 39.9 kg/m2) and class 3 (≥40 kg/m2). Hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg Diabetes mellitus was defined as a fasting plasma glucose ≥7 mmol/L while hypercholesterolaemia and hyperuricaemia were defined as ≥200 mg/dl and ≥420 μmol/L respectively. Blood pressure was measured in the left arm in

		the sitting position with the aid of a mercury sphygmomanometer using the auscultation method.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	**Primary (b)** Semi-structured questionnaire was used Based on a prevalence of 21.2% from a previous study in the southwestern part of the country and a level of precision of 5%, the desired sample size was calculated to be 257
	10. How was obesity specified in practice?	BMI of 18.5-24.9 kg/ m^2 was used as the reference (normal BMI), 25-29.9 kg/m^2 was used to define overweight while ≥30 kg/m^2 was used for definition of obesity. Obesity was further sub classified into class 1 (30-34.9 kg/m2), class 2 (35- 39.9 kg/m2) and class 3 (≥40 kg/m2)
	11. Characteristics of sample	Out of the 321 eligible respondents screened, 300 (93.5%) with a mean age of 37.6 ± 10.6 years had complete information. Overall, 60.3% of the respondents had at least 12 years of formal education with men being better educated compared to women (75.1% vs 49.1%, $p < 0.001$).

		Men also tended to have statistically higher monthly income, history of cigarette smoking and alcohol consumption while history of hypertension was more common in women (20.5% vs 10.1%, $p = 0.02$).
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	($n = 300$) Men ($n = 129$) Women ($n = 171$) Based on a prevalence of 21.2% from a previous study in the south-western part of the country and a level of precision of 5% the desired sample size was calculated to be 257.
	13. Which sampling method used?	Convenience sampling technique till the desired sample size was achieved.
	15. Which type of statistical method was used?	Means and standard deviations Chi-square test was used while for continuous variables, the student's t-test was used. Predictors of obesity were determined using a univariate binary logistic regression model. a multivariate logistic regression analysis
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	95% confidence intervals. Using a 2-tailed test, statistical significance was set at $p < 0.05$.
Empirical findings (objective 5)	18. What are the main findings?	Overweight and obesity was found in 53.3% and 21.0% respectively with a significantly higher prevalence in women compared to men

		(overweight: 62.0% vs 41.9%, p < 0.001; obesity: 29.8% vs 9.3%, p < 0.001). In univariate analysis, the odds of obesity were higher in women and in the presence of hypertension, hypercholesterolaemia and hyperuricaemia. However, in multivariate analysis, factors independently associated with obesity were women sex (OR 6.119, 95% CI 2.705-13.842, p < 0.001), hypercholesterolaemia (OR 2.138, 95% CI 1.109- 4.119, p = 0.023) and hyperuricaemia (OR 2.906, 95% CI 1.444-5.847, p = 0.003).
	19. What are the author-stated challenges?	None

62.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Sani Yaya, Michael Ekholuenetalu and Ghose Bishwajit
	2. Year	2018
	3. Aim	To establish the pattern of the risk factors of NCDs in sub-Sahara Africa region.
	4. Country	Benin, Burkina Faso, Cameron, Ivory Coast, Gambia, Ghana, Guinea, Mali, Niger, Nigeria, Liberia, Senegal, Sierra Leone and Togo
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Age Residence Educational level Religion Marital status Wealth index

		Working Number of children Alcohol consumption Currently smoking Exercise Fruit consumption Vegetable consumption
	6. How are these determinants specified in practice?	Age 15–19 20–24 25–29 30–34 35–39 40–44 45–49 Residence Urban Rural Educational level None Primary Secondary Higher Religion Christianity Islam Others/no religion Marital status Never married Married/currently living with a partner Wealth index Poorest Poorer

		Middle Richer Richest Working Not currently Currently working Number of children Nulliparous 1–4 4+ Alcohol consumption No Yes Currently smoke No Yes Exercise No Yes Fruit consumption Low Moderate High Vegetable consumption Low Moderate High
	7. How was data on these determinants collected?	Secondary dataset

	a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	National demographic and health surveys from participating countries from 2008 - 2016
	10. How was obesity specified in practice?	BMI and calculated as the ratio of weight in kilograms (kg) to the square of height in meters (m^2). It was categorized into; underweight (BMI < 18.5 kg/m^2) normal (BMI 18.5–24.9 kg/m^2) overweight (BMI 25.0–29.9 kg/m^2) obesity (BMI ≥30 kg/m^2)
	11. Characteristics of sample	Only women form the participating countries were included in the studies. They were aged from 15 to 49 years old. Sample were from both rural and urban settlements in the selected countries.
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	Total = 199,540 **Breakdown** Benin 16,599 Burkina-Faso 17,087 Cameroon 15,426 Cote d'Ivoire 10,060 Gambia 10,233 Ghana 9396 Guinea 9142 Liberia 9239 Mali 10,424 Niger 11,160 Nigeria 38,948 Senegal 15,688 Sierra Leone 16,658

		Togo 9480
	13. Which sampling method used?	Not stated
	15. Which type of statistical method was used?	Multinomial logistic regression
	16 what was the theoretical underpinning used in the study	None
	17. Which statistical model diagnostics tests were reported?	None
Empirical findings (objective 5)	18. What are the main findings?	While rural women were 1.25 times as likely to be underweight, compared with urban women (RR = 1.25; 95%CI = 1.22–1.28); the rural dwellers had 51% (RR = 0.49; 95%CI = 0.48–0.50) and 72% (RR = 0.28; 95%CI = 0.27–0.29) reduction in overweight and obesity relative to women with normal body mass index, compared with women from urban residence. Married women or those living with partners had 35% reduction in underweight, compared with those never married (RR = 0.65; 95%CI = 0.64–0.67); however, married women or those currently living with partners were 1.81 (RR = 1.81; 95%CI = 1.76–1.86) and 2.91 (RR = 2.91; 95%CI = 2.77–3.04) as likely to be overweight and obesity, compared with never married women. Smoking increased the risk of underweight (RR = 2.03; 95%CI = 1.92–2.16), but reduced the risk of overweight (RR = 0.70; 95%CI = 0.65–0.75) and obesity (RR = 0.78; 95%CI = 0.70–0.86)

	19. What are the author-stated challenges?	Cross-sectional study design used cannot adequately establish causality. The secondary data used limited the ability to measure vital micronutrients such as vitamin B12, folate and vitamin A.

63.

Headings	Review questions	Responses
General Information (objective 5)	1. Authors	Abdhalah K Ziraba, Jean C Fotso and Rhoune Ochako
	2. Year	2009
	3. Aim	The aim of this study was to shed light on the patterns of overweight and obesity in sub-Saharan Africa, with special interest in differences between the urban poor and the urban non-poor. The specific goals were to describe trends in overweight and obesity among urban women; and examine how these trends vary by education and household wealth
	4. Country	Burkina Faso; Ghana, Kenya, Malawi, Niger (1992; 2006), Tanzania, Senegal. (*Sub-Saharan*)
Methodology Used (objectives 1-4)	5. What are the determinants of obesity?	Wealth index/ Amenities Time (in years) Woman's education
	6. How are these determinants specified in practice?	*Wealth index*: possessions of amenities such as source of drinking water, toilet facilities and dwelling characteristics which were used to create a socio-economic status index, "wealth index".

		A scoring method was used to calculate the wealth index based on the presence of amenities.
	7. How was data on these determinants collected? a. What is the dataset used? (if method of data collection is secondary). b. If primary data, briefly describe method	Secondary Data **(a)** Demographic and Health Surveys by Measure DHS We used data from all sub-Saharan African countries with a survey containing women's nutritional status conducted between 1992 /1993 and another one carried out in 2003 or later. This criterion ensured that the estimates of changes over time, using survey-specific sample weights, were based on a period of at least ten years between the two surveys.
	10. How was obesity specified in practice?	For the purpose of this analysis, the variable was re-coded as tricotomous: Not overweight/ obese; overweight; obese. Using the conventional cut-off points, overweight was defined as BMI between 25 and 30; and obesity as BMI greater or equal to 30.
	11. Characteristics of sample	There was an average of 11.6 years between survey 1 and survey 2. *(All women*) About a quarter of women had no education whereas about 40% had primary education and 34% had secondary or higher education. Slightly more than half (nearly 56%) were working, and a majority (60.6%) were married.

		Each of the age groups 15-19, 20-24 and 25-29 comprised almost 20% of the total sample. Most women (45.5%) had less than two children ever born and a quarter had two or three children. Country: Burkina Faso (16.4%); Ghana (16.0%); Kenya (12.47%); Malawi (10.4%); Niger (7.3%); Senegal (17.4%) and Tanzania (20.2%).
	12 a. What was the sample size? b. what was the statistical basis for sample size used?	Used secondary Data We used data from all sub-Saharan African countries with a survey containing women's nutritional status conducted between 1992 and 1993 and another one carried out in 2003 or later.
	13. Which sampling method used?	*Not Applicable*
	15. Which type of statistical method was used?	Multivariate ordered logistic regression
	16 what was the theoretical underpinning used in the study	*Interactive model*: The interaction variables between the variable time lapse, and household wealth and education.
	17. Which statistical model diagnostics tests were reported?	None
	18. What are the main findings?	Descriptive results showed that the prevalence of urban overweight/obesity increased by

Empirical findings (objective 5)		nearly 35% during the period covered. The increase was higher among the poorest (+50%) than among the richest (+7%). Importantly, there was an increase of 45-50% among the non-educated and primary-educated women, compared to a drop of 10% among women with secondary education or higher. In the multivariate analysis, the odds ratio of the variable *time lapse* was 1.05 ($p < 0.01$), indicating that the prevalence of overweight/obesity increased by about 5% per year on average in the countries in the study. While the rate of change in urban overweight/obesity did not significantly differ between the poor and the rich, it was substantially higher among the non-educated women than among their educated counterparts.
	19. What are the author-stated challenges?	The female population used in this study may not be representative of the entire adult female population, given that the anthropometric measurements in the DHS are restricted to women who had given birth in the five years preceding the survey. Lastly, the lack of a uniform definition of what constitutes an urban and rural area poses a challenge in making comparisons and generalizations about observations across countries.

Appendix 4: Individual level variables measured in the studies identified in chapter 2.

Variables	Number of studies that measured it	Description/specification
Age	44	Years
Gender/Sex	31	Male Female
Place of birth	1	Urban Rural
Residence	6	Urban Rural
Ethnicity	11	Based on country's ethnic groups
Marital status	25	Single Married Cohabiting Divorced
Religion	7	Christian Islam
Education level	43	No formal education Primary Secondary Tertiary
Occupation/Employment status	20	Unemployed Self/informal employment Public sector Private sector
Socio-economic status	10	Low Middle High

Variables	**Number of studies that measured it**	**Description/specification**
Wealth index/Household amenities	19	Poorest Poorer Average Richer Richest
Household size	4	Total number of people in household
Physical activity	25	Inactive Moderately inactive Moderately active Vigorous
Sedentary behavior/work	5	Yes/No
Dietary intake	15	Serving bread/day Fruit serving/day Vegetable serving/day Eating out/week Sugar sweetened beverage/weak Frequent food consumption outside main meals Modernity of the type of foods consumed
Alcohol intake	21	Yes/No Never Ex-drinker Once/week Two to three times/week Four or more times/week
Smoking	21	Yes/No Never Current smoker Ex-smoker
Hypertension	10	Yes/No

Variables	**Number of studies that measured it**	**Description/specification**
Diabetes	9	Yes/No
Hypercholesterolemia	3	Yes/No
Hyperuricemia	1	Yes/No
Blood group and rhesus factor	1	Blood group: A, AB, B, O Rhesus factor: Positive/Negative
HIV status	2	Yes/No/ Don't know
TB status	2	Yes/No/ Don't know
Health status	3	Bad Moderate good
Clinical history	2	Menopause Pre menopause Peri menopause Post menopause
Pesticide usage	1	Yes/No
Mother's age	2	Age of mother in completed years
Mother marital status:	1	Single Married Cohabiting Divorced
Mother's occupation	1	works on a farm/garden or works in a shop/factory/office or sells items on the street/in the market
Mother's education	3	No formal education Primary school High school College or more

Variables	**Number of studies that measured it**	**Description/specification**
Father's education	2	No formal education Primary school High school College or more
Parity	7	0 1 – 3 4 – 6 ≥7
TV Viewing	5	Not at all <once a week At least once a week Almost everyday
Reading newspapers	2	Not at all <once a week At least once a week Almost everyday
Listening to radio	2	Not at all <once a week At least once a week Almost everyday
Means of transportation	2	Car/public transport motorbike Walking/Cycling
Total globalization	1	Social globalization Political globalization Economic globalization

Appendix 5: Stakeholder engagement questionnaire

College of Health and Life Sciences
Department of Clinical Sciences

Stakeholder engagement workshop:
Multi-level determinants of obesity in Ghana

Interview Schedule for 2nd pre-workshop:

'Identifying and conceptualising policy relevant research questions for empirical studies in Ghana'

Thank you for participating in this study.

Name	
Designation	
Place of work	
Title	
Gender	
Age	

Questions

1. Following the findings of review of the studies that have investigated the factors that affect obesity (see Box 1), what do you perceive to be the questions that future studies on obesity should focus on?

…….

…….

…….

Box 1: Summary of key findings from the literature review

- Sixty-three studies were reviewed. Of which, 22 papers used samples from Ghana
- Only 5% (n=3) of the reviewed studies were underpinned by a theoretical model/framework
- None of the study was longitudinal study (collected data overtime) and able to establish causation

- Only 1 study used a multi-level approach in investigating the determinants of obesity. The study, which was conducted in Ghana, although useful has the following limitations:
    a. Conducted only in three deprived areas of the capital city Accra (James Town, Ussher Town, and Agbogbloshie). Apart from lack of representatives, these areas are similar (eg all are urban poor settings and largely occupied by members of one tribe, Ga), and hence limits variation.
    b. Cross sectional study (limits establishment of causation)
    c. had a limited conceptualisation of the multi-level classifications by accounting for only 2 structures (i.e. individual level and community level – defined by enumeration areas).
- All studies assumed the independence of lifestyle behaviours that are risk factors to obesity eg physical activity, diet, obesity smoking, alcohol. This assumption might lead to inaccurate estimates and policy formulation because common underlying latent variables may simultaneously influence the propensity to engage in these lifestyle behaviours. Other lifestyle behaviors such as sleeping, sedentary behavior that have been found to relate to obesity have been missed in the literature
- Majority of the studies limitations particularly in the following areas:
    a. Measures for quality assurance purposes. For example, regarding analysis only 14% reported model diagnostics
    b. Explaining how missing data, if any, was addressed (19%)

2. The review also found a list of contextual or area level factors that affects obesity. These were: *region of residence, districts, neighbourhood, urbanization, crime level, social cohesion, trust among community members, population density, food environment, physical space for physical activity, economic globalization, feeling unsafe from traffic distant access to commercial facilities, perceiving garbage and offensive odors*

3. Are there any relevant contextual factors missing on this list?
   Yes No

   If yes, please tell me what these are

……….

……….

……….

Thank you

Appendix 6: Third round survey – stakeholders' engagement

College of Health and Life Sciences

Department of Clinical Sciences

Stakeholder engagement workshop:
Multi-level determinants of obesity in Ghana

Survey for workshop:

'Identifying and conceptualising policy relevant research questions for empirical studies in Ghana'

Thank you for participating in this study.

Name	
Designation	
Place of work	
Title	
Gender	
Age	

Questions

1. Please indicate on a scale from 1 to 7, 1 meaning "strongly disagree" and 7 meaning "strongly agree" how important each of the following research questions are to future studies on obesity

	Strongly Disagree						**Strongly Agree**	**Don't know**
Assessing the relationship between other lifestyle behaviours and obesity.	1	2	3	4	5	6	7	?
Examining the determinants of obesity across different ethnic groups/regions	1	2	3	4	5	6	7	?
Exploring the effects of socio-demographic and cultural (particularly around body image) and religious factors on obesity	1	2	3	4	5	6	7	?
The role of biological factors (particularly genetics) in explaining obesity	1	2	3	4	5	6	7	?
Effect of obesity on communicable & non-communicable diseases	1	2	3	4	5	6	7	?

	Strongly Disagree						Strongly Agree	Don't know
Conducting longitudinal instead of cross-sectional studies	1	2	3	4	5	6	7	?
Investigating micro and macroeconomic determinants of obesity	1	2	3	4	5	6	7	?
Economic impact of obesity	1	2	3	4	5	6	7	?
Obesity among children and adolescents	1	2	3	4	5	6	7	?
Assessing multi- level determinants of obesity	1	2	3	4	5	6	7	?
Incorporating alternative measures of obesity in observational studies	1	2	3	4	5	6	7	?

2. Please indicate on a scale from 1 to 7, 1 meaning "strongly disagree" and 7 meaning "strongly agree" how important each of the following factors are to understanding obesity

	Strongly Disagree						Strongly Agree	Don't know
Socio - and economic factors	1	2	3	4	5	6	7	?
Cultural, anthropological, and ethnocentric factors	1	2	3	4	5	6	7	?
Physical/mental health status and related behaviour	1	2	3	4	5	6	7	?
Demographic factors	1	2	3	4	5	6	7	?
Genetic factors	1	2	3	4	5	6	7	?
Household influences (subjective norms)	1	2	3	4	5	6	7	?
Obesogenic environment	1	2	3	4	5	6	7	?
Area of residence	1	2	3	4	5	6	7	?
Labour and leisure time activity	1	2	3	4	5	6	7	?
Level of pollution	1	2	3	4	5	6	7	?
Time availability	1	2	3	4	5	6	7	?
Childhood experience	1	2	3	4	5	6	7	?

Thank you

Appendix 7: Thematic analysis of stakeholders quotes on policy-relevant research questions

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
1	Exploring the effects of socio-demo-cultural (particularly around body image) and religious factors on obesity	9	002; 008;010; 013, 021, 022; 031, 032 ;042	002 More Qualitative studies to determine specific cultural, religious, and social characterizations that influence food choices and eating habits in different ethnic, geographic and social classes in Ghana. Influences of societal perceptions on body size and images among men and women in different social, economic, professional groupings in Ghana.
				008 Do cultural factors such as body image have any ramifications on obesity?
				010 How the cultural has factors such as body image impacted Obesity in Ghana…
				013 What are the impacts of social factors, for example, self-perception
				021 What are the consequences of societal influence that contribute to results such as body image on obesity
				022 With regards to personal values, what role if any, does upbringing, religion, and levels of education play in determining one's likelihood of being obese.
				031 What are the impacts of perception of body size on obesity?

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
				032 Religion or Faith groups and obesity (not much has been done in this line)
				042 Do cultural factors such as beliefs and moral values affect obesity?
2	Examining the determinants of obesity across different ethnic groups/regions	12	014; 016; 022; 031; 035; 037; 039; 040; 042; 043, 044, 045	014 To widen the areas of study
				016 What is the incidence rate of Obesity across all tribes or ethnic groups in Ghana?
				022 How are the differences in prevalence of obesity among the different tribes in Ghana?
				031 Are the factors that affect obesity different across ethnic groups in Ghana?
				035 Are there similar determinants of obesity in other regions of the country?
				037 on the limited ethnic group
				039 Examine the determinants of obesity across ethnic background
				040 In Ghana people from certain tribes such as the Gas and Fantis are assumed to have high obesity tendency. Are the determinants of obesity different across the different tribes in Ghana?

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
				042 Does one's tribe affect risk of obesity
				043 looking at the number of ethnic groups or tribes that we have in Ghana, a focus on only one tribe may not paint the real picture, future studies on obesity could be focused on at least three tribes
				044 Based on the findings below, future studies should include samples that are representative of most of the tribes in Ghana in order to ensure generalisation of study findings.
				045 what percentage of the Ghanaian population are obese and which areas and tribes are most affected? What is the incidence and prevalent rate of obesity in Ghana?
3	Assessing the relationship between *other* lifestyle behaviours and obesity.	16	003; 004; 009; 016;022; 024; 025; 027; 028; 031; 034; 041; 042; 044, 012, 022	003 Interrelationship between obesity and other lifestyle behaviours
				004 How does lifestyle behaviours such as sleeping affect obesity?
				009 Eating habits
				016 How does lifestyle contribute to or propagate the increase in the prevalence of Obesity?
				022 How does where one lives affect their propensity to become obese?
				024 Apart from the food we eat, what are the others causes of obesity Ghana.

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
				Assessing the impact of Human lifestyle as the cause of Obesity in Africa.
				025 It is important that subsequent studies find the correlation that exist when it comes to obesity and our behavioural orientations
				027 The correlation or linkage between lifestyle and its contribution toward obesity
				028 What interrelationships exist between other lifestyles behaviour and obesity?
				031 What are the relationship between obesity and other lifestyle behaviours?
				032 Eating disorders (binge eating and drinking) and obesity
				034 Food and Physical Activity
				041 Drugs or other medicinal agents contributing to weight gain: possible abuse or misuse
				042 Does one's lifestyle behaviour contribute to the risk of obesity? Does of knowledge of risk of obesity affect one's lifestyle behaviour?
				044 Future studies can focus on the influence of other explanatory factors, like stress and health seeking behaviours of individuals, on obesity.

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
				012 Factors that deter people who are turning obese from noticing and doing something about it early.
				022 What are the possible root causes of obesity in Ghana, how do they in the long term contribute to weight gain of the individual and at what rate do they influence the change in weight of the people? How do the various identified factors coalesce to lead to obesity and how do they relate to each other?
4	The role of biological factors (particularly genetics) in explaining obesity	6	007; 009;011; 024; 029; 032	007 Epidemiological studies in Obesity in Ghana in areas like, molecular epidemiology Genomic epidemiology, microbiome studies among obese persons in Ghana Immunological studies in obesity in Ghana
				009 Family history; Genetics
				011 Are there gender-based factors leading to obesity?
				024 Assessing hereditary as the main factor leading to obesity in Ghana.
				029 Effects of genetics on obesity
				032 The role of genes transcription and transformation (genetics) in obesity

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
5	Effect of obesity on communicable & non-communicable diseases	4	007,012,032; 041	007 Obesity and Clinical outcomes of specific non communicable diseases: the Ghanaian Experience.
				012 What mental space obese people find themselves in.
				032 Health comorbidities and medication and its relationship to obesity
				041 Emotional state (depression, stress, etc)
6	Conducting longitudinal instead of cross-sectional studies	3	006; 014; 015	006 the future there could be research on obesity that uses longitudinal study instead of a one off approach to data collection in a number of settlements
				014 Try to get more longitudinal study to be able to establish the different causes of Obesity in Ghana
				015 Try to get more longitudinal study
7	Assessing multi- level determinants of obesity	1	039	039 Confirm the multi-level approach study by opening sample locations. Increase the dimension in the multi-level approach to obesity.
8	Economic impact of obesity	2	017;018	017 In what way will obesity affect the economy?
				018 What are the impacts of obesity on economy

No.	Themes	Freq.	Participants who mentioned this theme	Quotes with associated participant ID's
9	Obesity among children and adolescents	2	030; 036	030 What is the level of knowledge of teenagers/adolescents on the causes of obesity?
				036 Childhood obesity causes, effects, and treatments.
10	Investigating micro and macroeconomic determinants of obesity	3	004; 011; 026	004 What is the relationship between education level and obesity? What is the relationship between car ownership and obesity?
				011 What are the socio-economic factors that can lead to obesity? Which professional grouping are at risk of obesity?
				026 Economic contextual factors such as food consumption
11	Incorporating alternative measures of obesity in observational studies	1	024	024 Waist to Hip ratio as against BMI in obesity in urban and rural areas could be looked at in future
12	Identifying generic determinants (push and pull factors) of obesity	2	012;022	012 Factors that deter people who are turning obese from noticing and doing something about it early.
				022 What are the possible root causes of obesity in Ghana, how do they in the long term contribute to weight gain of the individual and at what rate do they influence the change in weight of the people? How do the various identified factors coalesce to lead to obesity and how do they relate to each other?

