Determinants of Obesity in West Africa: A Systematic Review

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Abstract

Objectives: Obesity prevalence is increasing in West Africa. This study explores obesity determinants in West Africa to inform policy.

Methods: Scopus, Web of Science and PsycINFO were searched for relevant papers from March to April 2020. The search strategy included combinations of key words specific to each database. Eligibility criteria included studies on obesity determinants conducted in West Africa, and involving participants aged eighteen years and above. The quality of the studies was appraised using the Agency for Healthcare Research and Quality checklist. Data was synthesized qualitatively.

Results: Sixty-three (63) papers were selected. Majority of the studies originated from Ghana (n=22) and Nigeria (n=19). All included studies used cross-sectional study design. In all, 36 determinants were identified, of which 20 were demographic, socio-economic, lifestyle and biological factors, and sixteen 16 were environmental factors, like physical proximity to fast food outlets. Increasing age (OR=0.09, 95% CI= 0.12 to 65.91) and being a woman (OR=1.38, 95% CI=1.18 to 55.40) were the common determinants of obesity in West Africa.

Conclusion: Obesity in West Africa is determined by complex multi-faceted factors. There is an urgent need for robust engagement with wider stakeholder groups to develop obesity prevention and control policies in West Africa.

Introduction

Obesity is a global public health concern, and the World Health Organization (WHO) has estimated that it affects 650 million adults worldwide, with this burden projected to increase to one billion globally by 2030[1,2]. It is a modifiable risk factor for non-communicable diseases (NCDs), such as cardiovascular disease, type 2 diabetes, and various cancers[2,3]. In 2018, NCDs were responsible for 41 million (71%) of the world's 58 million deaths, with 15 million dying prematurely[4]. Low- and middle-income countries, including Africa, bear over 85% of the burden of these NCDs premature deaths, resulting in cumulative economic losses of US$7 trillion over the next 15 years and millions of people trapped in poverty[5]. 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[6].

Until recently, Africa was minimally affected by the obesity epidemic due to the burden of under-nutrition, HIV/AIDs, and tuberculosis[7]. However, current evidence shows that the continent is experiencing a swift rise in overweight and obesity prevalence as well as its associated co-morbidities because of a rapid ongoing nutritional and epidemiological transitions[7,8,9]. These dynamics, coupled with the epidemic of NCDs, create an urgent need for evidence-based sustainable actions to mitigate the obesity burden in Africa.

In West Africa, one of WHO's Africa subregions, about 52million people are with obesity, making it one of the subregions burdened with the obesity epidemic[10]. Based on this, obesity prevention and control policies have been implemented to address the epidemic. Key among them is the *National Policy for the Prevention and Control of Chronic Non-Communicable Diseases (NCDs) in Ghana, the National Policy on Food and Nutrition (NPFN) in Nigeria and the National Food and Nutrition Security (NFNS) in Sierra Leone*. Although these policies have created awareness about the obesity problem in West Africa, the prevalence of obesity continues to increase exponentially[11,12]. One primary reason for the shortfall of the obesity policies in West Africa is its inability to capture, holistically, all the determining factors of obesity[13,14]. Also, there is limited evidence to guide the implementation of these policies.

Several obesity determinants that could inform obesity prevention and control policies are identified in the literature. However, most of these determinants were discovered in high-income-countries (HICs); thus, they do not provide setting-specific obesity interventions/policies for West African countries. Hence, there is an unmet demand for a review of the determinants of obesity in West Africa. Therefore, this study aims to review factors associated with obesity in West Africa to inform context-specific interventions to address the obesity epidemic on the subregion. The findings may also provide recommendations for future empirical research in other LMICs.

Methods

Search strategy

Three electronic databases, Scopus, Web of Science and PsycINFO, were searched from March to April 2020 (updated search conducted from January to February 2021) for eligible studies using all possible combinations of search terms related to obesity determinants and Africa (Table 1). References of the papers identified in the electronic search were also screened for relevant studies. Identified studies were screened against the following eligibility criteria: (a)Quantitative studies that explored the determinants of obesity, (b) Studies written in the English language given the limited resources for translation, (c) Studies with participants aged eighteen years and above, and (d) Studies that used samples from West Africa settings.

(INSERT TABLE 1)

Data extraction

Two independent reviewers extracted relevant data from the selected studies using standardized data extraction questions developed a priori. The data extraction questions included information on the general characteristics of the studies, such as authors name and year of publication; methodological features like sample size and sample characteristics; and findings and recommendations from the authors. The questions were reviewed and agreed on by all the authors and pilot-tested before their usage. To ensure the quality of data extraction, 50% of the included papers were randomly selected and reviewed by a third reviewer. Any disagreements above 5% were resolved by consensus or through the opinion of another independent reviewer.

Quality appraisal

Two reviewers appraised the quality of the selected papers using the Agency for Healthcare Research and Quality (AHRQ) methodology Checklist to reflect the cross-sectional design of all included studies. The AHRQ assessed the quality of the included studies based on eleven checklists. For each question, a score of one (1) was given if the study met it and zero (0) if the study did not meet it. The scores of the questions were summed to represent the total score for each study. The total score for meeting all the criteria on the AHRQ checklist was eleven. None of the studies was classified as high quality since none of them met all the eleven checklists. Their scores ranged from 4 to 9, indicating a low to medium quality. Table 2 shows the number of studies that met each of the AHRQ checklist criteria.

(INSERT TABLE 2)

Data Synthesis/Analysis

Descriptive synthesis of data was performed to describe the methods, operationalization of methods, major limitations, suggestions, and recommendations for future research. Where appropriate, for each of these domains, the synthesis compared the findings from across the studies so that the themes could be put into wider perspectives.

Results

A total of 4,085 records were identified from the database searches; however, only sixty-three met the inclusion criteria (figure 1). All the sixty-three papers were cross-sectional studies. Majority of them used primary data (n=44) while the remaining used secondary data. Structured questionnaires were the common instruments used in collecting the data. The sample size of the studies that used primary data ranged from 59 to 6,959, and that of studies with secondary data ranged from 600 to 1,225,816. Fifty-five of the studies focused on only one West African country, mainly Ghana (n=22), Nigeria (n=19), Cameroon (n=4), Burkina Faso (n=3), Cote d' Ivoire (n= 2), Senegal (n=2), Togo (n=1), Gambia (n=1), Benin (n=1) while eight of them

focused on a combination of West African countries like Mali, Sierra Leone, Guinea, Liberia and Niger. All the studies were published between 2003 and 2019, with most of them in 2016 (n=10) and 2017 (n=10).

(INSERT FIGURE 1)

Measurement of determining variables

This review identified several determinants in the included studies. These determinants are categorised into demographic, socio-economic, biological, lifestyle and environmental variables, based on the Dahlgren and Whitehead ecological model of public[15]. The demographic variables included age and sex; socio-economic variables included level of education and employment status; biological variables comprised presence of hypertension, diabetes and hypercholesterolemia; lifestyle variables encompassed cigarette smoking, physical activity score, dietary score and alcohol consumption; and the environmental variables focused on neighborhood characteristics, like access to convenient stores and presence of recreational facilities, and extent of globalisation- which was an aggregate of social, political and economic globalisation that the study participants were exposed to.

Definition/Measurement of obesity

All sixty-three studies defined obesity based on the WHO BMI measurement of obesity. Thus, they classified BMI of < 18.5 kg/m^2 as people with underweight, 18.5–25 kg/m^2 as people with normal weight, 25.0–29.9 kg/m^2 as people with overweight and BMI ≥ 30.0 kg/m^2 as people with obesity. Additionally, three of the studies further measured obesity body fat[16] and abdominal obesity[17,18]. 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. Abdominal obesity was classified as a waist circumference of ≥ 102 cm in men or ≥88 cm in women, per WHO definition. Among the 44 papers that collected primary data, 32 of them used self-reported height and weight measures to estimate the BMI of the participants. Table 3 and 4 provide summary of the study characteristics, including measured variables.