Appendix 8 Mapping of quotes to themes on area-level factors to understand obesity

No.	Factors	Freq.	Participants who mentioned this factor	Quotes with associated participant ID's
1	Cultural, anthropological, and ethnocentric factors	6	002; 006; 014; 015;035; 039	002 An anthropological and ethnocentrical view and assessment of body size, image, eating habits in Ghana
				006 Cultural beliefs and obesity
				014 Religion
				015 Religion
				035 Religion
				039 Religious atmosphere
2	Socio - and economic factors	7	004; 005; 011; 012; 014;015; 016	004 Income level; Occupation type; Level of education
				005 Testing of the knowledge or technical know-how of the interviewees
				011 Professional background
				012 Education and illiteracy levels.
				014 Educational status; Occupation
				015 Employment status
				016

No.	Factors	Freq.	Participants who mentioned this factor	Quotes with associated participant ID's
				Socio economic status Level of education
3	Genetic factors	3	007; 017;018	007 Cell and Molecular Biology, Genomics studies
				017 hereditary,
				018 hereditary or genetic factors of an individual
4	Demographic factors	5	011; 015; 016; 022; 031;	011 Gender differences
				015 Ethnic/ tribe
				016 Age; Gender
				022 Relationship status
				031 Individual Characteristics
5	Obesity rate at the community and household level	1	029	029 Level of obesity of other community and family members
6	Obesogenic environment	2	005; 031	005 Laboratory experiment on junk food and its outcome
				031 Obesogenic environment
7	Physical and mental health status and related behaviour	8	011,014, 043, 037; 038; 022, 006, 043	011 Individual's health status
				014 Health seeking behaviour of the study population

No.	Factors	Freq.	Participants who mentioned this factor	Quotes with associated participant ID's
				043 Stress due to marriage issues, workplace problems
				006 Inadequate knowledge on the effect of our everyday activity on our health
				043 Lack of education on health hazards on certain foods
				037 The future studies should also entail intrinsic factors of individuals: example: psychological and emotional factors.
				038 pharmaceutical use and or usage stress
				022 Mental health issues (depression, anxiety, etc)
8	Area of residence	1	037	037 The study should be broadened in future to cover the most elite areas where quiet number of people are obese
9	Labour and leisure time activity	1	037;039	037 Focus should also be on utilisation of individual's leisure period
				039 Nature of work activity (sedimentary)
10	Lack of parental control	3	017; 018.022	017 lack of parental control
				018 Lack of parental control
				022 Family setting

No.	Factors	Freq.	Participants who mentioned this factor	Quotes with associated participant ID’s
11	Level of pollution	1	038	038 Exposure to pollutants
12	Time availability	1	022	022 Hours spent at work or school
13	Childhood experience	1	022	022 Childhood abuse and trauma

Appendix 9: Questionnaire for Ghana Obesity Survey 2021

Thank you for agreeing to take part in our study. The interviewer will measure your height and weight and asks about the things that influence your body mass including your locality, lifestyle, culture, health, and demographics.

The survey is part of a wider program of research about multi-level determinants of obesity.

We encourage you to take your time and think about the answers. If any of the questions are not completely clear to you, please let me know, and I'll read it again. There are no right or wrong answers. It is your views that are important. Your answers will help the Ghana Government in designing programmes to reduce obesity in Ghana.

All your answers will be confidential and used only for research and planning purposes. No personal information will be given to anyone else, and results will only be presented as groups. If you decide not to participate in this survey, there will be no impact other than we will miss your views and experiences.

Please note that you can withdraw from this research anytime – just let me know that you no longer want to participate. Should you withdraw from this research, your responses will not be used in our analysis.

In case you feel distressed during or after your participation as a result of the questions, please contact any the Ghana Health Service counselling centres, etc.)/.

The questionnaire will take about 15 minutes to complete.

This research has approval from the University of Brunel Research Ethics Committee and the Ghana Statistical Service

INTERVIEWER INSTRUCTION: Generate digital address *[This will be the basis for generating other area level information via GIS]*

Metropolis IDNO:

Participant IDNO:

REGION IDNO:

Date:

INTERVIEWER INSTRUCTION: Request politely for the measurement of height and weight (using the protocol)

Section A Questions about physical activity (Adapted from Health Survey for England 2016)

I'd like to ask you about the physical activity you have done in the past four weeks.

PhyAct
Can you tell me if you have done any physical activity during the last four weeks, that is since *(date four weeks ago)*? Include teaching, coaching, training and practice sessions.
1 Yes 2 No

If *PhyAct*= 1 THEN,
Activi
Which have you done in the last four weeks? PROBE 'Any others' up to 5?
CODE ALL THAT APPLY
1 Swimming
2 Cycling
3 Workout at a gym/Exercise bike /Weight training
4 Aerobics/Keep fit/Gymnastics/Dance for fitness
5 Running/Jogging/Walking
6 Football/rugby
7 Badminton/tennis
8 Squash
9 Exercises (e.g. press-ups, sit ups)
10 Traditional activities (e.g. farming, fishing, carving, sheanut picking)

FOR Activity: 11 TO 15 DO
Other activity
Have you done any other activities not listed on the card?
1 Yes 2 No

If Other activity=1, THEN
Name Other activity
INTERVIEWER: Probe for name/names of activity
. Write.
Text:……………

FOR Activity: 1-15 DO
Question
Can you tell me on how many separate days did you do (*activity*) for at least 15 minutes a time during the past four weeks, that is since (*date four weeks ago*)?

Time
How much time did you usually spend doing (*activity*) on each day? (Only count times you did it for at least 15 minutes)
Text…………

Intensity
During the past four weeks, was the effort of the (*activity*) usually enough to make you out of breath and sweaty?
1 Yes 2 No

Section B Questions about sedentary behaviour (Adapted from Health Survey for England 2016)

Introduction Sit
Now I'd like to ask you some questions about time that you might have spent sitting down. For these questions, I'd like you to think about what you have done in the last four weeks, that is since (date of interview – 4 weeks) when you were not doing your (paid) job.

TV Week
In the last 4 weeks, how much time did you spend sitting down watching TV (including DVDs and videos) on an average weekday (that is Monday to Friday)?
INTERVIEWER INSTRUCTION: This includes multi-tasking (using iPad, phone etc.) while sitting and watching TV.

_____hours per day
___minutes per day

WkSit2H
In the last four weeks, how much time did you spend sitting down doing any other activity on an average weekday (that is Monday to Friday)? Please do not include time spent doing these activities while at work.

INTERVIEWER INSTRUCTION: EXAMPLES OF THESE ACTIVITIES INCLUDE READING, , STUDYING, DRAWING, USING A COMPUTER, PLAYING VIDEO GAMES.

_____hours per day
___minutes per day

WESit1H
In the last four weeks, how much time did you spend watching TV (including watching DVDs and videos) on an average weekend day (that is Saturday and Sunday)?
INTERVIEWER INSTRUCTION: This includes multi-tasking (using iPad, phone etc.) while sitting and
watching TV.

_____hours per day
___minutes per day

WESit2H
In the last 4 weeks, how much time did you spend sitting down doing any other activity on an average weekend day (that is Saturday and Sunday)? Please do not include time spent doing these activities while at work.
INTERVIEWER: EXAMPLES OF THESE ACTIVITIES INCLUDE READING, STUDYING, DRAWING, USING A COMPUTER, PLAYING VIDEO GAMES.

_____hours per day
___minutes per day

Section C Questions about smoking and alcohol intake (Adapted from Health Survey England 2016)

I'd like to ask you other lifestyle behaviours.

SmokEver
May I just check, have you ever smoked a cigarette, a cigar or a pipe? We are
referring here to tobacco cigarettes, not e-cigarettes or other vaping devices that use liquids
1 Yes
2 No

INTERVIEWER INSTRUCTION: {IF SmokEver = Yes}
SmokeNow
Do you smoke cigarettes at all nowadays?
1 Yes
2 No

{IF SmokeNow = Yes}
DlySmoke
About how many cigarettes a day do you usually smoke?
INTERVIEWER: IF LESS THAN ONE A DAY, ENTER 0. IF RANGE GIVEN AND CAN'T ESTIMATE, ENTER MID POINT. IF RESPONDENT SMOKES ROLL UPS TAKE ESTIMATE OF NUMBER OF CIGARETTES.
Range: 0 to 97

ASK ALL
EvVape
Have you ever used an electronic cigarette (e-cigarette), or any other vaping device?
EXPLAIN IF NECESSARY: A vaping device is any product that you can use to inhale vapour rather like you would a cigarette. It includes ones that have a battery as well as ones that do not such as voke.
1 Yes
2 Yes - Only tried once or twice
3 No

IF EvVape =Yes OR Yes - Only tried once or twice
Vape Now
Do you use an e-cigarette or vaping device at all nowadays?
1 Yes

2 No

IF EvVape =Yes OR Yes - Only tried once or twice
VapeTm
When did you first start to use electronic cigarettes or vaping devices?
1. In the last 6 months
2. More than 6 months, up to 12 months ago
3. More than a year, up to 2 years ago
4. More than 2 years up to 5 years ago
5. More than 5 years ago

IF VapeNow= YES
VapeFrq
How often have you used an e-cigarette or vaping device in the last month?
1. Less than once a month
2. At least once a month but less than once a week
3. At least once a week but less than every day
4. Every day
IF VapeNow= YES

WeekVp
How many times do you use your e-cigarette or vaping device on a typical day?
INTERVIEWER READ OUT: ‘How many times’ refers to a ‘session’ i.e. picking it up, taking some puffs and putting it down again, NOT the number of puffs a day.
1. Less than once a day
2. Once
3. 2 to 3 times
4. 4 to 5 times
5. 6 or more times
6. SPONTANEOUS I vape for most of the time during the day

IF VapeNow= YES
WkVpTm
How much time in total do you spend using your e-cigarette or vaping device on a typical day? PROMPT AS NECESSARY.
1. Less than 5 minutes
2. 5 minutes to 30 minutes
3. More than 30 minutes but up to 1 hour
4. More than 1 hour but up to 2 hours
5. More than 2 hours

DrinkOft
Thinking now about all kinds of drinks, how often have you had an alcoholic drink of any kind during the last 12 months?

1 Almost every day
2 Five or six days a week
3 Three or four days a week
4 Once or twice a week
5 Once or twice a month

6 Once every couple of months
7 Once or twice a year
8 Not at all in the last 12 months

FRT (Adapted from Northern Ireland Health Survey, 2013-2014)
Thinking about the food that you eat; I would like you to tell me how often you usually eat the following foods. Fruit or vegetables, including fresh, frozen, dried, tinned and pure fruit juice?

1 More than once a day
2 Once every day
3 Most days
4 Once or twice a week
5 Less often or never

Section D Questions about views on obesity (Adapted from Northern Ireland Health Survey, 2013-2014)

Next, we would like to ask you questions about your views on obesity.
Please say how much you agree or disagree with the following statements.

'Being overweight is something you inherit from your parents'?
IF ASKED WHAT 'INHERIT' MEANS - 'By 'inherit', we mean it is something your parents pass to you through their genes'
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

And how much do you agree or disagree that 'Being overweight is a sign of good living'?
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

And how much do you agree or disagree that 'Being overweight is a sign of beauty'?
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

'Being overweight is unhealthy'?
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

'Most people who are overweight have put on weight because they eat too much'
(How much do you agree or disagree?)
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

'Most people who are overweight have put on weight because they exercise too little'
(How much do you agree or disagree?)
1 Agree strongly
2 Agree
3 Neither agree nor disagree
4 Disagree
5 Disagree strongly
8 (Don't know)
9 (Refusal)

Section E
ADAPTED PHYSICAL ACTIVITY NEIGHBORHOOD ENVIRONMENT SCALE (adapted from Oyeyemi et al 2013)

Next, we would like to ask you questions about your environment.

*Think about all the different facilities in and around your neighborhood that are related to exercise and walking, by this we mean **ALL** the area within approximately one kilometer or half a mile of your home or that you could walk to in **10-15 minutes**.*

A. RESIDENTIAL DENSITY

1) What is the main type of housing in your neighborhood?
1 [ ]   Detached single bungalows and duplexes

2 [ ]   Mix of bungalows, duplexes and apartments/ yards with shared facilities.

3 [ ] Apartments/ yards with shared facilities or flats of 1-2 stories.

4 [ ] Blocked apartment with multiple households per plot or flats.

INTERVIEWER: Please say how much you agree or disagree with the following statements.

B. ACCESS TO DESTINATIONS IN YOUR NEIGHBORHOOD

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Don't know/not sure
1) Many places such as shops, stores and markets to buy things I need are within easy walking distance of my home.	1	2	3	4	5
2) It is within easy walking distance from my home to access public buses and taxis in my neighborhood	1	2	3	4	5
3) There are many non-residential places such as schools, hospitals, workplaces etc. to go within easy walking distance of my home	1	2	3	4	5

C. STREET CONNECTIVITY

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Not applicable
4) There are many cross-junctions (Plus junctions) in my neighborhoods	1	2	3	4	5

D. SOCIAL ENVIRONMENT

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Don't Know/Not sure
5) I see many people in my neighborhood doing things like	1	2	3	4	5

walking, jogging, playing football and other sports					

E. NEIGHBORHOOD INFRASTRUCTURES

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree	Not applicable
6) My neighborhood has several places such as open field, school playground, parks, public space and gymnasium to exercise and play sports	1	2	3	4	5
7) There are separated pedestrian pathways on most of the streets in my neighborhood	1	2	3	4	5
8) It could be safe to bicycle in or near my neighborhood because there is little traffic	1	2	3	4	5
9) The walk and foot pathways in my neighborhood are unobstructed and good for walking	1	2	3	4	5

F. AESTHETIC QUALITY

	Strongly disagree	Somewhat disagree	Somewhat Agree	Strongly agree	Don't Know/Not sure
10) There are many beautiful things such as architectural design, shade trees, building varieties and attractive landscaping to look at while walking in my neighborhood	1	2	3	4	5
11) My Neighborhood is generally free from unattended					

domestic animals like goats, cattles, dogs etc	1	2	3	4	5
12) My Neighborhood is generally free from garbages, stagnant water and offensive odours	1	2	3	4	5

G. NEIGHBORHOOD SAFETY

	Strongly disagree	Somewhat disagree	Somewhat agree	Strongly agree
13) Walking is dangerous in my neighborhood <u>during the day</u> because of inadequate security from molestation, crime and harassment from hooligans, rascals and drug addicts	1	2	3	4
14) Walking is dangerous in my neighborhood because of the speed of traffic and aggressive driving	1	2	3	4
15) Walking is dangerous in my neighborhood <u>during the night</u> because of inadequate security from molestation, crime and harassment from hooligans, rascals and drug addicts	1	2	3	4

Section F Questions about you

Thank you for completing the previous questions. These are a short set of questions that ask about you and living circumstances

Gender

1. What is your sex? (**Adapted from HASE lifestyle survey)**

☐ Men ☐ Women ☐ Other

Age

2. Can I check, what was your age at your last birthday? (HSE 2016)

INTERVIEW INSTRUCTION: Range 0….120

Marital status

3. Are you …………...? (**Adapted from GSS 2021 Population & Housing Census**)

- ☐ Informal /living together
- ☐ Married (civil/ordinance)
- ☐ Married (customary/traditional)
- ☐ Married (Islamic)
- ☐ Married (other type)
- ☐ Separated
- ☐ Divorced
- ☐ Widowed
- ☐ Never married

Length

4. How long have you stayed at your locality?

- ☐ Less than 6 months
- ☐ 6 months to 1 year
- ☐ 1 year to 2 years
- ☐ 2 to 5 years
- ☐ More than 5 years

Ethnic

5. What is your ethnic group? (**Adapted from GSS 2021 Population & Housing Census**)

- ☐ Akan
- ☐ Ga-Dangme
- ☐ Ewe
- ☐ Guan
- ☐ Gurma
- ☐ Mole-Dagbani
- ☐ Grusi
- ☐ Mande
- ☐ All Others

Religion

6. What is your religion? (**Adapted from GSS 2021 Population & Housing Census**)

- ☐ Catholic
- ☐ Protestant
- ☐ Pentecostal/Charismatic
- ☐ Other Christian
- ☐ Islam
- ☐ Ahmadi
- ☐ Traditionalist
- ☐ No Religion
- ☐ Other (specify)

Income (**Adapted from HASE lifestyle survey**)

7. Which of these groups represents your **personal monthly** income from all sources (including pocket money, remittances, pensions), before any deductions for income tax, national insurance etc? (Adapted from HASE lifestyle survey)

☐ less than GH¢ 1000
☐ GH¢ 1000 to less than GH¢ 2000
☐ GH¢ 2000 to less than GH¢ 3000
☐ GH¢ 3000 to less than GH¢ 4000
☐ GH¢ 4000 to less than GH¢ 5000
☐ GH¢ 5000 and above

There are final questions about you

Gen Health **(Adapted from Health Survey for England 2016)**

8. How is your health in general? Would you say it is...READ OUT...?

1 …very good,
2 good,
3 fair,
4 bad, or
5 very bad?

Disability (**Adapted from Health Survey for England 2016**)

9. Do you have a long-standing illness or disability which affects or limits your day-to-day activities?

☐ Yes ☐ No ☐ Prefer not to say

Work (**Adapted from Health Survey for England 2016**)

10. Last week, were you:

*Tick **all** boxes that apply. Include any paid work, including casual or temporary work, even if only for one hour*

☐ working as an employee?

☐ on a government sponsored training scheme?

☐ self-employed or freelance?

☐ working paid or unpaid for your own or family’s business?

☐ away from work ill, on maternity leave, on holiday or temporarily laid off?

☐ doing any other kind of paid work?

- ☐ at school?
- ☐ other?

Thank you

Appendix 10: Generation of area-level variables using Geospatial Information Systems (GIS).

Introduction

The report here details how the thesis generated objective area-level variables for the multi-level analysis in chapter 8 using the Geospatial Information Systems (GIS). It employed two specific GIS tasks: 1. Display existing data spatially to identify a particular geographic entity (e.g., all population data in the selected metropolis) and assign variables of interest to that entity (e.g., the average distance between gyms) and 2. Generate new data using various proximity analysis protocols (e.g., restaurants, gyms) that can be spatially identified. The data generation process is explained in the methods section below.

Methods

Description of Study Area

The GIS analysis captured the three metropolises of interest in this thesis, i.e., the Accra, Kumasi, and Tamale metropolises. These metropolises had a combined surface area of about 1,045 square kilometres.

Research Design and Data Sources

The data for the GIS analysis was obtained from the Ghana Statistical Service as part of the collaborative survey conducted by the researcher and the Ghana Statistical Service. The dataset comprised the GPS coordinates (latitudes and longitudes) of all the individual households in the various metropolis, the districts and regions in which they were located.

Data acquisition

One of the greatest challenges facing GIS users is acquiring detailed data sources containing locational and attribute information on the built environment. However, due to the extensive survey conducted by the researcher and the Ghana Statistical Service, this challenge was addressed. Generally, spatial data can be acquired with primary or secondary data collection approaches. The primary approach is often through two methods:

1. Psychometric method based on surveys of individuals who report on characteristics of the environmental feature of interest.

2. Econometric method through direct or "systematic social" observations undertaken by fieldwork auditors who visit neighbourhoods to make observations or to complete an audit tool (Mujahid et al., 2007; Troped et al., 2001; Rosenberg et al., 2009; Schaefer-McDaniel et al., 2010; Pikora et al., 2002; Raudenbush & Sampson, 1999).

More recently, tools that enable the direct integration of collected spatial data into GIS have been developed, including Global Positioning Systems (GPS) (Stopher et al., 2008) and remote sensing (captured remotely using satellites to identify green space, topography etc.) These tools allow easy access to secondary data. Usually, secondary spatial data are collected with external sources, like, administrative data (e.g., from a census), commercial data (e.g., from market research companies), internet resources (e.g., company websites or Google Street view), and phone directories (e.g., yellow pages) (Moore & Roux, 2006; Auchincloss et al., 2008; Powell & Bao, 2009).

Comparatively, secondary data may be relatively cost-effective to obtain and can usually be sourced for specific areas or across a large geographical area (e.g., nationwide) than primary data. However, they are often not designed for the analytical purposes for which they are being used and therefore may not entirely meet the researcher's needs. Hence, validation against primary data is often preferable to ensure their accuracy. Occasionally, primary and secondary data are discordant, and this is primarily due to three possible errors, as outlined by (Boone et al., 2008):

1. Facilities included in the database are not found in the field.
2. Facilities included in the database are not considered the same service type when identified in the field.
3. Facilities found in the field are not in the database.

Specific results on the accuracy of secondary data sources have previously been reported for physical activity facilities (Boone et al., 2008; Paquet et al., 2008) and the food environment (Paquet et al., 2008; Lake et al., 2010; Hosler & Dharssi 2010; Cummins & Macintyre, 2009).

Conclusively, findings suggest most secondary data sources have sufficient error to introduce bias into analyses potentially. Therefore, both primary and secondary data are often required to ensure more comprehensive data. This argument informed the use of both primary and secondary area-level data. So, the data from the comprehensive survey in chapter 5 was used as a primary data source and key-filed to source further GIS data for this study.

Geocoding

Geocoding is the process of matching raw address information (e.g., the household addresses of study participants or the addresses of neighbourhood supermarkets, gyms etc.) with a digital spatial dataset that includes all addresses within the area of interest mapped to latitude and longitude coordinates (Longley et al., 2005). Geocoding is often preceded by data acquisition.