(INSERT TABES 3 AND 4)

Empirical findings on the determinants of obesity in West Africa

Sex was one of the common demographic variables identified in the included studies. Eleven out of the studies[19,20,21,22,23,24,25,26,27,28,29] found women to be a significant determinant of obesity when the influence of other variables like age, marital status, education level and employment status are controlled. These studies were from Ghana (n=3), Nigeria (n=5), Nigeria & Ivory Coast (combined) (n=1) and Senegal (n=2). Increasing age was also found as a demographic determinant of obesity in this review[19,20,24,25,26,27,30,31,32] across Ghana (n=2), Nigeria (n=5), Burkina Faso (n=1), Senegal (n=1). In terms of biological factors, only two studies[19,33] found hypertension and diabetes as positive determinants of obesity. These findings were from Ghana and Nigeria.

Regarding lifestyle variables, four of the studies, one each from Ghana[36], Burkina Faso[30] and Cameroon[34], and one from thirteen combined countries, namely: Benin, Burkina Faso, Cameron, Ivory Coast, Gambia, Ghana, Guinea, Mali, Niger, Nigeria, Liberia, Senegal, Sierra Leone and Togo[35], found cigarette smoking to be significantly associated with obesity. Similarly, four of the studies from Ghana[25,36], Nigeria[19] and Burkina Faso[30] found alcohol consumption as a determinant of obesity. Also, ten studies Nigeria[19,40] (n=2), Ghana[23,25,28,37,38,41] (n=6), Togo[39] (n=1) and Cameroon[34] (n=1) indicated that lack and low levels of physical activity showed that physical activity is significantly associated with obesity. Additionally, [42, 28]from Nigeria and Ghana found poor dietary habits as determinants of obesity. All these lifestyle variables were identified as determinants after the studies had controlled for other measured variables.

The socio-economic variables that were identified in the selected papers as determinants of obesity are education level (n=9), employment status (n=3) and Socio-economic status (n=3). These studies were also from Ghana (n=2), Nigeria (n=4), Togo (1), Burkina Faso (n=1) and Cameroon (n=1). Of the environmental factors, most of the variables and the subsequent findings were heterogeneous across all the six studies that measured environmental factors. For instance, Dake et al. (2016)'s[43] study on the influence of local food environment in a poor urban setting on

obesity discovered that for every additional convenience store in poor urban settings in Ghana, there was a 0.2kg/m2 increase in BMI, and every out-of-home cooked food place available, there was a 0.1kg/m2 reduction in BMI of residents while the study by Osayomi and Orhiere (2017)[43] on environmental factors and obesity in Nigeria identified that physical proximity to fast food outlets is a determinant of obesity. See tables 4 and 5 for a summary of the review.

(INSERT TABLE 5)

Discussion

This review aimed to explore the determinants of obesity in West Africa, one of Africa's subregions currently experiencing a rise in obesity prevalence. Sixty-three studies, mainly from Ghana, Nigeria, Cameroon, Burkina Faso, Cote d' Ivoire, Senegal, Togo, Benin and Mali were included in this review. The identified determining factors were categorised into demographic, socio-economic, biological, lifestyle and environmental factors. The findings of this review will be discussed based on these categorisations.

In terms of demographic factors, the review identified being a woman and increasing age as common determinants of obesity. One possible explanation for sex differences in obesity determinants is the influence of gonadal steroids on adipose tissue storage and distribution[45]. Evidence from several studies suggests the endocrine mechanism as the cause of the different obesity phenotypic expressions across sex[46-48]. The endocrine pathway predisposes women to have a higher likelihood of having obesity than males in 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[49,50]. Regardless of these hormonal explanations, evidence also shows that gender, as a social construct, also predisposes to obesity than men[51,52]. Women are less likely to engage in physical activities[51,53] and more likely to consume foods high in added sugars, such as chocolate and ice-cream than men[54]. However, they are more likely to report healthy eating practices[55]. 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[52,56]. 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[55,57]. Furthermore, studies have shown that most West African communities admire women with large body size[58-60]; 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[61-64]. Ageing is associated with metabolic imbalance, which is a

significant contributor to obesity[63]. The increase in perivascular adipose tissue associated with ageing influences the risk of obesity among the aged population[64]. Moreover, ageing is also associated with less physical activities because of musculoskeletal changes, like reduced joint spaces and osteoporosis, that occur with ageing[65]. As most developing countries undergo demographic transition, the increasing burden of conditions, like obesity, is expected[66]. Also, an increase in life expectancy is usually correlated with increase susceptibility with chronic diseases, like diabetes, that is also associated with obesity[63]. Nonetheless, the association between ageing and obesity can go both ways, as obesity can also hasten ageing phenotypic development[67]. 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[68]