It is prone to several errors, such as biased estimates of the associations between the built environment and health (Boone et al., 2008; Hay et al., 2009; Kravets & Hadden, 2007). For example, the match rate, which is the percentage of successfully geocoded addresses, could be a potential source of bias. First, a lower match rate, which may occur because of incomplete address information and errors such as incorrect street suffixes, misspelling of street names, suburbs, and postal area information, could introduce bias. Second, even when high match rates are achieved, addresses may be geocoded to the incorrect location, resulting in biased estimates.

The data compiled from the Ghana obesity survey were geocoded based on the latitude and longitude data provided. This form of geocoding increased the probability of high match rates by ensuring the coordinates was geocoded without any approximations. The data was also current, which ensured the was a minimal likelihood of change in address information at the time of collection and geocoding. Finally, the researcher implemented a centroid measure to standardise any outliers in the coordinates.

Centroid (geometric and population-weighted)

A centroid is a single point representing the “centre” of a spatial unit. Centroids may be used as points from which exposure measures are undertaken, such as proximity estimates or the density of features in a buffer. GIS enables the identification of geometric centroids (the geographical centre) or population-weighted centroids (the point that minimises the total distance to all the residents (or households) in an area).

Population weighted centroids are particularly useful when the population is homogeneously distributed in space (such as in rural areas or larger spatial units), and a geometric centroid will not result in a precise representation of accessibility for most residents. However, the centroid measures provide precise data as individual-level measures (e.g., using individual household location to derive accessibility measures). Therefore, for all households whose GPS coordinates were inadequate, the researcher implemented the centroid to determine a central point for these households.

Geo-data base Creation

For the generation of the geodatabase, the following data has been used.

1. Ghana country-based map using Google imagery
2. Coordinate data from the Ghana Obesity survey

Data processing and analysis

For the data processing, the following steps were taken:

- Geo-referencing of Ghana country image file.
- Generation of shapefile of all households from Ghana Obesity Survey
- Digitisation of road network in all metropolises included in the study
- Generation of a topological map

A google satellite imagery, which the researcher geo-referenced to the World Geodetic System 1984 datum (WGS84), will be used as the base map for all the analysis. GPS coordinates of all the households included in the Ghana Obesity Survey were extracted from the survey dataset, geocoded, and the centroid was used where applicable. The resultant dataset was then migrated onto a GIS platform, the Environmental Systems Research Institute (ESRI), ArcMap GIS software. The ESRI, ArcMap GIS software, was used to aggregate the data, create a topographic map, and highlight the individual households as points on the base map in line with GIS industry-standard operationalisation (Dolinskiy et al., 2020). The data was then processed and recorded in a processable standardised GIS format (Soler & Marshall, 2002).

Digitising in GIS converts geographic data, either from a hardcopy or a scanned image, into vector data by tracing the features. During the digitising process, features from the traced map or image are captured as coordinates in either point, line or polygon format (Manjula et al., 2010). There are four main types of digitisations:

1. Manual Digitizing – which is done using a digitising tablet. The digitiser manually traces all lines from the hardcopy map (e.g., Toposheet). The digital maps are then

created on the computer. It is less time consuming and has high accuracy compared with other digitising methods.

2. Heads-up Digitizing – This is similar to manual digitising. The manual digitising process digitises in hardcopy, but in this method, it scans the map directly and displays it on the desktop screen.
3. Interactive Tracing Method – This method is an advanced technique that has evolved from Heads-up digitising. It is quite excellent in terms of accuracy and speed.
4. Automatic Digitizing – This is converting raster to vector in an automated method using pattern recognition and image processing techniques. In this technique, the computer traces all the features on the map; it gives high accuracy with low time consumption. It allows customisation and improved quality of images. This process is also known as vectorisation.

On-screen digitisation is more accurate as compared to manual digitisation. This is because the image's resolution is higher in on-screen digitisation, so the digitiser can zoom the image to the scale of the original raster data and digitise the feature with a higher level of accuracy. On-screen digitisation is predominantly used in GIS industries.

To highlight the individual households, areas were digitised using on-screen digitisation and the surrounding road network layer digitisation. Layers are the mechanisms used to display geographic datasets in ArcGIS. The created layers were overlayed on the geo-referenced-base map and distinct features categorised for the analysis (Das et al., 2019).

Buffer Analysis

Buffers are boundaries placed around areas (e.g., the boundary of an administrative unit) or points (e.g., a household or the centroid of an administrative unit) using a predefined scale, with either a straight-line (Euclidean) or network distance. Buffers help capture all features of the built environment that surround a particular location. For example, the number of supermarkets within a buffer might be used to estimate a household's accessibility to supermarkets, among other factors. However, limitations include the binary representation of features (e.g., it is either considered in or out of the buffer), which can be overcome with the consideration of a fuzzy (using a decreasing weight function for distances further away) rather than sharp boundary (Chaix et al., 2009). Buffers are readily created within a GIS once the user has defined the scale, type (Euclidean and network distance), and point of origin (e.g., around a household or centroid). However, these decisions should be informed by the hypothesised relationship between the exposure and outcome (Diez, 2001). For example, a study by Spinney & Millward (2013) found the mean travel distance to an exercise centre as 4.71km; based on these findings, the researcher chose 2km, 5km and 10km as the radius of measure to explore the effects on accessibility on the various variables.

Generation of Variables

The researcher generated four new variables based on the dataset from the Ghana Obesity Survey and the key files from the Ghana Statistical Service. First, the plotted data of individual households were geocoded and migrated to ArcGIS to create these variables. Here the plotted data was saved as a shapefile for easy use and overlay. The new shapefile of individual households was then overlayed on the topographic base map of Ghana. Next, using the outlined areas of the base map, the metropolis under consideration were highlighted and set as fields of interest. This restriction then allowed the researcher to focus only on features and attributes of the three selected metropolises. The researcher then created a buffer of 2km, 5km and 10km to capture various features of the built environment, such as fast foods, supermarkets, restaurants and gyms/sports centres.

Results

After creating the base topographic map, the individually digitized households compiled as a layer shapefile were overlayed on the base map. In addition, the digitized road network was overlayed on the same topographic map with the individual household shapefile. The resultant image showed the various layers overlayed, consisting of the topologically connected junctions and edges.

Generated Variables

A total number of 24 variables were created (see table 1). The variables generated covered Fast foods, Supermarkets, Restaurants and Sports Centres.

Table 1: List of generated variables and specifications

Variable	Specification
Fast foods	This variable was created to represent all the physical structures of fast-food vendors in the 3 selected metropolis.
Restaurants	The restaurants were categorized based on their naming. In total 11,141 unique locations were identified and plotted accordingly with their unique attributes.
Gyms / Sports Centres	The total number of sports centres & shops identified were 634. These were all plotted and assigned their respective attributes in ArcGIS
Supermarkets	The total number of supermarkets identified were 214. These were all plotted and assigned their respective attributes in ArcGIS.
Fast foods within 10km	This variable was created to represent all the physical locations of fast-foods within a 10km radius of an individual household.
Fast foods within 5km	This variable was created to represent all the physical locations of fast-foods within a 5km radius of an individual household.
Fast foods within 2km	This variable was created to represent all the physical locations of fast-foods within a 10km radius of an individual household.
Restaurants within 10km	This variable was created to represent all the physical locations of restaurants within a 10km radius of an individual household.
Restaurants within 5km	This variable was created to represent all the physical locations of restaurants within a 5km radius of an individual household.
Restaurants within 2km	This variable was created to represent all the physical locations of restaurants within a 2km radius of an individual household.
Gyms / Sports centres within 10km	This variable was created to represent all the physical locations of gyms / sports centres within a 10km radius of an individual household.
Gyms / Sports centres within 5km	This variable was created to represent all the physical locations of gyms / sports centres within a 5km radius of an individual household.
Gyms / Sports centres within 2km	This variable was created to represent all the physical locations of gyms / sports centres within a 2km radius of an individual household.
Supermarkets within 10km	This variable was created to represent all the physical locations of supermarkets within a 10km radius of an individual household.
Supermarkets within 5km	This variable was created to represent all the physical locations of supermarkets within a 5km radius of an individual household.
Supermarkets within 2km	This variable was created to represent all the physical locations of supermarkets within a 2km radius of an individual household.
Fast-foods Average Straight-line Distance	This variable was created to represent the average straight-line distance from an individual household to any fast-food location in a given enumeration area.
Restaurant Average Straight-line Distance	This variable was created to represent the average straight-line distance from an individual household to any restaurant location in a given enumeration area.

Variable	Specification
Gyms / Sports Centres Average Straight-line Distance	This variable was created to represent the average straight-line distance from an individual household to any gym/sports centre location in a given enumeration area.
Supermarket Average Straight-line Distance	This variable was created to represent the average straight-line distance from an individual household to any supermarket location in a given enumeration area.
Fast-foods Average Straight-line Distance (Municipal)	This variable was created to represent the average straight-line distance from an individual household to any fast-food location in a given municipality.
Restaurant Average Straight-line Distance (Municipal)	This variable was created to represent the average straight-line distance from an individual household to any restaurant location in a given municipality.
Gyms / Sports Centres Average Straight-line Distance (Municipal)	This variable was created to represent the average straight-line distance from an individual household to any gym/sports centre location in a given municipality.
Supermarket Average Straight-line Distance (Municipal)	This variable was created to represent the average straight-line distance from an individual household to any supermarket location in a given municipality.

Fast foods

In total, 15089 physical fast-foods were identified in the three selected metropolises – Accra, Kumasi and Tamale. Of this, many were in the Accra metropolis (n = 14660), and a few (n= 288). Most of the fast-food joints in the Accra metropolis were located in the Anum Aban Square (n = 460) and the Las Palmas (n = 459). See table 2 for the location and counts of the fast-food variable

Table 2: Count of Fast foods per Community

Enumeration Area	Metropolis	Count of Fast foods
Anum Aban Square	Greater Accra	460
Las Palmas Restaurant	Greater Accra	459
Carpentry Shop (H/No. B381/26)	Greater Accra	456
Rasoul Alarkham Mosque	Greater Accra	452
Tesano Club	Greater Accra	451
Little Canan	Greater Accra	449
Islamic Centre for Education and Development	Greater Accra	449

Enumeration Area	Metropolis	Count of Fast foods
Shalom Video Centre	Greater Accra	440
Georgina Store	Greater Accra	440
Great Hollandians H/No. E260/12	Greater Accra	437
Osmanu Bon Al-Fan Mosque	Greater Accra	437
Goil Filling Station	Greater Accra	427
Sally Vicks Chemical Shop	Greater Accra	418
Ridge Hospital	Greater Accra	417
The Church of Pentecost	Greater Accra	415
Abass Stationery Dealer	Greater Accra	415
Post Office	Greater Accra	414
African House	Greater Accra	411
Universal Word Power Mission	Greater Accra	404
SDA Church	Greater Accra	402
Emma's Chemical Shop	Greater Accra	401
Revival Fire Chapel International	Greater Accra	401
Alhaji Kpeze's House	Greater Accra	398
Metropolitan Insurance Co. Ltd	Greater Accra	398
St. Anthony Prep. & J.H.S.	Greater Accra	396
Anchor House	Greater Accra	394
Bukom Square	Greater Accra	391
Jankony Bath House	Greater Accra	391
Edegray Memorial School	Greater Accra	381
Santana Guest House	Greater Accra	381
Kingdom Hall Of Jehovah Witness	Greater Accra	372
Nativity Presby Church	Greater Accra	348
Jokers Restaurant	Greater Accra	311
His Majesty Hotel	Greater Accra	308
Kofi Nyame Bekyere House	Greater Accra	288
Florida City	Greater Accra	288
Derbes Hair Klinik	Greater Accra	10
Osei Kuffour Memorial House Plt.4 Blk Xii	Greater Accra	10

Enumeration Area	**Metropolis**	**Count of Fast foods**
Habmay Pharmacy Annex	Greater Accra	10
Buokrom M/A Primary	Greater Accra	10
Palm Wine Bar	Greater Accra	10
Bomso Clinic	Greater Accra	10
Nana Fobi Memorial House (A.S 19)	Greater Accra	10
Jones E. Oteng Chemical Store	Greater Accra	10
New Life Herbal Clinic	Greater Accra	10
H/No. Plot 10 Block 2 (10) (Mile Post 3)	Greater Accra	10
P. G’s Plaza	Greater Accra	10
Faith Assemblies of God Church	Greater Accra	10
Plt. 7 Blk. 20	Greater Accra	10
Way & Pharmacy Limited	Greater Accra	10
Good Shepherd School	Greater Accra	10
Castillo Inn (Bh 7)	Greater Accra	10
All Saints Catholic Church	Ashanti	10
Mama B's Home Lodge	Ashanti	10
New Hotel	Ashanti	10
Tawfikiya Islamic School	Ashanti	9
Donewell Academy	Ashanti	9
Liberty Ministry International Church	Ashanti	9
I-Zakan Lic. Chem. Seller	Ashanti	9
Edwenase	Ashanti	9
Megzet Health And Beauty Clinic	Ashanti	9
Vra Transformer	Ashanti	9
Iadiya Primary School	Ashanti	9
S.D.A Primary School	Ashanti	9
Modex Filling Station	Ashanti	9
Seidu Awudu's Welding Shop	Ashanti	9
Mosque	Ashanti	9
A.M.E. Zion Primary School	Ashanti	9
Abdallah Alhassah	Ashanti	9

Enumeration Area	**Metropolis**	**Count of Fast foods**
Agapet Filling Station	Ashanti	9
Itiriya Eng./Arabic School	Ashanti	9
Zaitun Printing Press	Ashanti	9
Fulera Maternity Home	Ashanti	9
Club 2000	Ashanti	9
H/No. Che 233	Ashanti	9
1st November 1954 J.S. S	Northern	9
Norrip Primary School	Northern	9
Anbariya Islamic Institute	Northern	9
Northern School of Business (Nobisco)	Northern	9
Send Foundation of West Africa	Northern	9
Baptist Church	Northern	9
Sheikino Clinic	Northern	9
Charity Preparatory School	Ashanti	9
T.M.A. Office	Northern	9
Our Lady of Fatima Sch. Complex	Ashanti	9
The Base Spot	Greater Accra	9
Kabsad Scientific Hospital	Northern	9
Tssah Musa Chemical Store	Greater Accra	9
Kalpohini Kamaria Basic School	Greater Accra	9
Calid	Northern	9
Chief's Palace	Northern	9
Queen Salon	Greater Accra	9
West African Natural Health Service	Northern	8
Vineyard Charismatic Baptist Temple	Northern	8
Gallo House	Ashanti	8
Mighty God Ministries	Ashanti	8
Enapa Pub	Ashanti	7
Methodist Church	Greater Accra	7
Church Of Pentecost	Ashanti	5
Mosque Near H/No. Ch Blk.175	Ashanti	4

Enumeration Area	Metropolis	Count of Fast foods
Lari-Ni, Women Agric Processing Rice Huler	Greater Accra	4
Choggu Yapalsi L/A Primary School	Northern	4
Hse No. Plt 10a Blk B	Northern	2
Grand Total		**15088**

Restaurants

A total of 11,141 restaurants were identified in the three metropolises. Like the fast-food joints, many of the restaurants were in the Accra metropolis (n= 8,061), with the majority of these in the Anum Aban Square (n = 335) in the Accra metropolis. Other enumerated areas with many restaurants were the Carpentry shop area (n = 325), Rasoul Alarkham Mosque (n = 324), and the Las Palmas area (n = 323). See table 3 for the counts of restaurants per communities.

Table 3: Count of Restaurants per Communities in the Accra, Kumasi and Tamale Metropolises

Communities	Count of Restaurants
Anum Aban Square	335
Carpentry Shop (H/No. B381/26)	325
Rasoul Alarkham Mosque	324
Las Palmas Restaurant	323
Little Canan	322
Islamic Centre for Education and Development	322
Osmanu Bon Al-Fan Mosque	313
Great Hollandians H/No. E260/12	313
Tesano Club	307
Goil Filling Station	306
Nativity Presby Church	305
Georgina Store	298
Shalom Video Centre	298
Ridge Hospital	290
Anchor House	285
His Majesty Hotel	284
Jokers Restaurant	278
Sally Vicks Chemical Shop	272
The Church of Pentecost	259
Abass Stationery Dealer	259
Post Office	256
Metropolitan Insurance Co. Ltd	255
African House	254
Emma's Chemical Shop	247

Communities	Count of Restaurants
Jankony Bath House	244
SDA Church	242
Revival Fire Chapel International	242
Bukom Square	238
Alhaji Kpeze's House	225
Universal Word Power Mission	221
St. Anthony Prep. & J.H.S.	199
Edegray Memorial School	184
Santana Guest House	182
Kingdom Hall Of Jehovah Witness	166
Florida City	116
Kofi Nyame Bekyere House	116
Palm Wine Bar	31
Osei Kuffour Memorial House Plt.4 Blk Xii	31
Bomso Clinic	31
All Saints Catholic Church	31
P. G’s Plaza	31
Plt. 7 Blk. 20	31
H/No. Plot 10 Block 2 (10) (Mile Post 3)	31
Derbes Hair Klinik	31
Faith Assemblies of God Church	31
Castillo Inn (Bh 7)	31
Gallo House	31
Way & Pharmacy Limited	31
Liberty Ministry International Church	31
Nana Fobi Memorial House (A.S 19)	30
Jones E. Oteng Chemical Store	30
Buokrom M/A Primary	30
Good Shepherd School	30
New Life Herbal Clinic	30
Mama B's Home Lodge	29
Edwenase	29
New Hotel	29
Vineyard Charismatic Baptist Temple	28
Donewell Academy	28
West African Natural Health Service	28
Habmay Pharmacy Annex	28
Charity Preparatory School	27
Modex Filling Station	27
1st November 1954 J.S. S	25
H/No. Che 233	25
Mosque	25
Anbariya Islamic Institute	25
Seidu Awudu's Welding Shop	25
Baptist Church	25
Kalpohini Kamaria Basic School	25
Norrip Primary School	25

Communities	Count of Restaurants
Tawfikiya Islamic School	25
Northern School Of Business (Nobisco)	25
Mighty God Ministries	25
Itiriya Eng./Arabic School	25
S.D.A Primary School	25
Our Lady of Fatima Sch. Complex	25
A.M.E. Zion Primary School	25
Calid	25
Send Foundation of West Africa	25
The Base Spot	25
Sheikino Clinic	25
Tssah Musa Chemical Store	25
T.M.A. Office	25
Iadiya Primary School	25
Fulera Maternity Home	25
Chief's Palace	25
Kabsad Scientific Hospital	25
Agapet Filling Station	25
Abdallah Alhassah	25
Vra Transformer	25
Club 2000	25
Zaitun Printing Press	25
I-Zakan Lic. Chem. Seller	25
Queen Salon	25
Megzet Health And Beauty Clinic	23
Methodist Church	22
Enapa Pub	20
Church Of Pentecost	15
Hse No. Plt 10a Blk B	14
Mosque Near H/No. Ch Blk.175	12
Choggu Yapalsi L/A Primary School	12
Lari-Ni, Women Agric Processing Rice Huler	12
Grand Total	**11141**

Sports Centres

The total number of sports centres identified from the three metropolises was 634. Most of them were in the Accra metropolis (n = 479), followed by Tamale (n = 65). The Kumasi metropolis had the lowest number of sport centres (n = 60). In the Accra Metropolis, many of the sport centres were in His Majesty Hotel area (n = 16). See table 4 for detail description of the locations of the sport centres in the three metropolises.

Table 4: Count of Sports centres

Communities	Count of Sports Centres & Shops
His Majesty Hotel	16
Nativity Presby Church	15
Jankony Bath House	15
Ridge Hospital	15
African House	15
Little Canan	15
Anchor House	15
Post Office	15
Anum Aban Square	15
Abass Stationery Dealer	15
Carpentry Shop (H/No. B381/26)	15
Las Palmas Restaurant	15
Emma's Chemical Shop	15
Metropolitan Insurance Co. Ltd	15
Georgina Store	15
Osmanu Bon Al-Fan Mosque	15
Goil Filling Station	15
Rasoul Alarkham Mosque	15
Great Hollandians H/No. E260/12	15
Sally Vicks Chemical Shop	15
Shalom Video Centre	15
Tesano Club	15
The Church of Pentecost	15
Islamic Centre for Education and Development	15
Jokers Restaurant	15
Universal Word Power Mission	14
Alhaji Kpeze's House	14
SDA Church	14
Revival Fire Chapel International	14
Bukom Square	14
St. Anthony Prep. & J.H.S.	12
Edegray Memorial School	11
Santana Guest House	11
Kofi Nyame Bekyere House	9
Florida City	9
Kingdom Hall Of Jehovah Witness	9
Our Lady of Fatima Sch. Complex	2
Gallo House	2
A.M.E. Zion Primary School	2

Communities	Count of Sports Centres & Shops
H/No. Che 233	2
Vineyard Charismatic Baptist Temple	2
H/No. Plot 10 Block 2 (10) (Mile Post 3)	2
Donewell Academy	2
Habmay Pharmacy Annex	2
Seidu Awudu's Welding Shop	2
Buokrom M/A Primary	2
The Base Spot	2
I-Zakan Lic. Chem. Seller	2
Zaitun Printing Press	2
Iadiya Primary School	2
Palm Wine Bar	2
Calid	2
Anbariya Islamic Institute	2
Itiriya Eng./Arabic School	2
Faith Assemblies of God Church	2
All Saints Catholic Church	2
Fulera Maternity Home	2
Castillo Inn (Bh 7)	2
Tawfikiya Islamic School	2
Jones E. Oteng Chemical Store	2
Tssah Musa Chemical Store	2
Kabsad Scientific Hospital	2
Way & Pharmacy Limited	2
Kalpohini Kamaria Basic School	2
Derbes Hair Klinik	2
1st November 1954 J.S. S	2
P. G’s Plaza	2
Charity Preparatory School	2
Plt. 7 Blk. 20	2
Chief's Palace	2
Queen Salon	2
Liberty Ministry International Church	2
Edwenase	2
Mama B's Home Lodge	2
S.D.A Primary School	2
Megzet Health And Beauty Clinic	2
Agapet Filling Station	2
Mighty God Ministries	2
Send Foundation of West Africa	2
Modex Filling Station	2

Communities	Count of Sports Centres & Shops
Sheikino Clinic	2
Mosque	2
T.M.A. Office	2
Nana Fobi Memorial House (A.S 19)	2
Baptist Church	2
Club 2000	2
Bomso Clinic	2
New Hotel	2
Good Shepherd School	2
New Life Herbal Clinic	2
VRA Transformer	2
Abdallah Alhassah	2
West African Natural Health Service	2
Northern School of Business (NOBISCO)	2
Osei Kufour Memorial House Plt.4 Blk Xii	2
Norrip Primary School	2
Mosque Near H/No. Ch Blk.175	1
Hse No. Plt 10a Blk B	1
Choggu Yapalsi L/A Primary School	1
Enapa Pub	1
Lari-Ni, Women Agric Processing Rice Huler	1
Methodist Church	1
Church Of Pentecost	1
Grand Total	**634**

Supermarkets

The number of supermarkets in the three metropolises was 2481. Accra metropolis had most of them (n = 998), and many of these were in the Anum Aban Square (n = 75). Table 5 shows the number of supermarkets located in communities within the three metropolises.