Education level, employment status and socio-economic status were the identified socio-economic determinants of obesity. Studies[59,60,69] show that large body size is usually tied to affluence and social status in West African countries, like Ghana and Nigeria. Therefore, individuals with high education and employment status may tend to gain weight to keep up with the social status that comes with affluence[70]. Also, wealth usually comes with increased purchasing power, and this inherently increases accessibility to food choices that can be abused[71]. Additionally, 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[71]. Furthermore, the centralised systems of most West African countries put residential areas in city peripheries and work environments in city centres[72]. 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[72]. 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[73]. This, however, does not necessarily translate into healthy food choices that could reduce their risk of obesity[74].

The findings of this review are similar to the review findings of other reviews in both LMICS and HICs[70,75-79]. However, they were also inconsistent with other review[80]. The review found

men to be the common determinant of obesity as opposed to the finding of this review. This difference may be attributed to differences in sample characteristics.

Policy implications of review findings

The findings of this review indicate the need for specific policies to curtail the obesity epidemic in West Africa and, subsequently, other LMICs. These policies could include implementation of interventions to address gendered eating behaviours and education on socio-cultural weight perceptions and body image from the community-level up to the national level. Also, community-based physical activity interventions, appropriate for all age brackets, could be instituted in schools, churches and other social organisations to address age-related obesity incidence. Additionally, governments, through stakeholder engagements could address obesogenic environments by increasing accessibility and affordability of local foods rich in fibres, minerals, and vitamins, and reduce consumption of foods high in added salts and sugars at all population levels. Furthermore, governments could implement policies, such as decentralisation of government systems and enabling local economies, to reduce rural-urban migration, which is consequential in the obesity menace. Finally, social marketing approaches must be strategised to ensure obesity awareness to elicit favourable changes at individual and environmental levels.

Strength and limitations of this review

To the best of the researcher's knowledge, this is the first study to review the determinants of obesity in West Africa. Therefore, the findings could serve as a foundation for other future reviews/studies on obesity determinants in West Africa, in addition to providing a menu of policy options for West African nations and wider LMICs on obesity prevention and control. Also, this review included many studies; hence, it presents with more robust evidence on the determinants of obesity, and this could influence policy shift in the conceptualisation of relevant policies on obesity in West Africa. Even though this review included studies from most West African countries, there was a significant imbalance in the 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 conclusions of this review, and subsequently, the implications

as discussed above. Thus, caution must be taken in the interpretation of this review findings to avoid biased inferences.

Conclusion and Recommendation

The findings of this review indicated that obesity in West Africa is determined by demographic, lifestyle, biological and socio-economic factors such as age, sex, physical activity, and education. These findings present an urgent need for robust engagement with broader stakeholder groups to develop sustainable obesity prevention and control policies to address the obesity epidemic in West Africa. These policies could include education, awareness and implementation of diet and physical activity interventions to stimulate individual and environmental changes at subpopulation and population levels. This review recommends that future studies are conducted in other African subregions, like East Africa, to provide evidence on determinants of obesity to proffer obesity interventions that would have far-reaching benefits to the broader African continent.