Table 5: Count of supermarkets

Regions	Enumeration Area	Count Of Supermarket
Greater Accra	Anum Aban Square	75
Greater Accra	Rasoul Alarkham Mosque	69
Greater Accra	Carpentry Shop (H/No. B381/26)	67
Ashanti	Las Palmas Restaurant	65
Ashanti	Little Canan	65
Northern	Islamic Centre for Education & Development	65

Regions	Enumeration Area	Count Of Supermarket
Northern	Great Hollandians H/No. E260/12	62
Northern	Osmanu Bon Al-Fan Mosque	62
Northern	Tesano Club	62
Ashanti	Nativity Presby Church	60
Ashanti	Goil Filling Station	59
Greater Accra	Georgina Store	59
Northern	Shalom Video Centre	59
Ashanti	His Majesty Hotel	57
Greater Accra	Abass Stationery Dealer	56
Northern	Ridge Hospital	56
Northern	The Church of Pentecost	56
Greater Accra	Sally Vicks Chemical Shop	55
Northern	Post Office	54
Ashanti	Metropolitan Insurance Co. Ltd	53
Greater Accra	Anchor House	53
Ashanti	Jokers Restaurant	51
Greater Accra	African House	49
Greater Accra	Revival Fire Chapel International	48
Northern	SDA Church	48
Ashanti	Universal Word Power Mission	47
Greater Accra	Alhaji Kpeze's House	47
Greater Accra	Emma's Chemical Shop	47
Greater Accra	Jankony Bath House	44
Greater Accra	Bukom Square	43
Northern	St. Anthony Prep. & J.H.S.	43
Greater Accra	Kingdom Hall Of Jehovah Witness	33
Greater Accra	Santana Guest House	32
Greater Accra	Edegray Memorial School	31
Greater Accra	Florida City	27
Northern	Kofi Nyame Bekyere House	27
Ashanti	H/No. Che 233	11
Ashanti	Northern School of Business (Nobisco)	11
Ashanti	Our Lady of Fatima Sch. Complex	11
Ashanti	Vra Transformer	11
Greater Accra	Iadiya Primary School	11
Greater Accra	Itiriya Eng./Arabic School	11
Greater Accra	Kalpohini Kamaria Basic School	11
Greater Accra	Queen Salon	11
Greater Accra	S.D.A Primary School	11
Greater Accra	Send Foundation of West Africa	11
Greater Accra	Sheikino Clinic	11

Regions	Enumeration Area	Count Of Supermarket
Greater Accra	Tawfikiya Islamic School	11
Greater Accra	The Base Spot	11
Greater Accra	Tssah Musa Chemical Store	11
Northern	1st November 1954 J.S. S	11
Northern	A.M.E. Zion Primary School	11
Northern	Abdallah Alhassah	11
Northern	Agapet Filling Station	11
Northern	Anbariya Islamic Institute	11
Northern	Baptist Church	11
Northern	Calid	11
Northern	Chief's Palace	11
Northern	Club 2000	11
Northern	Fulera Maternity Home	11
Northern	I-Zakan Lic. Chem. Seller	11
Northern	Kabsad Scientific Hospital	11
Northern	Mosque	11
Northern	Norrip Primary School	11
Northern	Seidu Awudu's Welding Shop	11
Northern	T.M.A. Office	11
Northern	Zaitun Printing Press	11
Ashanti	Megzet Health And Beauty Clinic	10
Ashanti	All Saints Catholic Church	9
Ashanti	Castillo Inn (Bh 7)	9
Ashanti	Derbes Hair Klinik	9
Ashanti	Faith Assemblies of God Church	9
Ashanti	New Hotel	9
Northern	New Life Herbal Clinic	9
Ashanti	Charity Preparatory School	8
Ashanti	Edwenase	8
Ashanti	H/No. Plot 10 Block 2 (10) (Mile Post 3)	8
Ashanti	P. G’s Plaza	8
Ashanti	Palm Wine Bar	8
Ashanti	Way & Pharmacy Limited	8
Greater Accra	Habmay Pharmacy Annex	8
Greater Accra	Osei Kuffour Memorial House Plt.4 Blk Xii	8
Greater Accra	Plt. 7 Blk. 20	8
Ashanti	Bomso Clinic	7
Ashanti	Buokrom M/A Primary	7
Ashanti	Donewell Academy	7
Ashanti	Gallo House	7
Greater Accra	Good Shepherd School	7

Regions	Enumeration Area	Count Of Supermarket
Greater Accra	Liberty Ministry International Church	7
Greater Accra	Nana Fobi Memorial House (A.S 19)	7
Northern	Jones E. Oteng Chemical Store	7
Northern	Mama B's Home Lodge	7
Northern	Modex Filling Station	7
Ashanti	Enapa Pub	6
Ashanti	Mighty God Ministries	6
Northern	Vineyard Charismatic Baptist Temple	6
Northern	West African Natural Health Service	6
Ashanti	Church Of Pentecost	4
Ashanti	Mosque Near H/No. Ch Blk.175	4
Greater Accra	Lari-Ni, Women Agric Processing Rice Huler	4
Northern	Choggu Yapalsi L/A Primary School	4
Northern	Hse No. Plt 10a Blk B	4
Greater Accra	Methodist Church	3
Greater Accra	Ghana Secondary School	1

Buffer results

Number of facilities located within 10km, 5km and 2km in the metropolises

Fast food joints were the most common facilities located within 10km, 5km and 2km radius in the enumerated areas within the metropolises. This was followed by restaurants, supermarkets gyms. Tables 6 to 8 provides a detailed description of the number of fast-food joints, restaurants, supermarkets and gyms located within the specified radius in the enumerated areas, respectively.

Table 6: 10km buffer analysis showing count of facilities in enumerated areas.

Enumeration Area	Regions	Count of Fast Food 10km	Count of Supermarket 10km	Count of Restaurants 10km	Count of Gym/Sports centres 10km
Abass Stationery Dealer	Greater Accra	415	56	258	15
African House	Greater Accra	411	49	254	15
Alhaji Kpeze's House	Greater Accra	398	47	225	14
Anchor House	Greater Accra	394	53	285	15
Anum Aban Square	Greater Accra	460	75	335	15

Bukom Square	Greater Accra	391	43	238	14
Carpentry Shop (H/No. B381/26)	Greater Accra	456	67	325	15
Edegray Memorial School	Greater Accra	381	31	184	11
Emma's Chemical Shop	Greater Accra	401	47	247	15
Florida City	Greater Accra	286	27	115	9
Georgina Store	Greater Accra	439	59	298	15
Goil Filling Station	Greater Accra	427	59	306	15
Great Hollandians H/No. E260/12	Greater Accra	437	62	312	15
His Majesty Hotel	Greater Accra	308	57	284	16
Islamic Centre for Education and Development	Greater Accra	449	65	322	15
Jankony Bath House	Greater Accra	391	44	244	15
Jokers Restaurant	Greater Accra	310	51	277	15
Kingdom Hall Of Jehovah Witness	Greater Accra	372	33	166	9
Kofi Nyame Bekyere House	Greater Accra	286	27	115	9
Las Palmas Restaurant	Greater Accra	459	65	323	15
Little Canan	Greater Accra	449	65	322	15
Metropolitan Insurance Co. Ltd	Greater Accra	398	53	255	15
Nativity Presby Church	Greater Accra	348	60	303	15
Osmanu Bon Al-Fan Mosque	Greater Accra	437	62	312	15
Post Office	Greater Accra	414	54	256	15

Rasoul Alarkham Mosque	Greater Accra	452	69	324	15
Revival Fire Chapel International	Greater Accra	401	48	242	14
Ridge Hospital	Greater Accra	417	56	290	15
Sally Vicks Chemical Shop	Greater Accra	418	55	272	15
Santana Guest House	Greater Accra	381	32	181	11
SDA Church	Greater Accra	402	48	242	14
Shalom Video Centre	Greater Accra	439	59	298	15
St. Anthony Prep. & J.H.S.	Greater Accra	396	43	199	12
Tesano Club	Greater Accra	450	62	307	15
The Church of Pentecost	Greater Accra	415	56	259	15
Universal Word Power Mission	Greater Accra	403	47	221	14
20th Enterprises Stores/Shopping Centre	Ashanti	0	0	0	0
Alhaji Mahama's House	Ashanti	2	4	14	1
All Saints Catholic Church	Ashanti	10	9	31	2
Bomso Clinic	Ashanti	10	7	31	2
Buokrom M/A Primary	Ashanti	10	7	30	2
Castillo Inn (Bh 7)	Ashanti	10	9	31	2
Charity Preparatory School	Ashanti	9	8	27	2
Church Of Pentecost	Ashanti	5	4	15	1
Derbes Hair Klinik	Ashanti	10	9	31	2
Donewell Academy	Ashanti	9	7	28	2
Edwenase	Ashanti	9	8	29	2
Enapa Pub	Ashanti	7	6	20	1

Faith Assemblies of God Church	Ashanti	10	9	31	2
Gallo House	Ashanti	8	7	31	2
Good Shepherd School	Ashanti	10	7	30	2
H/No. Plot 10 Block 2 (10) (Mile Post 3)	Ashanti	10	8	31	2
Habmay Pharmacy Annex	Ashanti	10	8	28	2
Hse No. Plt 10a Blk B	Ashanti	2	4	14	1
Jones E. Oteng Chemical Store	Ashanti	10	7	30	2
Liberty Ministry International Church	Ashanti	9	7	31	2
Mama B's Home Lodge	Ashanti	10	7	29	2
Methodist Church	Ashanti	7	3	22	1
Mighty God Ministries	Ashanti	8	6	25	2
Modex Filling Station	Ashanti	9	7	27	2
Muntaka Mem Islamic School	Ashanti	8	7	31	2
Nana Fobi Memorial House (A.S 19)	Ashanti	10	7	30	2
New Hotel	Ashanti	10	9	29	2
New Life Herbal Clinic	Ashanti	10	9	30	2
Osei Kuffour Memorial House Plt.4 Blk Xii	Ashanti	10	8	31	2
P.G's Plaza	Ashanti	10	8	31	2
Palm Wine Bar	Ashanti	10	8	31	2
Plt. 7 Blk. 20	Ashanti	10	8	31	2
Public Toilet	Ashanti	10	8	31	2
Vineyard Charismatic Baptist Temple	Ashanti	8	6	28	2
Way & Pharmacy Limited	Ashanti	10	8	31	2

West African Natural Health Service	Ashanti	8	6	28	2
Zaitun Printing Press	Northern	9	11	25	2
A.M.E. Zion Primary School	Northern	9	11	25	2
Club 2000	Northern	9	11	25	2
Abdallah Alhassah	Northern	9	11	25	2
Chief's Palace	Northern	9	11	25	2
Mosque Near H/No. Ch Blk.175	Northern	4	4	12	1
Lari-Ni, Women Agric Processing Rice Huler	Northern	4	4	12	1
Fulera Maternity Home	Northern	9	11	25	2
Sheikino Clinic	Northern	9	11	25	2
1st November 1954 J.S. S	Northern	9	11	25	2
Seidu Awudu's Welding Shop	Northern	9	11	25	2
Agapet Filling Station	Northern	9	11	25	2
Baptist Church	Northern	9	11	25	2
Norrip Primary School	Northern	9	11	25	2
Tawfikiya Islamic School	Northern	9	11	25	2
Megzet Health And Beauty Clinic	Northern	9	10	23	2
Calid	Northern	9	11	25	2
Choggu Yapalsi L/A Primary School	Northern	4	4	12	1
Northern School of Business (Nobisco)	Northern	9	11	25	2
Send Foundation of West Africa	Northern	9	11	25	2
T.M.A. Office	Northern	9	11	25	2
Anbariya Islamic Institute	Northern	9	11	25	2
Queen Salon	Northern	9	11	25	2

Our Lady of Fatima Sch. Complex	Northern	9	11	25	2
Tssah Musa Chemical Store	Northern	9	11	25	2
I-Zakan Lic. Chem. Seller	Northern	9	11	25	2
H/No. Che 233	Northern	9	11	25	2
Itiriya Eng./Arabic School	Northern	9	11	25	2
Kalpohini Kamaria Basic School	Northern	9	11	25	2
Iadiya Primary School	Northern	9	11	25	2
S.D.A Primary School	Northern	9	11	25	2
The Base Spot	Northern	9	11	25	2
Mosque	Northern	9	11	25	2
VRA Transformer	Northern	9	11	25	2
KABSAD Scientific Hospital	Northern	9	11	25	2
Ghana Secondary School	Northern	0	1	0	0

Table 7: 5km buffer analysis showing count of each facility in the three metropolises

Enumeration Area	Count of Fast Food 5km	Count of Supermarket 5km	Count of Restaurants 5km	Count of Gyms 5km
Abass Stationery Dealer	244	15	75	5
African House	182	17	79	6
Alhaji Kpeze's House	25	11	37	1
Anchor House	240	20	156	11
Anum Aban Square	256	28	135	10
Bukom Square	30	12	64	4
Carpentry Shop (H/No. B381/26)	209	22	81	4
Edegray Memorial School	19	6	24	0
Emma's Chemical Shop	97	14	66	5
Florida City	9	4	12	0
Georgina Store	311	20	82	5
Goil Filling Station	265	33	204	14
Great Hollandians H/No. E260/12	277	32	210	15
His Majesty Hotel	35	13	107	4
Islamic Centre for Education And Development	348	27	133	12
Jankony Bath House	86	14	101	5
Jokers Restaurant	137	17	132	8
Kingdom Hall Of Jehovah Witness	16	5	19	0
Kofi Nyame Bekyere House	9	4	12	0
Las Palmas Restaurant	243	16	68	5
Little Canan	348	27	133	12
Metropolitan Insurance Co. Ltd	248	20	149	9
Nativity Presby Church	137	21	127	7
Osmanu Bon Al-Fan Mosque	277	32	210	15
Post Office	244	18	86	7
Rasoul Alarkham Mosque	273	34	207	15
Revival Fire Chapel International	30	12	61	2
Ridge Hospital	253	26	167	12
Sally Vicks Chemical Shop	155	15	60	2
Santana Guest House	17	7	22	1
Sda Church	35	14	57	2
Shalom Video Centre	311	20	82	5

St. Anthony Prep. & J.H.S.	47	10	32	1
Tesano Club	295	20	78	5
The Church of Pentecost	261	15	76	6
Universal Word Power Mission	133	10	43	2
20th Enterprises Stores/Shopping Centre	0	0	0	0
Alhaji Mahama's House	0	0	0	0
All Saints Catholic Church	6	2	19	1
Bomso Clinic	7	6	20	2
Buokrom M/A Primary	2	2	9	1
Castillo Inn (Bh 7)	8	4	22	1
Charity Preparatory School	1	1	6	0
Church Of Pentecost	0	0	0	0
Derbes Hair Klinik	6	3	18	1
Donewell Academy	1	2	6	1
Edwenase	4	3	15	0
Enapa Pub	1	2	1	0
Faith Assemblies of God Church	3	2	17	1
Gallo House	2	3	5	1
Good Shepherd School	7	6	21	2
H/No. Plot 10 Block 2 (10) (Mile Post 3)	1	2	4	1
Habmay Pharmacy Annex	6	2	13	0
Hse No. Plt 10a Blk B	0	0	0	0
Jones E. Oteng Chemical Store	2	2	9	1
Liberty Ministry International Church	3	3	7	1
Mama B's Home Lodge	7	5	17	1
Methodist Church	0	0	0	0
Mighty God Ministries	2	2	12	1
Modex Filling Station	3	3	12	1
Muntaka Mem Islamic School	2	3	5	1
Nana Fobi Memorial House (A.S 19)	7	6	21	2
New Hotel	3	2	6	0
New Life Herbal Clinic	5	2	15	0
Osei Kuffour Memorial House Plt.4 Blk Xii	1	2	4	1
P. G’s Plaza	7	4	24	2
Palm Wine Bar	8	6	28	2
Plt. 7 Blk. 20	8	6	27	2

Public Toilet	8	6	27	2
Vineyard Charismatic Baptist Temple	0	0	2	0
Way & Pharmacy Limited	7	6	27	2
West African Natural Health Service	0	0	2	0
Zaitun Printing Press	5	7	9	2
A.M.E. Zion Primary School	5	7	9	2
Club 2000	9	9	23	2
Abdallah Alhassah	9	9	23	2
Chief's Palace	7	9	21	2
Mosque Near H/No. Ch Blk.175	0	0	0	0
Lari-Ni, Women Agric Processing Rice Huler	0	0	0	0
Fulera Maternity Home	8	10	21	2
Sheikino Clinic	5	9	19	1
1st November 1954 J.S. S	5	9	19	1
Seidu Awudu's Welding Shop	4	4	12	1
Agapet Filling Station	4	4	12	1
Baptist Church	4	4	12	1
Norrip Primary School	4	4	12	1
Tawfikiya Islamic School	6	7	19	1
Megzet Health And Beauty Clinic	2	3	6	1
Calid	9	11	23	2
Choggu Yapalsi L/A Primary School	0	0	0	0
Northern School of Business (Nobisco)	8	10	21	2
Send Foundation of West Africa	9	11	23	2
T.M.A. Office	9	9	23	2
Anbariya Islamic Institute	9	11	24	2
Queen Salon	9	11	23	2
Our Lady of Fatima Sch. Complex	9	9	24	2
Tssah Musa Chemical Store	9	11	23	2
I-Zakan Lic. Chem. Seller	9	11	23	2
H/No. Che 233	9	9	24	2
Itiriya Eng./Arabic School	8	9	21	0
Kalpohini Kamaria Basic School	8	9	21	0
Iadiya Primary School	8	9	21	0

S.D.A Primary School	8	9	21	0
The Base Spot	8	9	21	0
Mosque	8	9	21	0
VRA Transformer	8	9	21	0
KABSAD Scientific Hospital	7	8	21	1
Ghana Secondary School	0	0	0	0

Table 8: 2km buffer analysis showing count of each facility in the metropolises

Enumeration Area	**Count of Fast Food 2km**	**Count of Supermarket 2km**	**Count of Restaurants 2km**	**Count of Gyms 2km**
Abass Stationery Dealer	11	3	12	0
African House	10	3	9	0
Alhaji Kpeze's House	5	2	9	0
Anchor House	27	8	72	3
Anum Aban Square	7	8	26	2
Bukom Square	3	2	8	0
Carpentry Shop (H/No. B381/26)	5	4	5	0
Edegray Memorial School	0	1	3	0
Emma's Chemical Shop	6	2	8	0
Florida City	0	2	1	0
Georgina Store	101	1	20	1
Goil Filling Station	204	4	39	5
Great Hollandians H/No. E260/12	207	4	34	5
His Majesty Hotel	2	2	3	0
Islamic Centre for Education and Development	58	3	21	0
Jankony Bath House	3	3	11	1
Jokers Restaurant	11	4	32	1
Kingdom Hall Of Jehovah Witness	4	2	2	0
Kofi Nyame Bekyere House	0	2	1	0
Las Palmas Restaurant	96	3	15	1
Little Canan	58	3	21	0
Metropolitan Insurance Co. Ltd	5	4	20	1
Nativity Presby Church	5	4	22	0
Osmanu Bon Al-Fan Mosque	207	4	34	5
Post Office	10	5	14	1

Rasoul Alarkham Mosque	202	7	31	6
Revival Fire Chapel International	7	2	8	0
Ridge Hospital	44	6	69	3
Sally Vicks Chemical Shop	48	2	8	0
Santana Guest House	0	1	4	0
SDA Church	10	2	9	0
Shalom Video Centre	101	1	20	1
St. Anthony Prep. & J.H.S.	4	1	6	0
Tesano Club	114	3	21	1
The Church of Pentecost	13	3	12	0
Universal Word Power Mission	5	0	4	0
20th Enterprises Stores/Shopping Centre	0	0	0	0
Alhaji Mahama's House	0	0	0	0
All Saints Catholic Church	1	0	0	0
Bomso Clinic	2	2	5	1
Buokrom M/A Primary	0	0	0	0
Castillo Inn (Bh 7)	3	0	12	1
Charity Preparatory School	0	0	0	0
Church Of Pentecost	0	0	0	0
Derbes Hair Klinik	0	1	6	0
Donewell Academy	0	0	2	0
Edwenase	1	0	1	0
Enapa Pub	0	2	1	0
Faith Assemblies of God Church	1	1	2	0
Gallo House	0	0	0	0
Good Shepherd School	2	1	4	0
H/No. Plot 10 Block 2 (10) (Mile Post 3)	0	0	2	0
Habmay Pharmacy Annex	0	0	1	0
Hse No. Plt 10a Blk B	0	0	0	0
Jones E. Oteng Chemical Store	0	0	0	0
Liberty Ministry International Church	0	0	0	0
Mama B's Home Lodge	0	0	1	0
Methodist Church	0	0	0	0
Mighty God Ministries	0	0	0	0
Modex Filling Station	1	0	0	0

Muntaka Mem Islamic School	0	0	0	0
Nana Fobi Memorial House (A.S 19)	3	1	5	1
New Hotel	0	0	0	0
New Life Herbal Clinic	0	0	1	0
Osei Kuffour Memorial House Plt.4 Blk Xii	0	0	2	0
P. G's Plaza	0	1	1	1
Palm Wine Bar	5	1	8	0
Plt. 7 Blk. 20	2	1	7	1
Public Toilet	2	1	7	1
Vineyard Charismatic Baptist Temple	0	0	0	0
Way & Pharmacy Limited	0	1	2	1
West African Natural Health Service	0	0	0	0
Zaitun Printing Press	0	0	0	0
A.M.E. Zion Primary School	0	0	0	0
Club 2000	3	1	4	1
Abdallah Alhassah	3	1	4	1
Chief's Palace	2	1	2	1
Mosque Near H/No. Ch Blk.175	0	0	0	0
Lari-Ni, Women Agric Processing Rice Huler	0	0	0	0
Fulera Maternity Home	3	2	4	1
Sheikino Clinic	3	3	6	1
1st November 1954 J.S. S	3	3	6	1
Seidu Awudu's Welding Shop	0	2	5	0
Agapet Filling Station	0	2	5	0
Baptist Church	0	2	5	0
Norrip Primary School	0	2	5	0
Tawfikiya Islamic School	4	1	6	0
Megzet Health And Beauty Clinic	0	0	0	0
Calid	3	1	10	0
Choggu Yapalsi L/A Primary School	0	0	0	0
Northern School of Business (Nobisco)	3	2	11	1
Send Foundation of West Africa	0	0	9	0
T.M.A. Office	5	6	9	1
Anbariya Islamic Institute	1	1	11	0

Queen Salon	0	0	9	0
Our Lady of Fatima Sch. Complex	4	6	10	1
Tssah Musa Chemical Store	0	0	9	0
I-Zakan Lic. Chem. Seller	0	0	9	0
H/No. Che 233	4	6	10	1
Itiriya Eng./Arabic School	0	0	0	0
Kalpohini Kamaria Basic School	0	0	0	0
Iadiya Primary School	0	0	0	0
S.D.A Primary School	0	0	0	0
The Base Spot	0	0	0	0
Mosque	0	0	0	0
VRA Transformer	0	0	0	0
KABSAD Scientific Hospital	5	7	10	0
Ghana Secondary School	0	0	0	0

Healthy Diet

Healthy Diet and Fast foods

The map below (figure 1) shows the three metropolises of study with a healthy diet variable plotted in red and blue points (red= not having a healthy diet, blue = having a healthy diet). The yellow points are the fast-food and restaurant locations identified in the study area. The map identifies two concentration points for fast-food and restaurant locations and the associated healthy diet categorization. It shows that the individuals located in the concentration points of the fast-food and restaurant locations do not consume a healthy diet. The spread of individuals with a healthy diet is concentrated at the furthest points of fast-food and restaurant concentration points. Healthy diet concentration points are also predominantly devoid of any fast-food and restaurant location. In some cases, the fast-food and restaurant location is situated on the boundaries of the healthy diet concentration points.