LIST OF FIGURE AND TABLES

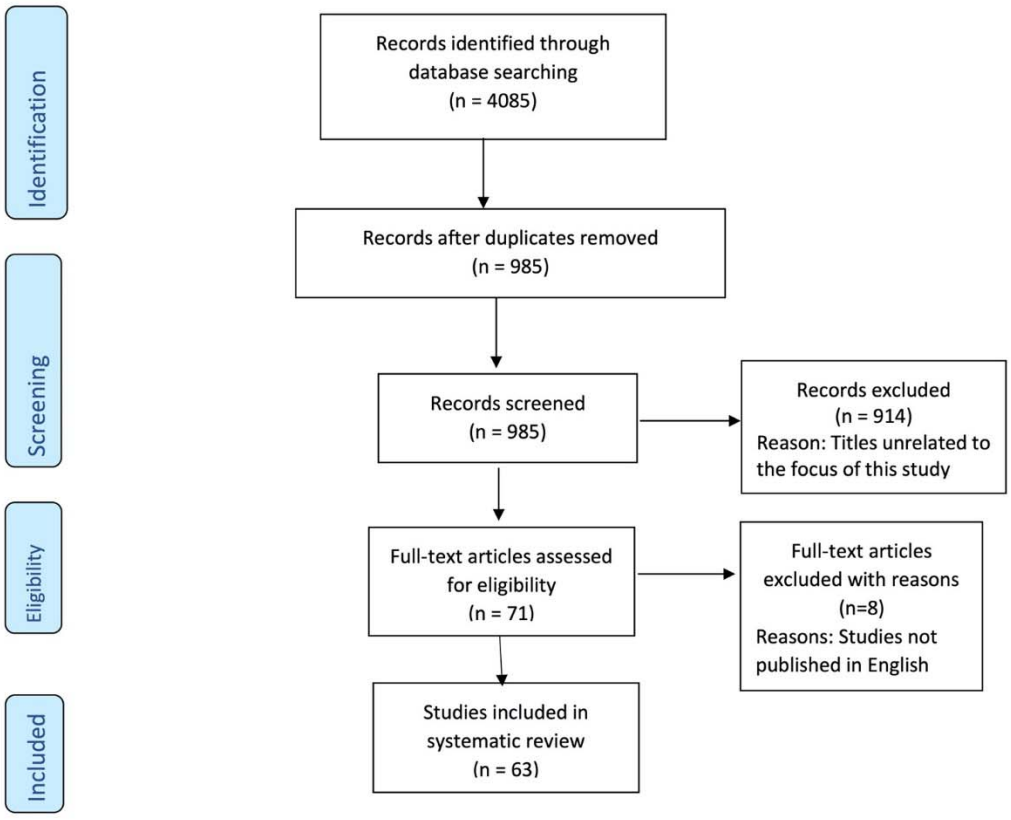

Figure 1: Prisma Diagram for the Selection Process

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 *Mozambique* 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 in order to get an overarching picture of the literature space prior to focusing on West Africa. These search terms were entered differently in each database, per database requirements.

Table 2: Number of studies that met the AHRQ checklists

AHRQ Checklists	Number/proportion (%) of studies that met it
1) Define the source of information (survey, record review)	61 (97)
2) List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	50 (79)
3) Indicate time period used for identifying patients	47 (75)
4) Indicate whether or not subjects were consecutive if not population-based	44 (70)
5) Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants	23 (37)
6) Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)	9 (14)
7) Explain any patient exclusions from analysis	17 (27)
8) Describe how confounding was assessed and/or controlled.	22 (35)
9) If applicable, explain how missing data were handled in the analysis	12 (19)
10) Summarize patient response rates and completeness of data collection	31 (49)
11) Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or	8 (13)

AHRQ Checklists	Number/proportion (%) of studies that met it
follow-up was obtained	

Table 3: Basic characteristics of the sixty-three included studies

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
Abdula (2010)	To explore the determinants of overweight and obesity in mothers and children in Ghana	Ghana	C	576 household olds	Males and females ≥ 3years	Logistic regression
Addo et al. (2015)	To determine the prevalence of obesity and overweight and associated factors among workers of a financial institution in Accra Metropolis.	Ghana	C	180	≥ 18 years employees from selected financial institutions in Ghana	Logistic regression
Addo & Leon	To investigate the	Ghana	C	1,015	615 men and 400 women aged 25 years and	Logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
(2009)	distribution of obesity and its association with pre-adult wealth and adult socio-economic factors in urban Ghanaian civil servants.				above and employed in government ministries and departments in Accra	
Ajayi et al. (2016)	To show the collective burden of obesity and overweight in sub-Saharan Africa.	Nigeria South Africa Tanzania Uganda	C	1463	Participants were 200 nurses from Nigeria, 489 schoolteachers in South Africa, 276 teachers in Tanzania, 298 village residents in peri-urban and 200 rural location in Uganda. They were both males and females and aged from 18 years and above.	Binary logistic regression Chi square goodness of fit test
Akarolo-Anthony et al. (2014)	To examine the correlates of obesity	Nigeria	C	1058	males and females, aged ≥18 and recruited from a government worksite at the Federal Secretariat Complex in Abuja	Log-binomial regression analyses