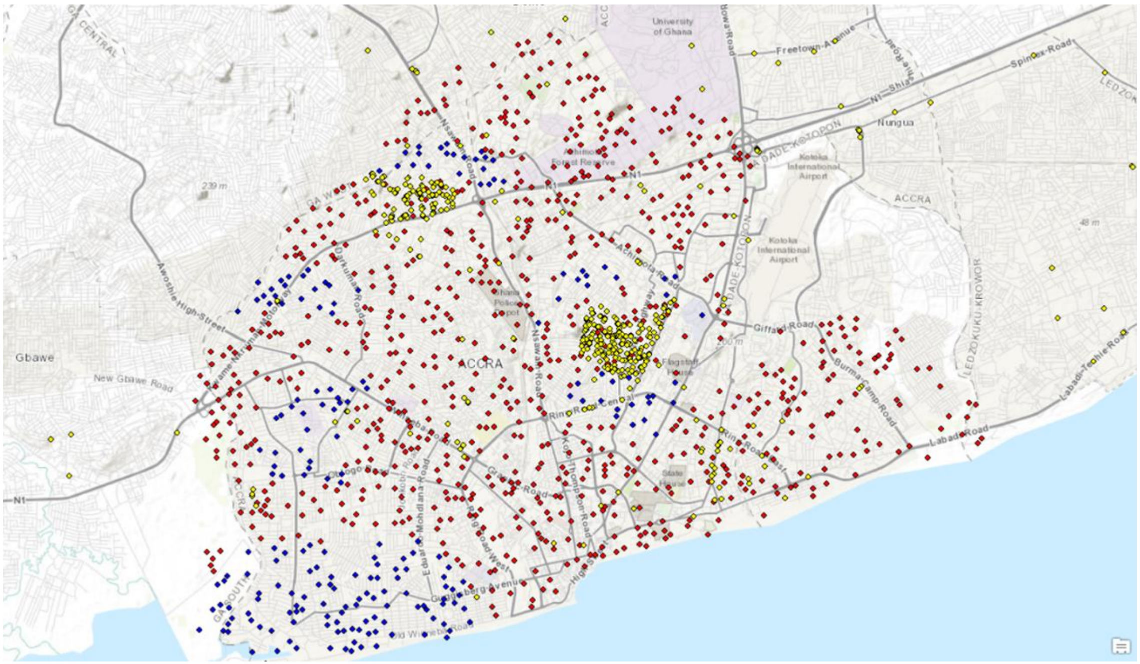

Figure 1: Topographical map depicting Healthy Diet and Fast-food points

Healthy Diet and Sports Centres & Shops

Figure 2 below is a topographic map showing healthy diet and sport centres points in the metropolises. The healthy diet variable is plotted in red and blue points, with red indicating ‘not having a healthy diet and blue describing ‘having a healthy diet, and the sport centres are in green. The map shows that the individuals located in the sports centre’s concentration points do not consume a healthy diet. Healthy diet concentration points are also predominantly devoid of any sports centres. In some cases, the sports centres are situated on the boundaries of the healthy diet concentration points.

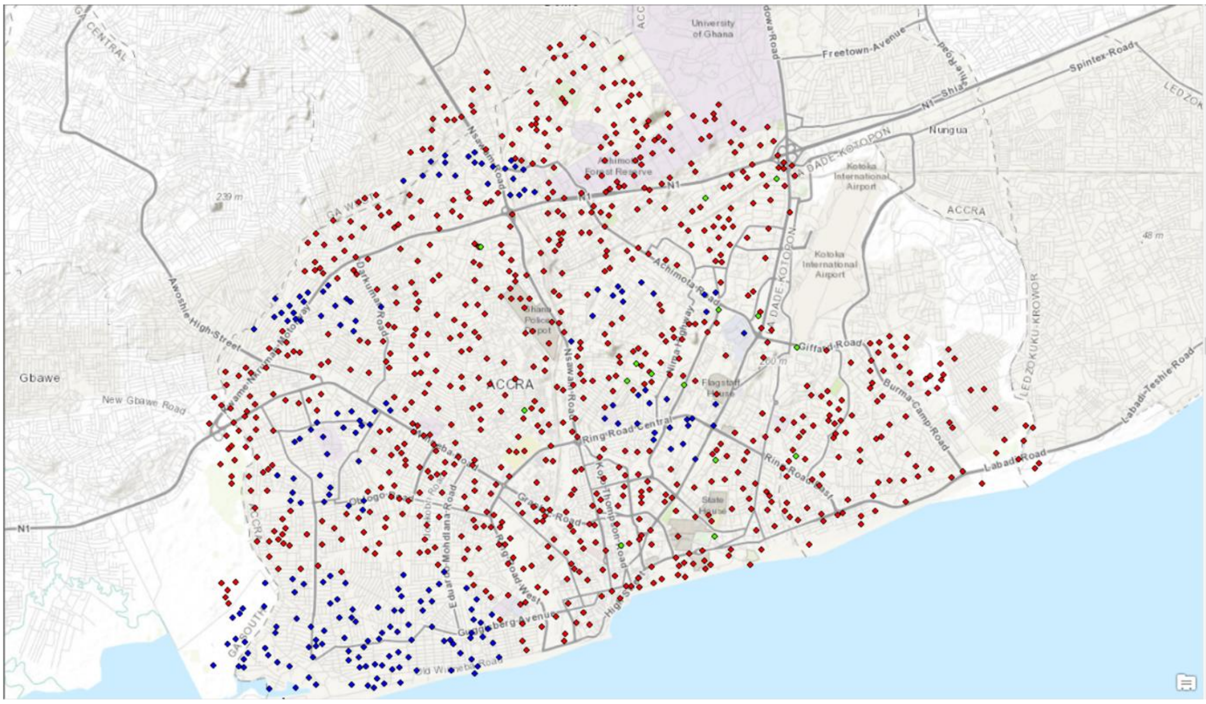

Figure 2: Topographical Map depicting Healthy Diet and Sports centres & shops points

Healthy Diet and Supermarkets

Figure 3 below shows healthy diet and supermarkets concentration points in the metropolises. Like the previous maps, the healthy diet variable is plotted in red and blue points (red= not having a healthy diet, blue = having a healthy diet). The white points are the supermarkets in the enumerated areas. The map indicates that individuals located in the concentration points of the supermarkets do not consume a heathy diet. The individuals located in the healthy diet concentration points were predominantly devoid of any supermarkets. However, in some instances, the supermarkets were in areas where individuals consume a healthy diet.

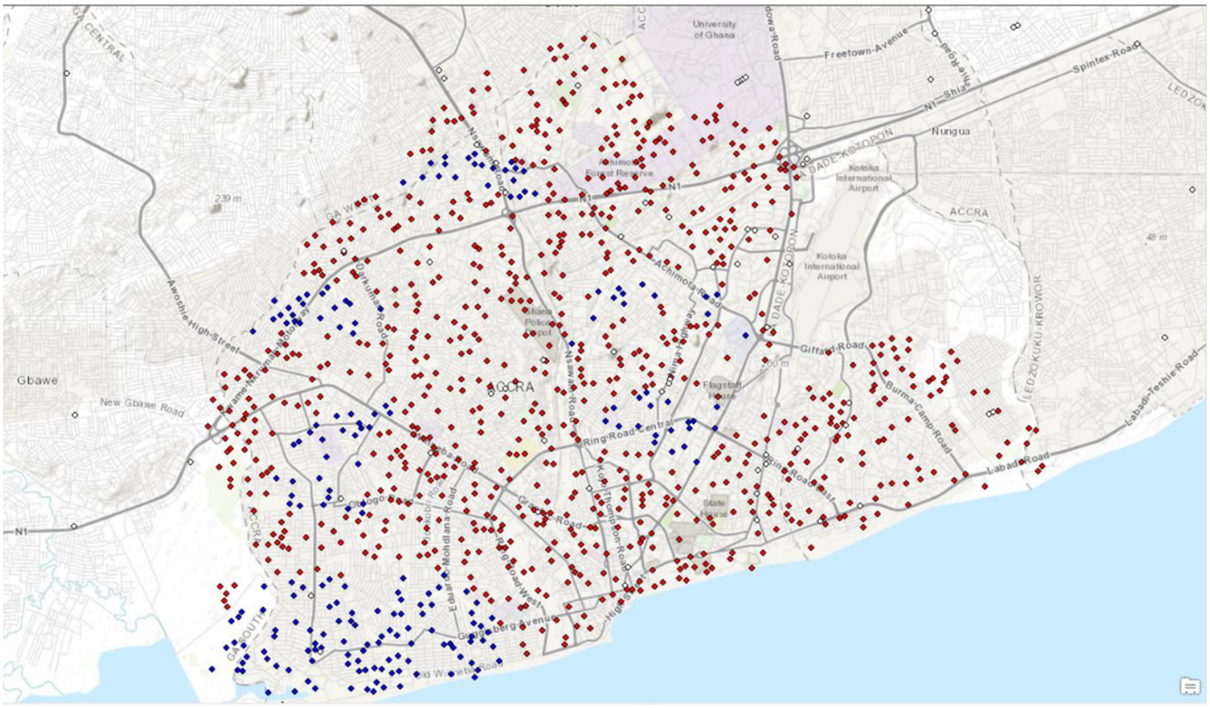

Figure 3: Topographical Map depicting Healthy Diet and supermarket points

Physical Activity

Physical activity and fast-food & restaurants

The map below (Figure 4) shows physical activity and fast foods concentration points in the metropolises. Physical activity is plotted in red and blue (blue= not being physically active, red = being physically active) and fast food & restaurant are in yellow. The map identified a concentration point for fast-foods and restaurants and the associated physical activity categorization. It shows that individuals located at the highest concentration point of fast-foods and restaurants are predominantly physically active. The second concentration point reflected a split between physically active and inactive individuals.

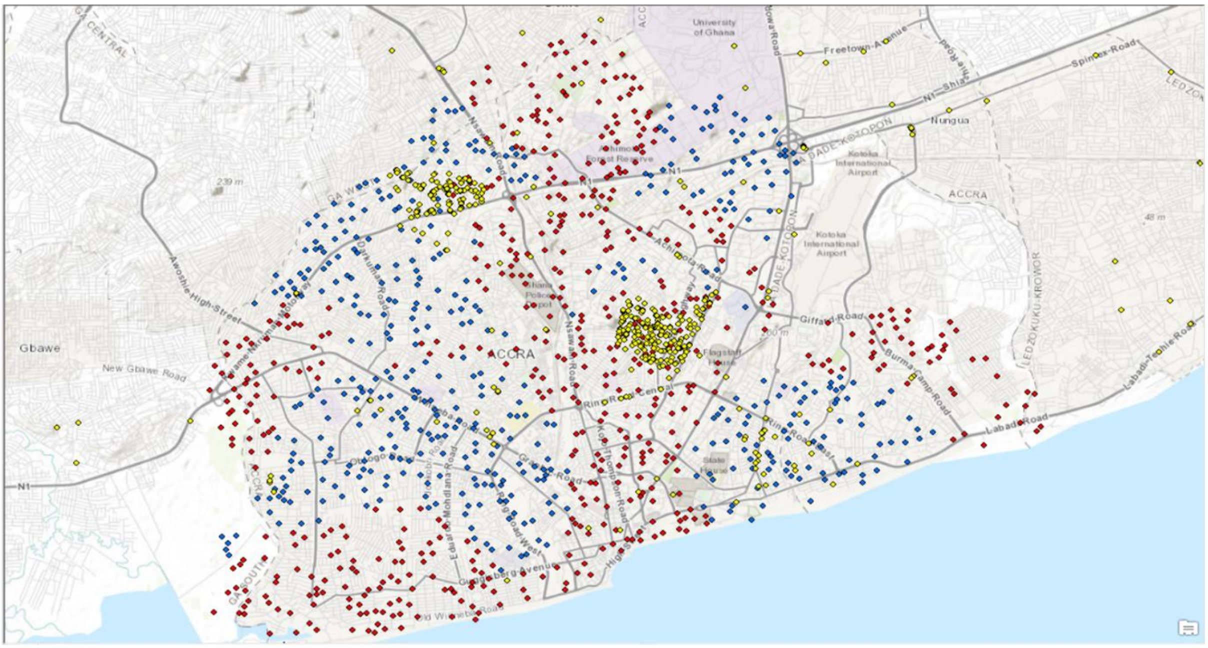

Figure 4: Topographical map depicting physical activity and fast-food points

Physical activity and sports centres

The physical activity map (figure 5) indicated that gyms (plotted in green) were in areas where the individuals were predominantly physically active (plotted in red), with very few facilities located in areas of reduced physical activity (plotted in blue).

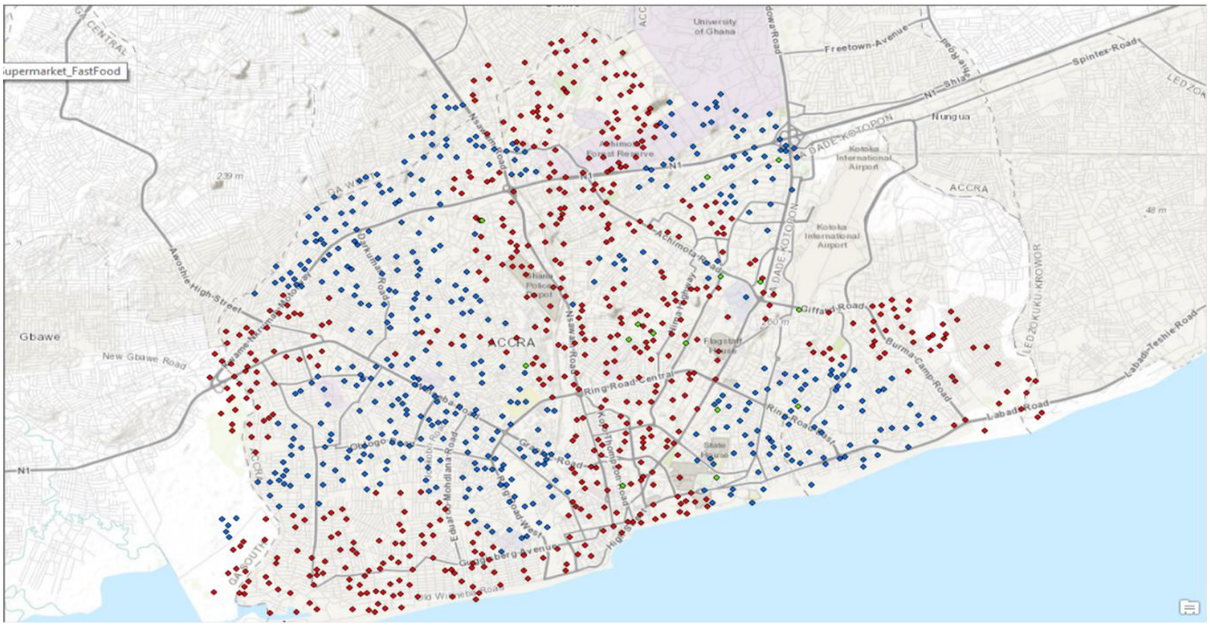

Figure 5: Topographical Map depicting Physical Activity and Sports centres & shops points

Physical activity and supermarkets

Figure 6 shows a topographic map of physical activity, plotted in red and blue points (blue= not being physically active, red = physically active) and supermarkets, plotted in white. It revealed that the supermarkets were in areas where the individuals were predominantly not physically active, with few facilities in areas of physically active individuals.

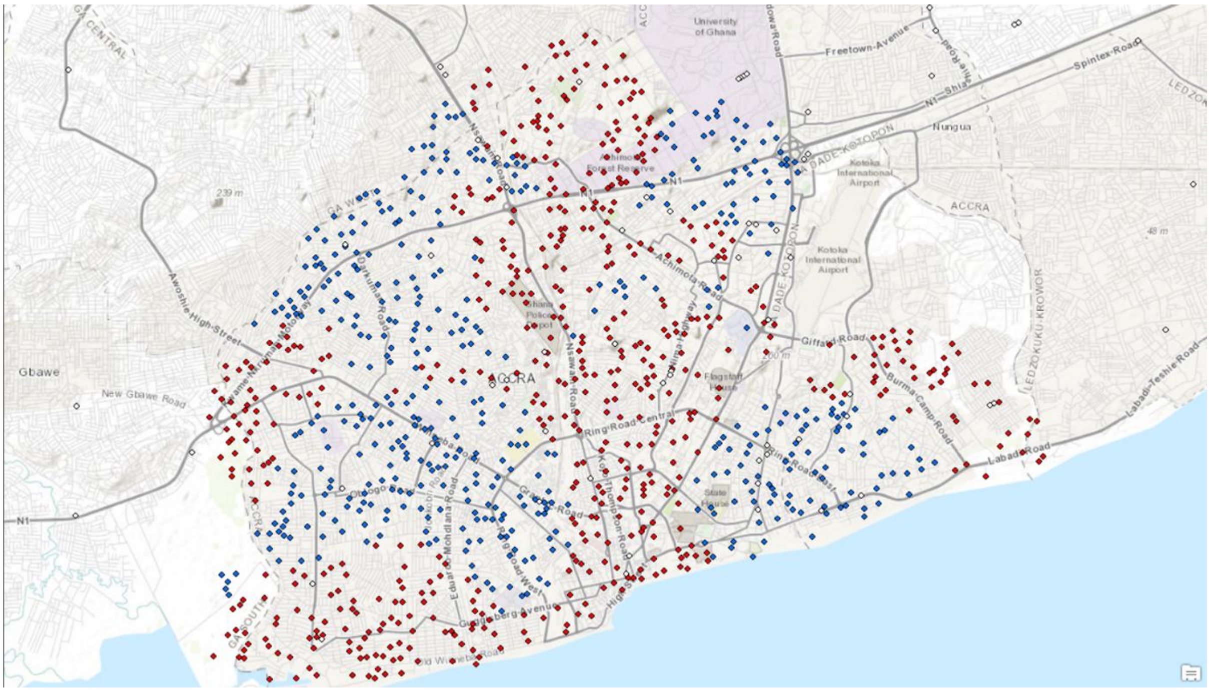

Figure 6: Topographical Map depicting Physical Activity and Supermarket points

Overweight

Overweight and fast foods & restaurants

For overweight and fast foods, the map below (figure 7) shows that individuals in the concentration points of fast-food & restaurants concentration points (yellow plots) were predominantly overweight (overweight is plotted in red and blue points; blue= not overweight, red = overweight). However, there were some restaurants and fast-food joints located in areas where the individuals were not overweight.

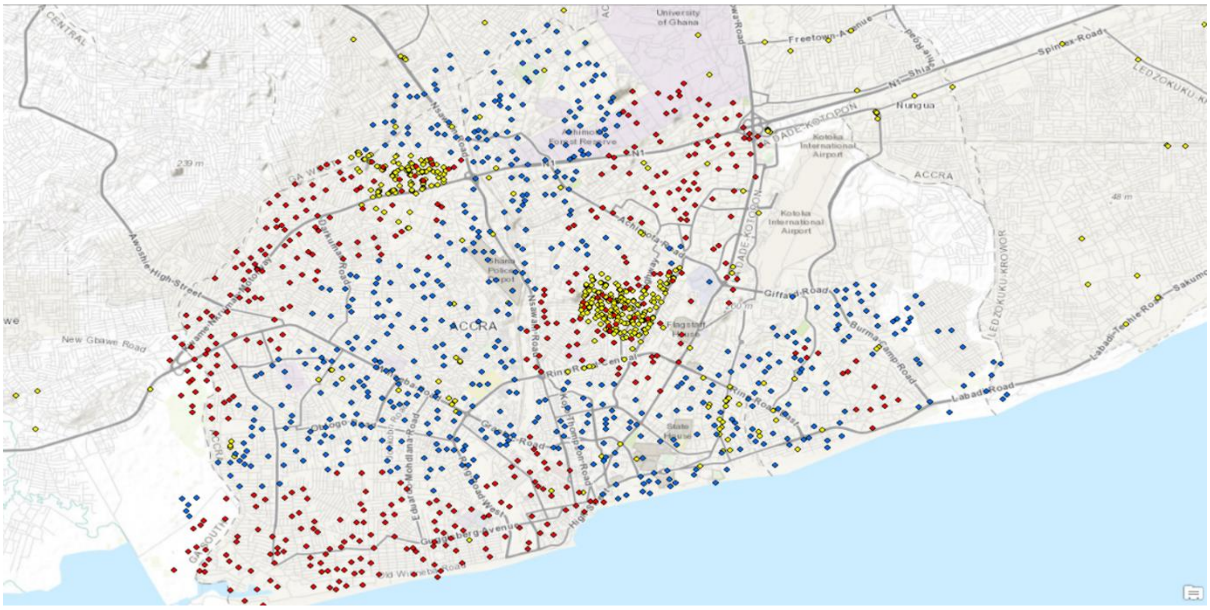

Figure 7: Topographical map depicting overweight and fast-food points

Overweight and sports centres

The map in figure 8 shows the spread of sport centres (plotted in green) in the metropolises. It indicated that the sport centres are in areas where the individuals were overweight, (overweight variable plotted in red and blue points (blue= not overweight, red = overweight). However, a few centres were in communities where individuals were not overweight.

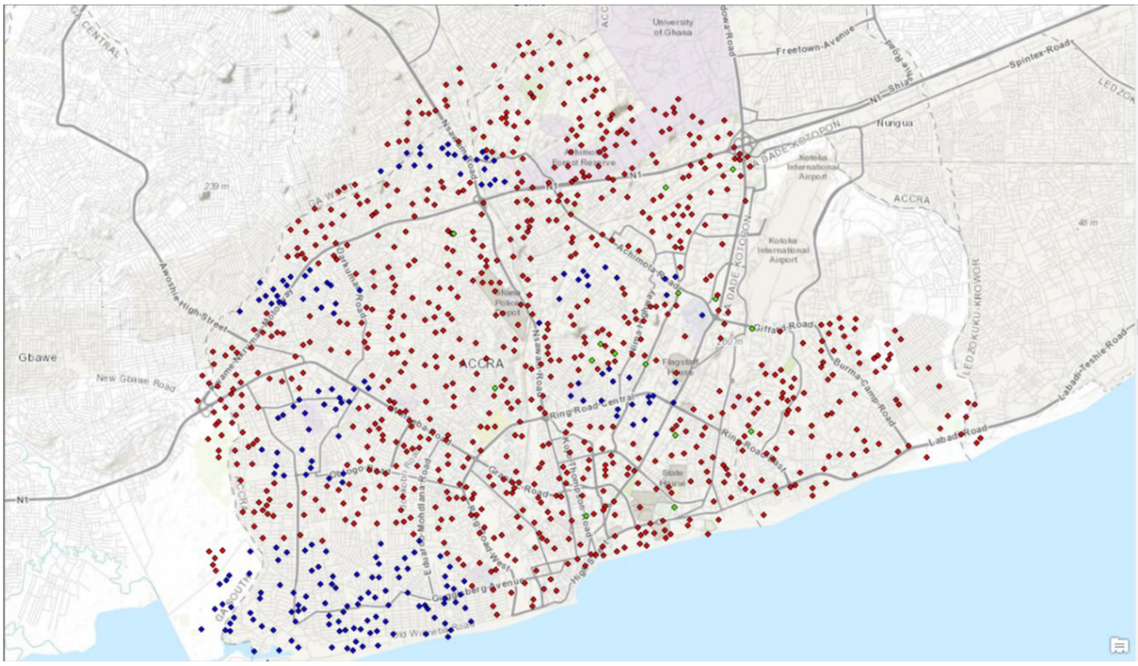

Figure 8: Topographical Map depicting Overweight and Sports centres & shops points

Overweight and supermarkets

For overweight and supermarkets (figure 9), the supermarkets were concentrated (green points) in areas where the individuals were overweight. But there were a few facilities located in communities where individuals were not overweight. The overweight variable is plotted in red and blue points (blue= not overweight, red = overweight).

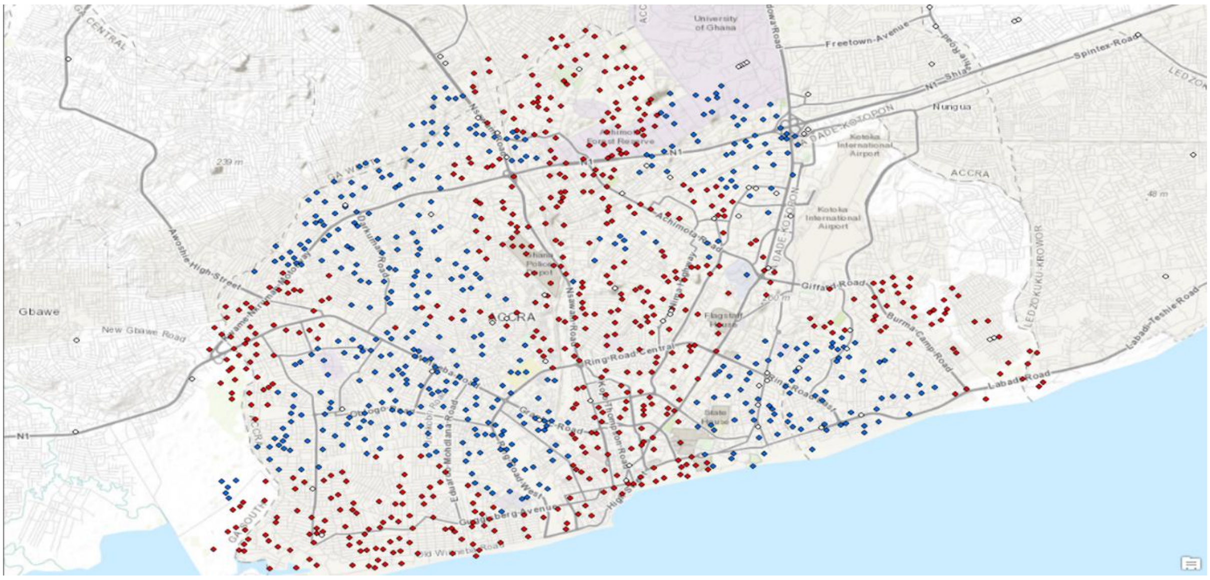

Figure 9: Topographical map depicting overweight and supermarkets points

Discussion

Appendix 10 generated area-level variables, particularly objective measures to supplement the primary data collected in Chapter 5 of the thesis. The rationale was to facilitate the multi-level analysis of obesity, given the evidence on the need for such a complementary approach in analysing area-level determinants of obesity. The area-level variables generated here are similar to those identified in chapter 2. But in quantifiable terms, the variables (n= 15) generated here are more than the area-level studies identified in chapter 2, mainly due to the advanced GIS approach used.

Also, none of the specific studies identified in chapter 2 accounted for the varying levels of accessibility on obesity, i.e., facilities located within 2, 5 and 10km, as demonstrated in this appendix. Generating varying levels of accessibility to specific facilities, i.e., fast foods, gyms and supermarkets, is essential because it provides objective and comparative data to population-level obesity interventions. Comparatively, those studies also included other objective variables, like neighbourhood aesthetics, that were not generated here. Therefore, future studies can generate this variable to investigate its relationship with obesity in Ghana, especially as they have been implicated in the risk factors of obesity.

The maps in this appendix show that obesity appears to be concentrated in certain areas within the metropolises, indicating similar lifestyle characteristics within clusters. This finding, however, is descriptive; thus, it does not provide objective estimates. Nevertheless, the purpose of the GIS analysis here was to generate area-level variables for further empirical analysis in chapter 8 of the thesis and not to examine how cluster characteristics influence the risk of obesity. Such analyses and their subsequent findings are shown in chapter 8 of the thesis.

Appendix 11: Survey responses from the stakeholders

Table 1: Responses to the survey: 'The research findings showed that religion and culture affect obesity in Ghana. For example, it was identified that Muslims are more likely to be obese. Similarly, Gas have a higher tendency to be obese. In your opinion, what are the possible interventions to address these factors?'

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
001	Education on the consequence of obesity. Possible financial interventions to enhance quality nutrition Community based association with the aim of campaigning against obesity in Muslim and traditional religious settings	Education campaigns on consequences of Obesity Financial incentives to enhance quality nutrition Campaign against obesity in religious and traditional settings
002	Late eating, bad diet, lack of exercise, failure to eat Alkaline foods and Alkaline Water!	Campaigns on healthy dietary and exercise practice
003	Government health policy, self-discipline, education, target training and awareness	Government policies on health, Target training and awareness of obesity
004	Intensive public education on the effects of Obesity	Intensive mass education on the effects of Obesity
005	1. Education, advocacy groups, creating recreational centres in these communities 2. Advocacy groups 3. Creating recreational centres in areas these communities	Education and advocacy campaigns on obesity through advocacy groups Recreational centres in target communities
006	Public awareness creation on the phenomenon	Mass awareness on obesity
007	Education on dietary requirements, education on increased physical activities, education on balanced diet, more vegetables less fast food	Education campaigns on dietary requirements, balanced diet and increased physical activity
008	Eat home cooked meal, reduce or avoid intake of roadside food, moderate eating habit, avoid junk foods	Campaigns on consumption of home cooked meal Education on healthy dietary habits

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
009	Regular exercises, eating balance diet, reducing stress, having enough sleep.	Awareness campaigns on regular exercises, balance diet, adequate sleep, and stress reduction
010	1. Change of eating habits among the Gas 2. More education on the effects of obesity by religious leaders 3. Traditional and cultural leaders must link up with the Ghana Health to sensitize the people about obesity 4. Bariatric surgery	Education on dietary habits for Gas Education campaigns on the effects of obesity by religious leaders Public sensitization on obesity by traditional& cultural leaders and Ghana Health Service. Bariatric surgery
011	Proper lessons on food and nutrition should be part of teaching in religious organization Regular medical check must be organized for members Family history and heredity background must be looked at	Teachings on diet in religious organisation Regular Medical checks for target members
012	1. Regular Exercise 2. Education of the health effects on obesity 3. Early childhood education on eating habits 4. Paradigm shift in some religious rituals that contribute to obesity among practitioners	Regular exercise Education campaigns on the health effects of obesity Early education on dietary habits for children Campaigns on religious practices that contribute to obesity
013	For religion, the religious teaching should emphasize on the health risks related to obesity and the need to stay healthy. For the tribes, i think the problem may be much deeper but starting with educating the young ones may help deal the issue. For the adults it may be difficult if not impossible.	Religious teachings on the health risk associated with obesity Education campaigns on obesity for the youth
014	Physical activities	Campaigns on Physical activities
015	1.Physical activities e.g exercising 2.Good eating habits	Campaigns on exercises and dietary habits
016	Education, Healthy Lifestyle, Routine Check-ups	Education on healthy lifestyle Routine check-ups

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
017	Public Education to change the Public education on food and nutrition	Mass/public education on food and nutrition
018	Education Regular Physical Activity Healthy Eating Weight Management Programs	Education campaigns on obesity Regular physical activity Campaigns on healthy eating Weight management programs
019	1. Education on balanced diet 2.Education on importance exercise 3. Desisting from sugar -sweetened beverages 4. Pregnant women should visit often for their antenatal and adhere to good practices taught 5. More education on co morbidities associated with obesity.	Education campaigns on balanced diet Education campaigns on importance of exercises Campaigns on desisting from sugar-sweetened beverages Education of pregnant women on antenatal visits adherence Education campaigns on comorbidities associated with obesity
020	1. Reduce the intake of bad fat food 2. Do more exercise 3. Less of sugary food 4. More fibre food 5. More of vegetables	Education campaigns on the benefits of diets high in fibre vegetables, and less in bad fat and sugar Education on exercises
021	Health promotion on healthy eating on radio station and television station will be of benefit to them	Mass-media education campaigns on healthy diet
022	1. Mass Public Education through social media and traditional media. 2. Involving religious organisations and traditional authorities in educating the public on obesity 3. Introduction of compulsory diet education for every client at our health facilities	Mass-media education on obesity using religious and traditional leaders Compulsory dietary education at health facilities
023	Regular education on the relating causes of obesity amongst these predominant groups Conscientization on effects of obesity in these noted areas by Public Health authorities	Regular education campaigns on the causes and effects of obesity by public health authorities for the target population

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	Provision of exercise outlets eg gyms in these noted localities. Stakeholder engagement on the benefits of shedding excess energy as a result of less physical activities.	Campaigns to provide community exercise outlets and play areas in identified localities Education campaigns on the benefits of physical activities on shedding excess energy
024	Education on the effects of obesity Community based exercise groups	Education on the effects of obesity Education campaigns on community-based exercises
025	Being obese definitely comes with the mindset of the individual. Ghanaians mostly enjoy these junk foods which mostly causes obesity, this isn't broad though throughout but there's definitely going to be a higher rate of obesity in the greater Accra than in the others due to what we consume in this part. So, it's a very debatable issue but it also comes down to the attitude and eating habits of individuals	Educational campaigns on eating habits and attitudes towards obesity
026	Choosing healthy foods and beverages, Water as replacement for sugar-sweetened beverage reduces energy intake, body weight, consuming less processed or canned foods.	Education campaigns on healthy dietary choices
027	Religion sensitization or public education on the dangers involved in the eating of foods that do cause obesity, abolishment of cultural practices that do cause obesity.	Public education on the dangers of consuming foods that cause obesity Campaigns to abolish cultural practices that cause obesity
028	Adopting a healthy or sporting activity after consumption of these foods that have the tendencies to increase body weight. Limiting the quantity of food consumed	Campaigns on adopting healthy lifestyles
029	Community education on effect of obesity Education on the causes of obesity	Community-based education on effects and causes of obesity
030	Regular exercise, checking of weight regularly, laws to guide obesity, more parks and gardens should be created, regulate the use of Gas,	Laws to guide obesity Recreational centres, laws to guide obesity, Campaigns on regular exercises Education on regular weight checks

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
031	They have to be active, avoid sitting at one place, engaging in vigorous activities to reduce weight, check their food intake and exercise frequently.	Awareness campaigns on healthy lifestyle
032	1. Public education on dietary and healthy eating habits. 2. Research into factors that affect consumer choices and hence the food people buy so people can be encouraged to make conscious and responsible choices 3. Price and availability of quality food on our markets. Healthy foods should be made affordable. 4. Set a national goal of reducing obesity, starting from the basic schools	Public education campaigns on dietary habits Education on healthy dietary choices Nationwide campaigns on obesity reduction starting from basic schools Campaigns to make healthy foods affordable
033	Education. Easy Accessibility of Recreational centres. Ensure adequate Security in urban areas, so people can freely exercise. Lifestyle modifications Diet modification. Involvement of traditional and religious leaders in lifestyle modifications and education.	Education on obesity Campaigns on the need for accessible recreational centres Campaigns on lifestyle modifications Campaigns to ensure adequate security in urban areas so people can exercise freely Education campaigns on lifestyle modifications using traditional and religious leaders
034	Consuming local foods Education Choosing healthier foods Reduce intake of processed foods Improving sleep Reducing stress Increasing physical activity	Education on consuming local foods and reducing intake of processed foods Education on healthy dietary choices Campaigns to improve sleep, reduce stress and increase physical activity
035	Modification in the lifestyle of people, Engagement in more physical activity (exercising), Encouraging the practice of eating slowly and being mindful of when and what to eat, taking in less sugary drinks and food.	Campaigns to promote lifestyle modifications Campaigns to encourage healthy dietary habits
036	1.Acceptance-based behavioural intervention 2. Self-regulation 3. Mindful decision making	Awareness campaigns on behavioural changes towards obesity

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	4. Identifying and committing to improve 5. Willingness to accept discomfort 6. Reduced pleasure for the sake of losing weight	
037	Finding out what factors specifically contribute to the phenomenon first. Looking at how diet and daily physical activity affect this trend. Creating awareness of how obesity affects quality of life. Introducing lifestyle changes that seek to curtail this trend.	Awareness campaigns on the effects of obesity on quality of life Education on lifestyle changes that could curtail obesity
038	Healthy eating plan, Regular Physical Activities	Education campaigns on diet Education to promote regular physical activities
039	1. Limiting consumption of unhealthy foods (eating sweets, refined grains) 2. Increase physical activities 3. Change family behaviours likely to lead to obesity 4. Limit sit down activities	Education on limiting the consumption of unhealthy diets Campaigns to increase physical activity Education campaigns on the influence of family behaviours associated with obesity
040	1. Share research findings with opinion leaders such as chiefs and Imams to create awareness of such issues 2. Organising small group symposium with the opinion leaders to educate the people most likely affected. 3.Sensitising the groups most likely affected through their children in school. 4. Providing community parks and gyms in communities most likely to be affected. 5. Providing enough jobs to help healthy living easily achievable. 6. Government reducing taxes on fruit and vegetables imported whereas encouraging more cultivation of local fruits and providing storage for the farmers and market women to reduce wastage to promote easy access to vegetables and fruits	Awareness campaigns on obesity through chiefs and Imams Education campaigns for small groups on obesity through opinion leaders Sensitisation campaigns on obesity in schools Campaigns to provide community parks and gyms Campaign to provide enough jobs to help healthy living Campaigns to reduce taxes on fruits and vegetables. Campaigns to encourage cultivation of local fruits and access to vegetables and fruits

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
042	Reduce stress Healthy eating Diet (choosing healthier foods, whole grains, vegetables, fruitful, healthier fats) Limiting refined or highly processed foods Increase in Physical activity level (regular PA) Limiting sedentary lifestyle (sitting time) Conscious effort to change habit Bariatric surgery	Education campaigns to promote healthy dietary choices Campaigns to promote and increase physical activity Campaigns to limit sedentary lifestyle Education campaigns on dietary habits Awareness on bariatric surgery
044	Encourage people to exercise	Education campaigns to encourage physical activity
045	Public education on obesity Am with the view that the government should intensify its flagship program on planting for food and job especially in the area of fruit and vegetables.	Public education on obesity Education campaigns to intensify government's program on fruit and vegetables cultivation
046	Intensify education on healthy dietary regimen Create awareness on obesity and its consequences Engage religious leaders in the fight against obesity Encourage physical activities as part of our lifestyle	Intensive education on healthy diet Awareness campaigns on consequences of obesity Education campaigns on obesity through religious leaders Education campaigns to promote physical activity as a lifestyle
048	1.Community Health Education targeted at the Gas and Muslims 2. Behavioural Interventions in both the Muslim and Ga communities 3.Discussion of Research findings with communities involved and encourage them to come up with their lifestyles	Community-based education campaigns on obesity for Gas and Muslims Campaigns on obesity-related behavioural interventions for Gas and Muslims Obesity Education campaigns on obesity-related lifestyles
049	Cultural myth portraying obesity as sign of good living must be discarded	Campaigns to demystify cultural beliefs on obesity as a sign of good living
051	1.Education on lifestyle change at the level of the community and various religious platforms	Education on lifestyles at the community level and in religious groups

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	2. Recreational activities involving physical activities regularly could be organized by leaders of such groups	Education campaigns to encourage regular physical activities by religious and traditional leaders

Table 2: Responses to the survey: 'The research showed that about 80% of Ghanaians don't eat fruit and vegetables and only 10% of Ghanaians are physically active and eat fruits and vegetables. Physical activity and diet are interconnected lifestyle variables that influence the odds of obesity in Ghana. In your estimation, what interventions could promote the practice of healthy diet and physical activity?

Respondents ID	**Respondents Responses/Interventions**	**Interpretation of interventions**
001	Government intervention such as setting up community sport centres / gyms, community gardens where fruits and vegetables can be grown to ensure affordability and all year-round availability of fruits and vegetables	Campaigns to encourage government to set community sport centres and gyms, and ensure all year-round fruits and vegetables availability and affordability
003	Education on importance of exercise and healthy eating. Targeted awareness programme, policy to ensure healthy diet and exercises especially in our schools	Education campaigns on the importance of exercises and healthy eating Targeted awareness programs to ensure healthy diet and exercises in schools
004	The government should subsidies food/fruits that promote healthy living. The governments should also create more recreational centres that are less expensive for individual to afford	Campaigns to encourage government subsidies on foods that promote healthy living and create recreational centres that are affordable
006	Make available fruits available to the targeted groups at a lower cost. Still conduct public education on the subject matter. Considering the impact of a city's green infrastructure, i would recommend the creation of inner city greening to encourage physical activities and leisure in open spaces.	Campaigns to make fruits available and affordable to the target groups. Education campaigns on physical activity and diet. Education to promote creation of inner city greening to encourage physical activities and leisure in open spaces
007	Dietary education should start in early childhood education from kindergarten, MOE to employ due to Ian in zonal offices of education, to MOE/GES to actively encourage physical education in schools, Areas to be specially allocated in Districts, sub districts and in communities for physical exercise, special days once a week for an hour to be allocated	Education on diet in early childhood education. Campaigns to encourage physical education in schools by Ministry of education and Ghana education service at district and sub-district levels. Campaigns to encourage allocation of an hour in a week for public servants to exercise.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	for public/civil servants for exercise as it is done in some countries like Rwanda.	
008	health education on diet, fitness seminars, advertise more on the importance of fruits in our diet, appealing to government and other corporate bodies to provide fitness centres and gyms, encouraged physical education modules in schools, adopting social prescriber	Education on diet and fitness seminars/advertisement on the importance of fruits in diets. Campaigns to promote physical education modules in schools. Campaigns to appeal government and other cooperate bodies to provide fitness and gyms.
009	1.Heath promotion programmes should be intensified by Ghana heath service and other agencies, 2. MoFA should promote cultivation of adequate fruits and vegetables. 3. Educational curriculum at the basic level should factor the need to consume more fruits and vegetables 4. School feeding programme should factor and include provision of fruits.	Campaigns to intensify health promotion programs in Ghana by health service and other agencies. Campaigns to encourage ministry of food and agriculture cultivate adequate fruits and vegetables. Awareness to promote the inclusion of more fruits and vegetables on the curriculum at basic schools. Campaigns to encourage the provision of fruits in the school feeding program
011	1.This must be part of curriculum from basic education in subjects like agriculture and science 2. Education through the media with medical experts 3. Parents must include fruits and vegetables in their routine diet in the house 4.Promotion of Ghanaian food in major restaurants	Campaigns to include physical activity and diet in subjects like agriculture and science in the curriculum of basic education Mass media campaigns by medical experts Campaigns to encourage parents to include fruits and vegetables in their routine diet in the house Campaigns to promote Ghanaian food in major restaurants.
012	1. Physical Education in all levels of our educational eco-system 2. Training facilities and centres should be incorporated into our urban planning systems 3. Workplaces should encourage physical training and healthy eating habits. E.g. some banks in Ghana have gymnasiums in their premises 4. Fun clubs for physical trainings and education	Campaigns to include physical education in all levels of the educational ecosystem. Campaigns to ensure the incorporation of training facilities in urban planning Campaigns for workplaces to encourage physical training and healthy eating habits. Funding for physical training education and fun clubs.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	should be embraced and funded 5. CSR funding should find itâ€™s way within the physical training activities in the country	
013	1). Offices should have exercise breaks at least twice in a week. All workers will be taken to room where they will guided through some exercise routines 2) Also, prices of fruits and vegetables are high so it make it difficult for the many people to live by it 3) Parents should start with their children and feed them fruits and vegetable always	Campaigns to promote exercise breaks at least twice in a week in offices and workers should be guided through some exercise routines. Campaigns to make prices of fruits and vegetables affordable. Awareness campaigns to encourage parents to feed their children with fruits and vegetables always.
014	Education on importance of consuming fruits and vegetables and rewards for the consumption of such products	Education campaigns on the importance of consuming fruits and vegetables and rewards for the consumption of fruits and vegetables.
016	PROMOTING AND ADVERTISING OF HEALTHY LIFESTYLE.	Awareness campaigns to promote and advertise healthy lifestyle
017	health education, nutrition education, dietary change strategies in schools and across the nations	Education on health, nutrition, and dietary changes strategies in schools and across the nation.
018	Supervision of Physical activity Creating places for physical activities	Campaigns to create and supervise physical activities
019	1. Cutting down prices of fruits and vegetables and making it available in all parts of the country irrespective of the season. 2. other people attribute to not eating fruits and vegetables to the poor handling of such produce by our market woman. So our market woman should be educated well on good practices / storage so they don't lose their nutrients. 3. Many also get access to these foodstuffs but the mode of preparation is so poor that at the end of the cooking process they end up losing their core nutrient.	Campaigns to make fruits and vegetables available and affordable in all parts of the country in all seasons. Education for market women on good healthy diet practices Public education on best practices in preparing healthy foods. Public education campaigns on healthy dietary practices following exercises.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	4. Others do exercise but as soon as they are done with the exercise, they end up taking in more calories than the body needs and that ends up like zero work. so, I think they should be well oriented on such	
020	1. The price of the fruits and vegetables 2. Education on what to eat at what time 3. More adverts should be shown on tv like the olden days. 4. The benefits of eating fruits and vegetables should be done on tv	Campaigns to make fruits and vegetables affordable Education on what to eat and time to eat Media advertisement on the benefits of eating fruits and vegetables
021	The general public must be educated on the importance of including fruits and vegetables in their daily diet.	Public education on the importance of including fruits and vegetables in daily diet.
022	1. Government should Invest more in the production of fruits and vegetables and possibly subsidise to encourage its intake 2. Creation of awareness through medIa to emphasise the need for exercise and the consumption of fruit and exercise 3. Introduction of physical activity for all in our secondary and tertiary institutions. 4. Government should Invest in public gymnasiums and fitness centres in communities	Campaigns for government to invest and subsidise the production of fruits and vegetables to encourage its intake Awareness creation through media on the need for exercises and consumption of fruits. Campaigns to introduce physical activity in secondary and tertiary institutions Campaigns to encourage government invest in public gymnasiums and fitness centres in communities.
023	General public education by health workers on the necessity of choosing healthy foods to limit the intake of unhealthy foods Encourage local community workers to introduce regular physical activities as part of their schedule Community efforts as a whole should support healthy eating and active living In a variety of settings for	Public education on the necessity of choosing healthy foods to limit the intake of unhealthy food by health workers Campaigns to encourage regular physical activities as part of the schedules of local community workers. Campaigns to promote healthy eating and active living in communities and basic schools.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	example in basic schools p.e courses should be re-visited with emphasis on healthy living patterns Marketing of fruit and vegetables should be subsizied if possible by governmental intervention to encourage affordability	Campaigns for government to subsidise fruits and vegetables to encourage affordability.
024	Education on the health benefits of eating vegetables and fruits.	Education campaigns on the health benefits of eating fruits and vegetables.
025	I think the normal Ghanaian has a lot faith in their doctors, so that can be the grassroot where that attitude can start from because assuming you fall Ill and go to the hospital onec	Awareness to promote attitudinal changes on healthy lifestyles by doctors.
026	One-to-one counselling/advice or group counselling/advice; Self-directed or prescribed physical activity; Supervised or unsupervised physical activity; Home-based or facility-based physical activity;	One-to-one counselling or group counselling physical activity.
027	1. Enforcement of law on vegetable farmers to adopt the best practices of growing vegetables which tends to increase vegetable production, making it more affordable and readily available to the market for easy access to boost more vegetable intake and to serve the right proportion in our diet 2. Introduction of communal health associations/fun clubs to undertake weekly/weekend body exercises to burn some fats in the body which causes obesity	Law enforcements on best practices in vegetables cultivation by farmers to increase vegetable yield and inherently make it more affordable and available. Communal health/fitness clubs to promote weekly/weekend exercises.
028	Encourage Ghanaians to eat more fruits and vegetables through volunteering and advocacy to table out the risks of unhealthy eating Less pricing of vegetables and fruits to promote it consumption for a healthy lifestyle	Advocacy campaigns to encourage Ghanaians eat more fruits and vegetables Campaigns to ensure fruits and vegetables affordability Education to promote the consumption of specific vegetables and fruits that contain less sugar and more fibre