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
Akinyeniju et al. (2016)	To examine the association between socio-economic status (SES) and obesity in Ghana	Ghana	C	2341	Sample included women aged ≥18 years surveyed as part of the Ghana SAGE study.	
Aladeniyi et al. (2017)	To determine the correlates of obesity among public service workers in Akure	Nigeria	C	4, 828	Sample included both males and females from Ondo, but the females were thrice the number of males. Their ages were from ≥18.	Logistic regression
Engle-Stone et al. (2018)	T examine associations between household and individual characteristics and overweight and obesity	Cameroon	C	1,251	Sample included only women. Pregnant women were exempted from the study	Logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
Atuahene et al. (2017)	To estimate overweight/obesity, hypertension and diabetes prevalence and associated risk factors among public servants.	Ghana	C	257	Sample included males and females, age 20 to 59 years and from Nadowli district of Ghana. Their religion was Christianity and Islamic.	Logistic regression
Becquey et al. (2010)	To describe dietary patterns of adults in Ouagadougou and to study their relationship with anthropometric status of the subjects.	Nigeria	C	1,072	Individuals aged 15-65 years: 276 women and 261 men from Wemtenga (structured district) and 281 women and 254 men from Taabtenga (unstructured district)	Multiple linear regression and logistic regression
Ghose B. & Yaya S. (2018)	To investigate the time trends in body mass index (BMI) and	Nigeria	C	69, 401	Adult non-pregnant women aged between 15 and 49 years.	Multinomial logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	relationship between media use and body weight status among adult women in Nigeria.					
Blankson & Hall (2010)	To describe the anthropometric and physical status of a sample of elderly women in rural Ghana and examine factors associated with low BMI.	Ghana	C	59	Elderly women from 115 households in two identified villages in Ghana	Linear regression
Boua et al. (2018)	To investigate the distribution of BMI and prevalence of obesity,	Burkina-Faso	C	2,706	Sample included males and females aged from 40 to 60 years.	Multivariate hierarchical regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	and to determine the socio-demographic and behavioural correlates with BMI					analysis
Chigbu et al. (2018)	To explore the prevalence and factors associated with obesity in Enugu state, Nigeria.	Nigeria	C	6,459	Male and female adults aged 20 – 60 years form both urban and rural setting in Enugu.	Multinomial regression analysis
Chukwuonye et al. (2013)	To investigate the prevalence of abdominal obesity in Abia State, Nigeria.	Nigeria	C	2,807	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.	logistic regression analysis
Cohen et al. (2018)	To determine the impact of bio-cultural factors on the	Senegal	C	597	Sample comprised 393 adults from the agglomeration of Dakar and 204 adults from the rural Kaolack region.	Binary logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	nutritional status of Senegalese adults.					
Corsi et al. (2010)	To explore the extent to which body mass index (BMI) varies between small areas or neighbourhoods in low- to middle-income countries	Benin Burkina Faso Ghana Guinea Liberia Niger Togo Senegal Mali Sierra Leone, Cameroon Ivory Coast Nigeria Gabon	C	451,321	Sample included non-pregnant women aged from 20 to 49 years both with or without children from participating countries.	Multilevel analysis

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
Dake et al. (2011)	To examine the sociodemographic correlates of obesity among Ghanaian women	Ghana	C	5,279	Sample included only women aged from 15 to 49 years living in any of the ten regions of Ghana.	Multinomial logistic regression
Dake et al. (2016)	To examine the characteristics of the local food environment in an urban poor setting in Accra and the associated risk of obesity for residents	Ghana	C	657	Sample included males aged from 15 – 59 and females from 15 – 49 and residents James town, Ussher town and Agbobloshie. Participants had an average of 25.58kg/m^2 and the females had a higher BMI on the average than males	Multilevel analysis, bivariate ordinary least squares regression
Dake (2012)	To investigate spatial autocorrelation in BMI using the cluster as the	Ghana	C	4,454	Only women aged between 15 and 49 years	Histogram, Box plots and Cartogram