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	Eating specific vegetables and fruits that contains less sugar but more fibre	
029	1. Training and supporting of fruit and vegetable farmers by government and or NGO'S 2. Inclusion of fruit and veggies in the menus of the school feeding program and second cycle schools. 3. More effective public education on the uptake of fruits and vegetables 4. Having more jingles on the benefits of fruits and vegetables	Training and supporting of fruit and vegetable farmers by government and or NGO'S Awareness to promote the inclusion of fruits and vegetables in the menus of school feeding program and second cycle schools. Public education on the uptake of fruits and vegetables Advertisements on the benefits of fruits and vegetables
030	More cultivation of fruits, subsidy for fruit farmers, supply of fruits school going pupils so that taking fruits become part of them.	Campaigns for cultivation of more fruits, subsidy for fruit farmers, supply of fruits to school going pupils so that fruits become part of them.
031	Adding more vegetables and fruits to our daily diets	Advocacy for adding more vegetables and fruits to our daily diets
032	1. Education/ is the key in getting people to understanding that 'we are what we eat'. People must be educated through appropriate platform. Linking lack of exercise and eating fruits to cardiovascular diseases may encourage people to eat well and engage in physical activity 2. Policies that encourage lifestyle changes must be encouraged 3. Government and Non-governmental agencies must regularly work to provide list of health and non-healthy food items on the market. 4. Government must increase taxes on importation of 'unhealthy' food items, including drinks. The idea is to make unhealthy foods expensive and out of reach of the ordinary citizen	Education campaigns in getting people to understand that ‘we are what we eat’ through appropriate platform. Campaigns to educate people on the correlation between lack of exercise and eating fruits to cardiovascular disease to encourage people to eat well and engage in physical activity. Advocating for more policies that encourage lifestyle changes. Campaigns by Government and non-governmental organisations to provide list of healthy and non-healthy food items on the market. Introduction and implementation of high taxes on the importation of unhealthy food items and drinks by Government.
033	Education on the need to eat healthy (balanced diet) Educating the population on what actually is regular exercise as a lot of people don't understand what it	Education on the need to eat a balanced diet Educating the population on what is regular exercise as a lot of people don't understand what it means to regularly exercise and the

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	means to regularly exercise and the importance of it. Increase production, availability and affordability of fruits and vegetables.	importance of it. Advocacy for increase in production, availability and affordability of fruits and vegetables.
034	One to one counselling Supervised physical activity Eat more fruits and vegetables Reduce intake of soft drinks and high fat or calorie snack foods.	Advocacy campaigns for one-to-one counselling Campaigns for supervised physical activity Education on the need to eat more fruits and vegetables Campaigns to reduce intake of soft drinks and high fat or calorie snack foods.
036	1. Proper education on the consumption of fruit and vegetables, 2. School going people should be made aware of the right places to buy food. 3. Food vendors should be well scrutinised with regards to their knowledge in proper dietary before they are issued with permit to sell. 4. Physical activities should be made compulsory at all cooperate institutions. That is to say, there should be Physical Activity break in the course of working. 5. There should be a National Day of Eating fruit and vegetables like the national chocolate day. 6. Teachers and educational workers should be made stakeholders in this course as they are in the front line. 7. If possible, there should be fruit and vegetable farms in every educational institution.	Proper education on the consumption of fruit and vegetables, Campaigns to create awareness on the right places to buy food for school going people. Introduction and implementation of laws that's seeks to scrutinize food vendors on their knowledge on proper diets before given permits to sell food. Campaigns to make physical activities compulsory in all cooperate institutions. Advocacy campaigns for the introduction of Nation Day of Eating fruit and vegetables. Campaigns to make teachers and educational workers stakeholders in this course. Advocacy for fruit and vegetable farms in every educational institution
037	Building habits from childhood. Focusing on inculcating healthy lifestyles from primary through senior high schools. Making wholesale changes to food served at schools. Example reducing carbohydrates, transfat, white bread and other unwholesome foods. Introducing more greens, salads	Education on the need to inculcate healthy lifestyles from primary through senior high schools. Campaigns to make wholesale changes to food available in schools. Campaigns to make obesity a key focus of physical education and allocating more time for physical education and sports in schools.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
	and fruits in school menus. Making obesity a key focus of physical education. Dedicating more time to physical education and sports in schools. This will most likely usher in a new generation that is aware. This will also help spread the ideas to the wider society.	
038	Education on the benefits of healthy diet and physical activity	Education on the benefits of healthy diet and physical activity.
039	Promote the study through much inclusion in education curriculum implementation Include more fruits and vegetables in the meals of students/pupils pricing of staple foods in grocery stores, cafeterias to support healthier choices	Promotion of the study through much inclusion in education curriculum implementation Campaigns to include more fruits and vegetables in the meals of students/pupils
040	1. Creation of community parks and gyms in most areas can help promote physical activities. 2. Taxes reduced for fruits and vegetables farmers to reduce the cost in the market. 3. Campaign for healthy living should be intensified.	Advocacy for creation of community parks and gyms in most areas to help promote physical activity. Campaigns for reduction of taxes for fruits and vegetables farmers to reduce the cost in the market Campaign for healthy living should be intensified
042	Nutrition focused education Use of peer groups (keep fit clubs) to serve as a motivation platform Encourage the use of fruit and vegetables as snack and limit the intake of fizzy drinks Growing what we eat (backyard garden) Behaviour Change Interventions	Nutrition focused education campaigns Advocacy campaigns for peer groups to serve as a motivation platform Campaigns to encourage the use of fruit and vegetables as snack and limit the intake of fizzy drinks Awareness creation on Behavioural Change Interventions
044	Continues education on the need to eat healthy and exercise and further emphasis on the health implications of not doing so.	Continuous education on the need to eat healthy and exercise and further emphasis on the health implications of not doing so.

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
046	Creating Awareness, conscientizing the population on the importance of physical activities and healthy diet Fruits and vegetables are seasonal crops, hence we need to hence the production of the favorable crops in our medium	Awareness creation and conscientization of the population on the importance of physical activities and healthy diet
048	1.Education on the benefits of fruits in our diets 2. Making fresh fruits available and accessible to all 3. Reducing the cost of fruits	Public education on the benefits of fruits in our diets Campaigns to make fruits available and accessible to all Campaigns to reduce cost of fruits
051	Creation of new varieties of meals which involve fruits and vegetables Growing of fruit and vegetables to make them readily available Nutritional education on the benefits of fruits and vegetables to sensitize it use	Awareness creation of new varieties of meals which involve fruits and vegetables Advocacy on growing fruit and vegetables to make them readily available Nutritional education on the benefits of fruits and vegetables to sensitize it use
052	Education Make these these vegetables affordable and presentable	Campaigns to make vegetables affordable and presentable
053	Having a community exercise program within each community. Institutiing physical fitness programs in our schools Educating citizenry on the need to live an healthy life Making a conscious effort as individuals to exercise atleast twice or thrice in a week. Encourage the eating of fruits and vegetables within our society	Advocacy for community exercise program within each community Campaigns for instituting physical fitness programs in our schools Education of citizens on the need to live a healthy life Campaigns to encourage individuals to make it a conscious effort to exercise at least twice or thrice in a week.
055	Community health centres should be built Fruit and vegetables should affordable Physical education should be compulsory in our basic schools to develop the habit of exercising	Campaigns for community health centres Campaigns to make fruits and vegetables affordable Campaigns to make physical education compulsory in basic schools

Respondents ID	Respondents Responses/Interventions	Interpretation of interventions
056	The various sectors of institutions should inculcate at least a one day compulsory exercise fir its employees.	Institutions to inculcate at least a day compulsory exercises for employees
057	More keep fits campaigns need to be launched to create awareness	Awareness campaigns through the provision of more keep fits.
058	Education on the benefits of healthy eating	Education campaigns on the benefits of healthy eating
059	The workplace The community Primary health care	-
060	yes	-

Table 3: Responses to the survey: 'Regarding the lifestyle variables, the findings showed that factors influencing them could be dissimilar. For Instance, men were found to be more likely to engage in physical activities but less likely to eat a healthy diet. However, in some instances, the factors were comparable. For example, individuals who agreed that overweight is inherited from parents were less likely to engage in physical activity and eat a healthy diet. Similarly, individuals with perceived good health status were at lesser odds of eating healthy diet and participating in exercises. Given these findings, what do you think is/are possible intervention/s to address the factors that limit participation in physical activity and consumption of healthy diet?

Respondents ID	**Respondents Responses/Interventions**	**Interpretation of Interventions**
001	Education is key in changing perspectives. Health policies encouraging doctors to include physical therapies in health administration could be of immense help Alternative restaurants and eateries promoting vegan and healthy meals, this can be done through private government partnerships to lure public	Education and health policies on the inclusion of physical therapies in health administration. Campaigns to promote vegan and healthy meals restaurants and eateries through private public partnership
003	Work pattern, economic impact on individuals/family, ignorance, lifestyle	Education on work pattern, lifestyle, and economic impact for individuals/family
004	Educations should be intensified	Intensified education
006	As indicated in my earlier submission on green infrastructure/spaces within inner cities, i recommend the creation and sustaining the snfrastructure that will support physical activities and also keep educating the general public on the subject matter.	Campaigns to promote and sustain infrastructure that supports physical activities.
007	Use of other means of transport like the use of bicycles to be promoted in the universities and shs. Special bicycle lanes to be provided in all towns and cities. Community keep fit groups to be encouraged at all levels	Campaigns to promote the use of other means of transport, like bicycles, in Universities and SHS. Campaigns to provide special bicycle lanes in all towns and cities Campaigns to encourage community keep fits.
008	Public sensitisation, joining fitness groups, free community fitness centres	Public sensitisation Campaigns for people to join fitness groups and make community fitness centres free.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
009	Health experts should be charged to constantly engage the public on the need to engage in physical activity and consumption of healthy food irrespective family health status to debunk those perceptions.	Public education on physical activity and consumption of healthy diet by health experts to debunk perceptions regarding obesity
010	Learn ways to manage your time better. Find time-management techniques that work for you. Ask others how they manage to fit good nutrition into their lives. Don't try to make too many changes at once. ... Ask your family and friends for help as you change your eating behaviour. ... Cook quick meals.	Campaigns to encourage time and healthy dietary practices
011	1.physical education should be part of basic education in Ghana 2. recreation parks must be part of our city planning 3. every meal should come with vegetables and little meat and fatty vegetables 4. dietitians must be given opportunity to bring their expertise in our schools and religious organization	Campaigns to promote the inclusion of physical activity in basic education in Ghana Campaigns to ensure the inclusion of recreation parks in city planning. Education for meals to have vegetables and little meat and fatty vegetables Campaigns for dietitians to share their expertise in schools and religious organisations.
012	1.a paradigm shift in our appreciation of obesity 2. Continuous education especially for focus groups 3. Government food policy to drive the consumption of fruits and vegetables	Education for paradigm shift in appreciation of obesity Continuous education for focus groups Government food policy to drive fruits and vegetables consumption
013	1) the mindset of people needs to be changed. People should be educated to know that they are responsible for their own health and hence must make it a priority 2) also the economic implications of not eating healthy and lack of exercise must be emphasized. In the future, the country may not have enough healthy	Public education to change people's mindset and emphasise on the economic implication of unhealthy lifestyles.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	people to work for it. This should be hammered into the minds of the people.	
014	Physical activities must be given priority in schools and communities, supply and education on good dieting	Campaigns to prioritise physical activities in schools and communities, and education on good dieting
016	Introducing gyms in our local communities.	Campaigns to introduce gyms in local communities
017	More education on the benefits of exercising and eating more fruits organising aerobics in communities at least once on a week serving kids with fruits in schools so they could also inform their families about it and the more they eat it the more they will get usr to it	Education on the benefits of exercises and fruits consumption Aerobic exercises in communities at least once in a week Campaigns to serve kids with fruits in schools
018	Pricing strategies, that is, making dietary products available at a cheap price long term media campaign	Campaigns to make dietary products available and affordable Long term Media campaign
019	1. Because we are now dealing with evidenced based medicine, we should for groups comprising of those obsessed and encourage them in exercise and when they achieve good results would serve as testimony for more to join. 2. there should be more education geared towards changing of mindset . So that they understand eating food that cost maybe 50gh cedis ending up giving you disease that will deplete almost all your resource. Which of them would they prefer?	Evidence-based awareness campaigns to encourage physical activity Public education on healthy diet and its economic implications
020	1. All have to do with education. Most people think by just exercise you are good to go. But now we just know it is not. So, education is key in all this	Education on the importance of both exercises and diet

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
021	The importance of physical activity should be taught in schools, church, workplaces, mosques and on the radio and tv stations.	Education on the importance of physical activity in schools, church, workplaces, mosques and on the radio and tv stations.
022	Public education to transform their mindset	Public education to change mindsets
023	Education on the effects of obesity encouraged at all health stakeholder levels More and more research incentives for would be academics venturing into this area of research.	Education on the effects of obesity at all health stakeholder levels Research incentives for academics venturing into obesity
024	Education on the benefits of physical activity	Education on the benefits of physical activity
025	The normal Ghanaian would rather prefer to sit in a car for a 10-minute walk and it mostly happens with those who have the easy means to do so. And with fruit it needs to be part of one's attitude even though our health officials can enact ways of making the normal Ghanaian adapt to it	Education on attitudinal changes on diet and physical activities by health officials
026	Interventions that are focused on the individual usually consist of an assessment of a participant's physical activity and readiness to change, a tailored activity plan, and identification of community interventions through a centralised health provider or promoter.	Tailored and community interventions on physical activity by health provider or promoter
027	1. Lack of training personnel and training equipment/facility 2. Financial difficulties to access training facility/gem 3. Lack of intrinsic/extrinsic motivation to encourage an individual to participate in physical body exercises	Campaigns to make training personnel, facilities and equipment available and affordable. Campaigns to motivate individuals to participate in physical activities
028	Basically, public health education could help to reduce ignorance on the part of the individual with perceived good health status	Public health education to reduce ignorance among persons with perceived good health status
029	1. Effective public sensitization	Effective public health sensitisation

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
030	Building training parks in various communities, more education obesity,	Campaigns to build training parks in communities Education on obesity
031	No matter which group one belongs from the above, one needs to strike a balance , that is to say one needs to engage in physical activities and eat a healthy diet aways	Campaigns to promote both physical activities and healthy diet
032	1. Encourage the formation and joining of community 'keep fit clubs', especially in the metropolis. 2. Children should be rewarded at home for exercising and eating fruits. This will encourage them to keep up a good habit. 3. Balance the act of eating and exercising to reduce calories at the right quantities. People should be encouraged to see a nutritionist where appropriate to get professional advise on eating	Campaigns to encourage the formation and joining of community 'keep fit clubs', especially in the metropolis. Reward children for exercising and eating fruits Awareness campaigns on the need to balance the act of eating and exercising to reduce calories at the right quantities Awareness on the need to de see nutritionist where appropriate to get professional advice on eating
033	Inculcate recreational activities in our every day life, as this greatly reduces the stress levels. Hence, recreational, tourist and sporting sites should be easily accessible to the populace	Campaigns to inculcate recreational activities in daily lives Campaigns to make recreational, tourist and sporting sites accessible to the populace
034	Education	Education
036	1. There should be proper education 2. Physical education should be made compulsory in the educational institutions. 3. Certain reality tv shows (i.e. Di asa) should be looked into and given proper scope. 4. Physical activity break should be introduced to all cooperate institutions. 5. Women should be encouraged to take more physical activities.	Compulsory physical education in educational institutions Campaigns to include physical activity break in all cooperate institutions. Awareness campaigns to encourage physical activity among women Reality TV shows on physical activity (Di asa).

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
037	The focus should be on awareness creation. If people know the facts, it will clear all misconceptions about how obesity is linked to physical activity and diet.	Awareness creation on misconceptions about obesity
038	Poverty and laziness	-
039	Government regulatory policies to promote physical activities and composition of staple foods	Government regulatory policies to promote physical activities and composition of staple foods
040	1. Intense campaign on obesity and its consequences. 2. Government should make effort to help healthy living be less costly since it really expensive to eat right and subscribe to fitness centres for the ordinary Ghanaian. 3. BMI should be included as compulsory vital signs checked when one visits the hospital. I believe this can inform the people to make healthy decisions. 4. Due to crimes on the rise, early morning jogging which is a form of physical activity are not been considered by the general populace so if issues of security and safety are addressed well in the country, physical activities are likely to increase among the populace especially the youth. 5. Physical education in schools should be given the necessary attention than it is now.	Intense campaign on obesity and its consequences. Government policies to make healthy lifestyle practices affordable Campaigns for compulsory BMI checks in hospitals Campaigns for secure exercise environment Campaigns to increase attention on physical education in schools
042	Education (providing evidence based analysis) encouragement not been self-motivated enough creating diversity in meals (variety) lack of resources for physical activity	Evidence-based public education to encourage physical activity and motivate meal variations Campaigns to address lack of resources for physical activity
044	Deliberate involvement.	Campaigns to promote deliberate involvement in physical activity
045	Public sensitization on the ban of imports gmo foods and encouraging of local grown goods.	Public sensitization on the ban of imports gmo foods and encouraging of local grown goods.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
046	Education on the impact of environmental factors in the expression of genetic tendencies	Education on the impact of environmental factors in the expression of genetic tendencies
048	1. Prescription of physical activities to suit individual needs 2. Supervised physical activity 3. Home based physical activities shd be prescribed. 4. Inculcating physical activity in social activities for different age categories	Campaigns for tailored physical activity prescription, supervised physical activity and home-based physical activities.
051	Education on importance of physical activity in daily routines regular organization of physical activities at workplaces, community, neighbourhood, schools etc	Education on importance of physical activity in daily routines regular organization of physical activities at workplaces, community, neighborhood, schools etc
052	Stress workload and other engagements economic burden	Campaigns on stress, workload and other engagements, and economic burden
053	Strategizing your menu and consciously following it. Economic factors may also limit people from having a healthy diet. Unavailability of some of the healthy diet, fruits and vegetables to purchase	Campaigns for menu strategizing and ensuring availability and affordability of healthy diet.
054	Consumption of less processed and sugary foods eat a lot of dietary fiber incorporate a weight training regiment eat healthy foods as family cultivate the habit of cooking at home limit screen times incorporate a regimental weight training	Campaigns to promote consumption of less processed and sugary foods, consumption healthy diet and screen times limitation. Campaigns to incorporate regimental weight training.
055	Time constraints lack of knowledge to engage in these activities affordability of healthy diet	Awareness campaigns to provide knowledge on healthy lifestyles. Campaigns for affordable healthy diets Campaigns on time constraints

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
056	I think the various media houses should be charged to publicise the benefits of eating fruit to the people	Media publications on the benefits of eating fruits
057	Public sensitization on the ban of imports gmo foods and encouraging of local grown goods.	Public sensitization on gmo foods and encouraging of local grown goods.
058	Reduction on gym fees	Reduction on gym fees
059	Creating a healthy eating environment role of government in promoting healthy eating	Campaigns to create a healthy eating environment and government to promote healthy eating
060	Education on the obesity and associated risk, community participation in physical activity, inter community sporting exercises, programs to help obese patients to gain access to healthy lifestyles etc	Education on the obesity and associated risk, community participation in physical activity, inter community sporting exercises, programs to help obese patients to gain access to healthy lifestyles etc

Table 4: Responses to the survey: 'The local food environment, i.e., the number of fast-food joints and supermarkets in an area, was found in the study to increase the risk of obesity in Ghana. In your opinion, what interventions could address the influence of the food environment on obesity in Ghana?'

Respondents ID	**Respondents Responses/Interventions**	**Interpretation of Interventions**
001	Industrial regulation on the location of fast foods in the community Price discrimination in high-risk communities where obesity is at its peak	Industrial regulation on the location of fast foods in the community
002	These fast food joints must sell their foods with lots of vegetables and include alkaline diets that contains lots of antioxidants. Oil and fats must also be reduced be using modern utensils that require less oil or do not require oil at all to prepare food dishes	Awareness campaigns for fast-food vendors to sell their foods with lots of vegetables and include alkaline diets that contains lots of antioxidants
003	Educate food vendors on using healthy cooking ingredients, educate the populace on calorie intake, public education on healthy eating, enforce government policy on healthy eating and encourage physical activities amongst the populace	Education on healthy cooking ingredients for vendors Public education on calorie intake and healthy eating Government policy enforcement on healthy eating Campaigns to encourage physical activities amongst the populace
004	Seminars and conferences should be organized within the districts for the owners of the supermarkets to educates them on the effects of selling foods that cause obesity. Proper monitoring of fast food joints within the regions and districts by health officers and also educating them on the effects of the items used in the preparation of their food. Strick rules should be implemented on the insurance of license for the operations of fast food joint.ie individuals with the requisite knowledge and qualifications should be issue with the license to operate food joint and supermarket	Education for vendors on obesity causing foods and the effects of items used in food preparation. Campaigns to ensure monitoring of fast food and supermarket operations by health officials. Strict licensing for food operators

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
005	1. Healthy foods shops 2. Above shops should have affordable foods 3. Education of cooks of these fast-food joints on need to cook foods in a healthy way (vegetable oils, etc) 4. These supermarkets should make available fruits and vegetables at affordable prices 5. The fast food joints should have natural juices from fruits available 6. These fast food joints should incorporate lots of vegetable in their foods	Campaigns to promote healthy food shops Education campaigns for food vendors on healthy dietary practices Campaigns to make fruits and vegetables affordable and available Campaigns for food vendors to incorporate lots of vegetables in their foods
006	Engage the fast-food service providers on the application of best practices that will mitigate the phenomenon under study	Education campaigns for food vendors on best dietary practices
007	The hospitality industry should encourage and promote our known local food and local dishes at the fast food joints and supermarkets. Letâ€™s eat what we grow and grow what we eat. Letâ€™s serve local dishes at all functions. Mofa, ministry of tourism, ghana tourism authority, moh/ghs/fda should monitor all fast food joints and supermarkets to serve and market fresh well stored food esp vegetables. School feeding program to serve our children delicious and healthy local dishes from our numerous local cuisines. Let all tourists get use to our local cuisines	Campaigns for hospitality industry to promote local foods at fast-food joints and supermarkets Regulation of fast-food joints and supermarkets by government agencies Awareness to promote the inclusion of local foods in the school feeding program
008	Proper training for fast food vendors on proper food production, introduce high taxes on fatty foods, regulate the activities of fast food joints through registrations, proper control of food joints and supermarket on the production and selling of high fatty foods.	Training for fast food vendors on food production Increase taxation on fatty foods Regulations on fast-food operations

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
009	1. Ministry of health should engage fast food operators on the essence of providing balance and heathy food to consumers. 2. All fast-food operators should be issued with license by heathy service. 3. Local government authorities should continuously monitor the activities of fast operators to ensure compliance. 4. Mofa to liaise with fast food operators to supply them with healthy raw materials.	Education campaigns for food vendors on healthy food practices by the ministry of health Licencing for all food vendors Government monitoring of fast-food activities Campaigns for the ministry of agriculture to supply fast-food operators with healthy raw materials
011	1.the nutritional benefits of local foods must be stressed through public education by the national health service and the ministry of health 2.there must be conscious effort to promote Ghanaian restaurants where local foods are only sold 3.foreign supermarket and restaurants must be given a certain percentage of foods of Ghanaian staples to be sold 4.the fda should also check the kinds of items sold in these foreign supermarkets and malls	Public awareness campaigns to stress the nutritional benefits of local foods by the national health service and the ministry of health Campaigns to promote Ghanaian restaurants where local foods are only sold Regulations on foreign supermarket and restaurants to include a certain percentage of foods of Ghanaian staples to be sold
013	1) the food environment should be change to have abundance of affordable fruits and vegetables since it appears people consume more of what they find available 2) more government support related to food supply should be channelled to major food environments in the country. 3) education on healthy eating should be carried out at these food environments to help people eat better for their health.	Campaigns to promote abundant and affordable fruits and vegetables Education to create awareness on healthy eating
014	Encourage the use of organic foods by fast food joints and more fruits and vegetables joints in the communities	Education to encourage the use of organic foods by fast food joints and more fruits and vegetables joints in the communities

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
015	1.we should encourage establishment of more fruit and vegetables joints in our communities 2. more education on the dangers of consumption of junk foods	Campaigns to encourage the establishment of more fruit and vegetables joints in our communities Education on the dangers of junk foods consumption
016	Encouraging and making home cooking interesting and easy also less costly.	Campaigns to encourage and make home cooking interesting and affordable
017	Encouraging people to eat organic foods discourage the intake of junks	Education to encourage healthy eating practice
018	Government regulations on eating healthy foods	Government regulations on eating healthy foods
020	The food and drugs board can come in to let pp know what they r buying. 2. The food been sold in the malls should be label to let pp know the amount of fat it is in each food.	Awareness campaigns on diet by the food and drugs boards Awareness on dietary intake through food labelling
021	The government should increase the taxes on unhealthy food been sold by the supermarket and fast food	Increase taxation on unhealthy foods sold by food vendors and supermarkets
022	Policies to regulate the operation of fast-food joints Education of fast food operators on better options Identification of such environments and the implementation of effective health education through health facilities within that environment Engaging religious and traditional leaders in educating community members within identified environment	Policy regulations on fast-food joint operations Education campaigns for food operators Health education campaigns through facilities in the identified environment Community education by religious and traditional leaders
023	License allocations for these fast foods should be regulated to reduce prevalence sales of foods prone to get people obsessed...	Regulations of fast foods
024	Training of food vendors on healthier food options	Training of food vendors on healthier food options
025	The everyday Ghanaian would by all means at least once in a day need something from the supermarket, it would take dedication to keep a good health to stay away from things that aren’t healthy for our daily lives. It’s all about the	Campaigns on dietary-related attitudinal changes

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	mindset and how one wants to stay healthy and keep a good shape. And with the fast food, there can’t be any deterrent to it because at least once the person is selling, no one would be able to stop them from selling and the same happens to whoever who buys so it all comes down to the attitude of individuals and how healthy they want to be	
026	Applying nutrition standards in childcare facilities, schools, hospitals, and worksites. Providing incentives for supermarkets or farmers' markets to establish their businesses in underserved areas. Improve transportation access to healthier food retailers and/or implement comprehensive in-store markets and promotion.	Campaigns to apply nutrition standards in childcare facilities, schools, hospitals, and worksites. Incentives for supermarkets or farmers' markets to establish their businesses in underserved areas. Campaigns to improve transportation access to healthier food retailers and/or implement comprehensive in-store markets and promotion
027	1. Regularization of obese intake foods at odd times by regular consumers of junk food 2. Rightful addition of ingredients in the food preparation by food vendors 3. Educating the general public on the consequences of taking in obese foods	Education campaigns for food vendors and the general public on healthy foods
028	Increasing the sale of more healthy vegetables and fruits and, reducing the sale of unhealthy foods from 6pm regulating the kind of foods sold in supermarkets and food joints by implementing strict policies	Campaigns to increase the sale of more healthy vegetables and fruits and, reduce the sale of unhealthy foods from 6pm. Regulations on the kind of foods sold in supermarkets and food joints
030	Regulate the fast food joint industry, educational training on obesity for fast food operators, intensive supervision of their products,	Regulations on the operations of the fast-food industry Training on obesity for fast-food vendors Campaigns for intensive supervision of food operators’ products
031	We should have more grocery shops around also fast food joints should add fruits and vegetables to their menu	Campaigns for more grocery shops Education to encourage the inclusion of fruits and vegetables in the menu of fast-food joints.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	again, the government should only approve gmo foods and supper markets should be selling more of gluten free foods.	Campaigns for government to approve only gmo foods and supermarket to sell more of gluten free foods.
032	1. Enforcing by-laws on establishing and running food joints with the view to ensuring that the right standards are met. Apply punitive measures where appropriate. 2. Educate and encourage fast food joints to sell health foods and drinks 3. The general public must be educated on the dangers of eating 'junk foods' provided by fast food joints	Enforce by-laws on establishing and running food joints with the view to ensuring that the right standards are met. Education campaigns for fast-food joints to sell health foods and drinks Public education on the dangers of eating 'junk foods' provided by fast food joints.
033	Policy wise, fast food vendors must be ensured they serve a well balanced diet vegetables and fruits should be easily available and affordable. Supermarkets should have fruits and vegetables stands in from of the supermarkets so people can easily see and patronize	Campaigns to promote the sale of balance diet by fast-food vendors Campaigns for fruits and vegetables availability and affordability Campaigns to encourage supermarkets to have fruits and vegetables stands in so people can easily see and patronize
034	Increasing availability to healthier food and beverage choices in public areas.	Campaigns to increase healthier food and beverage choices available in public areas.
035	Introducing exclusion zones for fast food outlets to limit the setting up of fast food joints around schools, creating awareness on the effects of junk food consumption, stakeholder engagement with fast food operators to as much as possible reduce sugar and calories in their diets, government introducing taxes on unhealthy foods and beverages and introducing subsidies for healthy foods.	Campaigns to introduce exclusion zones for fast food outlets around schools Stakeholder engagement with fast food operators to as much as possible reduce sugar and calories in their diets Increase taxation on unhealthy foods and beverages and introduce subsidies for healthy foods.
036	1. People should be encouraged to prepare their own food (the right diet) 2. There should be proper checks on the proliferation of fast food joints. 3. Education on the need to prepare the right diet by	Campaigns to encourage people to prepare their own food Campaigns to ensure proper checks on the proliferation of fast-food joints. Education campaigns on the need for healthy dietary practice Campaigns to encourage food vendors to follow laid down recipe

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	individuals should be encouraged instead of patronising fast food joints. 4. If possible, fast food joints vendors must be encouraged to follow a laid down recipe. 5. Supermarkets must be tasked to sell some percentage of fruits and vegetables amongst their stocks.	Campaigns to task supermarkets to sell some percentage of fruits and vegetables amongst their stocks.
037	With human lifestyle changing, fast food joints and 'prepared food, canned, tinned and cooked meals from supermarkets are going to be even more popular. The food and drugs authority should come out with a regulatory policy thats ensures that all food vendors eliminate transfats and excessive sugars from their ingredients. Also ghana can learn from countries such as the uk and enforce strict labelling on all prepared, canned foods and general groceries from supermarkets. The amount in weight and percentage per serving of sugars, fats(saturated fats), salt , all tranfats shoud be labelled so consumers are aware of what they consume.	Regulations on healthy diet for food vendors by the food and drugs authority Campaigns to ensure strict food labelling so consumers are aware of what they consume.
038	Thoroughly supervision by authorities, using more of vegetables in preparing their food and reducing the intake of oil and spicies in food.	Thorough supervision of food operators by authorities
040	1. The people involved should be educated on obesity and the need to promote healthy foods in their restaurant, fast food joints and supermarkets. Eg. The indomie sellers should be advised to ensure vegetables are more than the noodles when preparing it. Supermarket should procure healthy foods like skimmed milk than the diary ones. 2. More taxes to be placed on the junk food importation to discourage its patronage. 3. The general public should be educated on obesity and	Education campaigns on obesity for food operators Taxes junk food importation to discourage its patronage. Public education on obesity and desensitize them of the notion that eating junk food equate affluence

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	desensitize them of the notion that eating junk food equate affluence.	
042	Policies to regulate the content of meals by these food joints to prevent the use of unwholesome products Standardisation of recipes regulate advertisement education self-discipline	Policies to regulate the content of meals by these food joints to prevent the use of unwholesome products Campaigns to promote standardisation of recipes Campaigns to regulate food advertisement Education and self-discipline
045	The fast-food joints should be monitored by the municipal and district health and safety officer and also educate them on the right ingredients to be used.	Campaigns to ensure fast-food joints monitoring by the municipal and district health and safety officer and educate them on the right ingredients to be used.
046	Reduce intake of junk foods fast food joints should include healthy and safe menus food joints should include more fresh fruits and vegetables and make healthy foods more affordable	Education to reduce intake of junk foods Campaigns for fast food joints to include healthy and safe menus
048	1. The food joints must be educated to intentional provide health diets 2.policy makers must help with interventional policies at both the production and distribution level and ensure its implementation 3. increased taxes on junk food to help reduce the intake	Educational campaigns for food joints to intentionally provide healthy diets Increase taxation on unhealthy foods Campaigns to promote interventional policies at both the production and distribution level and ensure its implementation by policy makers.
051	Regular inspection of food menu to ensure addition of fruits and vegetables . Also the serving of healthy diet proper approval of processed food into the country setup of food point that use more of vegetables and fruits eg. fresh juices,smoothies from fruits and vegetables	Regular inspection of food menu to ensure addition of fruits and vegetables. Campaigns to ensure proper approval of processed food into the country and setup of food point that use more of vegetables and fruits e.g., fresh juices, smoothies from fruits and vegetables
052	Educate the fast-food vendors and restaurants owner to include more vegetables base food in their menu reduce the old content in the food	Education campaigns for fast-food vendors and restaurants owner to include more vegetables base food in their menu.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
053	Having a comprehensive education program on healthy food having an attitudinal change in the consumption of fast food. Policy development in the area of healthy food. Having a second look at certain food imports that are most likely to increase obesity among citizens.	Education campaigns on attitudinal change towards healthy food and campaigns for policies around healthy food.
054	1.health education on dietary habits in general 2.increasing fruits and vegetable cultivation by farmers 3. More education on sugar containing foods on the market 4. Enact and enforce laws on built environment on health 5. Establish more age specific recreational centres 6. Promote manufacturing of sugar containing food products	Public education on dietary habits Campaigns to increase fruits and vegetable cultivation by farmers Campaigns to enact and enforce laws on built environment on health Campaigns to establish more age specific recreational centres Campaigns to promote the manufacturing of sugar containing food products
055	Fast food joints should be encouraged to prepare balance diets to customers. People should be encouraged to eat balance and healthy food. Much education should be done for the awareness of eating good healthy food	Campaigns to encourage fast food joints to prepare balance diets for customers. Campaigns to encourage people to eat balance and healthy food. Education awareness on eating good healthy food.
057	The rate of foreign franchises like KFC, MacDonalds incoming to the country must be regulated and checked in the sense of more organic foods must be on the menu. Also, more fruit joints need to be opened to add more fibre dietary	Regulations on foreign franchises Campaigns for the opening of more fruit joints
058	Education to the sellers of food to include healthy food	Education campaigns for food sellers to include healthy food
059	Food composition	Campaigns on food composition
060	1. The fast-food joints should display the health hazards of their products. 2. Their operations should be limited to specific times of	Campaigns for fast-food joints to display the health hazards of their products.

Respondents ID	Respondents Responses/Interventions	Interpretation of Interventions
	the day 3. They should be encouraged to offer fruits and vegetables as part of their products	Campaigns to limit the operations of fast-food joints to specific times of the day Campaigns to encourage food vendors to offer fruits and vegetables as part of their products.
061	Education or awareness creation on â€œeating our typesâ€• . The mere presence of eateries does not necessarily mean eating just food. But education on healthy eating habits especially the different kinds of types for various the various blood groupings. This is vital because specific food types cause the obesity in specific blood types. Awareness on nutritional values of foods must also be vigorously pursued.	Education or awareness campaigns on healthy eating habits and nutritional values of foods.
062	The food and drug authority must put checks on the expiration of products in supermarkets so people don’t consume expired food substances. An expired foods can make people bloat , hence, the rise in obesity Inability to wait for a well cooked food. Food vendors are in a hurry to make money so itâ€™s prepared in a rush hence adding certain spices that has an effect on our health Ministry of food and agriculture must collaborate with food and drugs authority to institute measures to check the food operators as to the right additives that will not make a lot of people become obsessed.	Regulations on food expiration and operations of food vendors by the ministry of food and agriculture.

Appendix 12: Stakeholders' proposed interventions to address each of the identified determinants of health.

Interventions to address the influence of religion and culture on obesity		
Interventions	***Stakeholders' ID***	***Frequency***
Education campaigns on causes, consequences, myth, and effects of obesity	001, 046,004,012, 024, 029, 037, 023, 003, 006, 018, 032, 033, 045, 049, 019, 027, 039	18
Education campaigns on obesity by Ghana Health Service, advocacy groups, traditional and religious leaders	010, 022, 040, 051, 046, 013, 005	7
Setting/community-based education on obesity, exercises, diet and healthy lifestyles	001, 011, 022, 024	4
Awareness campaigns on dietary habits and dietary choices	008, 018, 025, 032, 034, 035, 042, 010	8
Public awareness campaigns on lifestyles modification (healthy diet, physical activity, good sleep, weight checks, medical checks, and stress reduction)	002, 007, 009, 015, 046, 08, 012, 014, 018, 020, 030, 034, 038, 016, 028, 031, 033, 035, 037, 048, 019, 039, 044, 021, 027, 036, 042, 011	28
Campaigns to provide recreational centres and safe exercise areas	005, 003, 040, 033	4
Financial incentives, reduced taxes on healthy foods, job creation and laws on obesity	001, 032, 040, 045, 030	5
Education campaigns on healthy lifestyles for children and youth	012, 013	2
Bariatric surgery	042, 010	2
Interventions to address the influence of physical activity and diet on obesity		
Interventions	***Stakeholders' ID***	***Frequency***
Campaigns to promote government subsidies on fruits and vegetables and ensure fruits and vegetables availability and affordability	001, 004, 006, 013, 019, 020, 022, 023, 027, 028, 029, 030, 033, 039, 040, 048, 055, 052	18
Setting/community-based awareness programs on healthy lifestyles (exercises, diet)	003, 006	2
Campaigns to create and promote community recreational/physical activity/training/fitness clubs	012, 018, 022, 040, 027, 042, 057	7
Early childhood education/school-based campaigns on exercises and diet	007, 008, 009, 011, 012, 017, 022, 023, 036, 037, 039, 053, 055	13
Education campaigns/counselling on healthy lifestyles (consumption of	008, 009, 011, 012, 013, 017, 020, 021, 022, 023, 024, 025, 026, 028, 029, 031,	30

fruits and vegetables, and physical activities) and its benefits by agencies, health workers and advocacy groups	032, 033, 034, 036, 038, 040, 042, 044, 046, 048, 051, 052, 053, 058	
Campaigns to promote public cultivation of fruits and vegetables	009	1
Awareness campaigns on the need for parents/schools to include fruits and vegetables on food menus	011, 013, 029, 030, 037, 039	6
Campaigns to promote Work-based exercises programs	011, 013, 023, 036, 056	5
Education campaigns for food vendors on best hygienic practices in cultivating and handling fruits and vegetables to promote its public consumption	019, 036, 053	3
Advertisements on benefits of healthy diet using mass media	016, 020, 029	3
Increase taxation on unhealthy foods	032	1
Campaigns to institute a national day of consuming fruits and vegetables	036	1
Campaigns to establish fruit and vegetable farms in every educational institute	036	1
Campaigns to promote operation grow what you eat	042	1
Campaigns to encourage change in the mode of transportation (bicycles) in universities and SHS	007	1
Special bicycle lanes to be provided in towns and cities	007	1
Incentives to children to encourage exercises and fruit &vegetables consumption	032	1
Campaigns for reality physical activity tv shows to be encouraged, like Di Asa	036	1
Campaigns for governments to provide community security to promote physical activities	039, 040	2
Work-based physical activity breaks	036, 051	2
Campaigns to make BMI checks compulsory in health facilities	040	1
Education campaigns on time management and screen time limitations	010, 054, 055	3

Interventions on the influence of the food environment on obesity		
Interventions	***Stakeholders' ID***	***Frequency***
Government regulations and monitoring of supermarkets and fast foods operations, food importations and food labelling	001, 004, 005, 007, 008, 009, 011, 018, 022, 023, 028, 030, 032, 036, 037, 038, 042, 045, 046, 048, 051, 053, 057, 060, 062	25
Education campaigns for supermarkets and fast-food vendors on obesity consequences and best dietary practices	002, 003, 004, 005, 006, 007, 008, 009, 013, 014, 022, 024, 027, 030, 031, 032, 033, 035, 036, 038, 040, 045, 046, 048, 052, 053, 055, 058, 060	29
Public education on healthy diet and food-related attitudinal changes by government agencies, opinion leaders, religious and traditional leaders	003, 011, 013, 015, 017, 020, 022, 025, 027, 032, 040, 042, 054, 055, 061	15
Government to enact laws, introduce taxes and subsidies to promote healthy eating	003, 013, 027, 035, 054, 080, 021, 035, 040, 048, 009, 026	12
Campaigns to encourage healthy meals in schools	007, 026	2
Campaigns to promote Ghanaian restaurants that sell local foods	011	1
Campaigns to promote fruits and vegetables availability and affordability	015, 057, 033, 034, 026, 033	6
Campaigns to encourage home cooking and make home cooking affordable	016, 036	2
Campaigns for supermarkets to make fruits and vegetable stands more visible for easy access	033	1
Laws to ensure that some percentage of supermarkets products are fruits and vegetables	036	1

Appendix 13: Characteristics of the studies identified in the further analysis in chapter 9.

Study	Author	Setting	Obesity intervention	Finding
Does the Mexican sugar-sweetened beverage tax have a signalling effect?	Álvarez-Sánchez et al. 2018)	Mexico	Tax on sugar-sweetened beverages (SSB)	Taxes on SSB together with related campaigns could influence SSBs consumption.
An economy of scales: A selective review of obesity's economic causes, consequences, and solutions	Cawley (2015)	USA	Tax on energy-dese foods and menu labelling	The policies have substantial influence on obesity prevalence
Obesity in America: A Market Failure?	Hemphill (2018)	USA	Market regulations, public education, taxes, subsidies	Government obesity interventions, like taxes, could be vulnerable to failures and potential public health risk.
Are sugar-sweetened beverage Taxes a cost-effective means of reducing weight?	Lusk (2014)	Canada	Taxes on SSBs	The consequence of tax on obesity is not simple and enough to influence obesity.