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	spatial unit of observation.					
Damorou et al. (2013)	To determine the prevalence of obesity and its risk factors among workers in Lomé	Togo	C	510	Male and female workers aged 18 years and above in Lomé.	linear regression
Dickson et al. (2016)	To assess the association between dietary diversity (DD) score, socioeconomic status (SES) and maternal BMI, and the variation of the effects of DD and SES at	Ghana	C	2038	Sample included women from 15 – 59 years and their partners from 15 to 49 years old. Sample was from both rural and urban settlements.	Quantile regression analysis

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	different points of the conditional distribution of the BMI.					
Diendéré et al. (2019)	To determine the prevalence and factors associated with overweight/obesity among women living in rural and urban Burkina Faso	Burkina Faso	C	2191	Women aged from ≥25 years from selected rural and urban areas	Multivariate logistic regression
Doku & Neupane (2015)	To explore trends in overweight/obesity and underweight and associated factors were	Ghana	C	20,012	Women aged from 15 to 49 years from four demographic and health surveys conducted in Ghana; 1993, 1998, 2003 and 2008	Multinomial logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	explored among 15 to 49 years old women in Ghana.					
Maruf & Udoji (2015)	To explore prevalence of overweight and obesity and their associations with socio demographic variables in a Nigerian population.	Nigeria	C	1,521	Male and females aged 18 years and above	Multinomial logistic regression
Fezeu at al. (2005)	To determine the association between socio-economic status and adiposity in urban Cameroon	Cameroon	C	2,831	Samples were recruited from Biyem-Assi, an urban area of Yaoundé, the capital city of Cameroon. The participants included civil servants, businessmen, and students aged 25 years and over.	Logistic regression model Logistic regression model
Fezeu et al.	To compare the 10-year	Cameroon	C	3,160		Multivariate

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
(2008)	changes in the distribution of adiposity in rural and urban Cameroonian populations					logistic regression models
Goryakin et al. (2015)	To assess the impact of globalization on overweight and obesity on 56 selected countries	Ghana Gabon Benin Burkina Faso Cameroon Cote d'Ivoire Guinea	C	1,225,816	Sample included only women from 15 to 49 years in some selected low- and middle-income countries.	Ordinary least squares (OLS)
Grey et al. (2006)	To investigate the distribution of overweight and obesity and its relationship with	Gambia	C	200	The subjects were divided by gender (male–female) and by age (14–25 and 35–50 years). Each group I made up of 50 respondents	Chi Square test

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	socio-economic and behavioural factors in a developing-country population undergoing rapid nutritional transition.					
Koussoh et al. (2019)	To assess correlates of overweight and obesity among women in a sub-urban population of Abidjan, Côte d'Ivoire.	Côte d'Ivoire.	C	327	Study involved only women 15 years old and above	Logistic regression model.
Lartey et al. (2019)	To examine recent changes in obesity prevalence and associated factors for	Ghana	C	5,821	Sample included adults aged 50 years and older in Ghana. They were drawn from the WHO SAGE 2007/08 (Wave 1; n = 4158) and 2014/15 (Wave 2; n = 1663).	Multinomial and binomial logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	older adults in Ghana between 2007/08 and 2014/15					
Luke et al. (2014)	To examine whether low levels of PA are associated with excess weight and adiposity.	Ghana	C	500	Sample included young male and female adults aged 25 to 45 years	multiple linear regression
Macia et al. (2010)	To determine the prevalence of obesity in Dakar	Senegal	C	600	men and women aged from 20 years and above living in the Dakar.	Logistic regression
Chidozie et al. (2009)	To examine relationships between SES and BMI, investigate whether variations in BMI are influenced by	Nigeria	C	1,067	552 men and 515 women aged between 30 and 60 years	Multivariate linear regression analysis

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	differences in SES, and estimate the prevalence of overweight and obesity in a semi-urban population in Nigeria.					
Mogre et al. (2015)	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	Ghana	C	552	Male and female participants aged 18–36 years attending the University for Development Studies, School of Medicine and Health Sciences Tamale, Ghana	Multinomial logistic regression
Neupane et al.	To assess the magnitude	Sub-Saharan	C	250,651	Sample included only women from 32 countries	Logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
(2016)	and disparity of overweight and obesity by residence, level of education and wealth quintile using cross-sectional data from 32 countries.	Africa			in Sub-Saharan Africa. Their mean age was 28.46 years	
Ngianga-Bakwin & Saverio (2014)	To examine the geographic variation of overweight and obesity prevalence at the state-level among women in Nigeria	Nigeria	C	27, 967	Sample included only women aged from 15 – 49 years old.	Multivariate Bayesian geo-additive regression models
Nonterah et al. (2017)	The study characterized the socio-demographic	Ghana	C	2,014	Men and women aged 40–60 years who had been resident within the study area for at least	Hierarchical linear regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	and behavioral factors influencing BMI among adults in rural Northern Ghana.				10 years.	analysis
Nuertey et al. (2017)	To determine the prevalence of obesity and overweight and its associated factors amongst registered pensioners in Ghana	Ghana	C	4813	Male and female members of the National pensioners association (NPA) in all the ten regional capitals in Ghana, aged sixty years and above.	Logistic regression
Chinedu et al. (2017)	To investigate the body weight distribution amongst sexes and different age groups in educational institutions	Nigeria	C	1,394	Male and females aged 2 to 75 years and from four educational institutions in, Ota.	Logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	in Ota, Southwest Nigeria.					
Obirikorang et al. (2016)	To determine the prevalence and risk factors of obesity among practicing nurses in three selected hospitals in the Kumasi metropolis.	Ghana	C	825	Females (83.9%) and males (16.1%) with an average age of 31.6 ± 9.7 years.	Logistic regression
Obirikorang et al. (2015)	To describe differences in prevalence of obesity and cardio-metabolic risk factors between urban and rural settlements in the	Ghana	C	672	Male and female participants from the Ashanti region of Ghana with a median age of 50 years	Multivariate logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	Ashanti Region of Ghana.					
Okoh (2013)	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.	Nigeria	C	18,107	Women aged 20 to 49 were included in the study	multi-nominal logistic regression
Olatunbosun et	To explore the	Nigeria	C	998	Sample included male and female civil servants	logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
al. (2010)	prevalence of obesity and overweight in an urban setting in Ibadan, Nigeria.				aged from 19 -70 years in Ibadan.	
Ajayi et al. (2016)	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.	Nigeria South Africa Tanzania Uganda	C	1,463	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. They aged 18-80years	Binary logistic regression
Osayomi & Orhiere (2017)	To determine the small-area variations in the prevalence of	Nigeria	C	234	Sample included male and females from Ibadan North LGA, Nigeria aged from 18 years and above.	Simple linear regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	overweight and obesity in an urban area of Nigeria and its association with socio-economic, environmental, dietary and lifestyle risk factors.					
Oue´draogo et al. (2008)	To document the prevalence and the socio-spatial variations of obesity and to identify individual and household characteristics, lifestyles and dietary practices	Burkina Faso	C	2022	Male and females aged from 35 years and above	Chi-square

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	contributing to obesity and its socio-spatial distribution.					
Oyebisi & Olumakaiye (	To assess fast food consumption pattern and body weight status among the undergraduates of Obafemi Awolowo University, Ile-Ife, Nigeria	Nigeria	C	360	Sample included male and female students aged below 18 years and above from the Obafemi Awolowo University, Ile-Ife, Nigeria during the rain semester in 2011/2012 session	Regression analysis
Oyeyemi et al. (2013)	To investigate the mediating effects of PA and sedentary time on	Nigeria	C	1,411	The sample consisted of 43.1% women and 56.9% men from Nigeria	Generalized Linear Models

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	the associations of neighbourhood environmental factors and body mass index (BMI) among Nigerian adults.					
Oyeyemi & Adegoke (2012)	To examine associations between neighbourhood environment variables and overweight in Nigeria adults.	Nigeria	C	1818	Samples included males and females from age 25 to 65 years systematically recruited from 38 neighbourhoods categorized into in Maiduguri, Nigeria.	Logistic regression analysis
Pasquet et al. (2003)	To examine the current prevalence of	Cameroon	C	771	Sample included all men and women 20 years and above. Pregnant and lactating mothers	Logistic regression model

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	overweight and obesity in Yaoundé, the capital city of Cameroon and search for possible causal factors				were excluded from sample.	
Peltzer et al. (2014)	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	Ivory Coast Nigeria	C	835	Samples were selected from 22 universities. They were aged from 16 to 30 and above. Participants were both males and females.	Multivariate logistic regression
Ramsay et al.	To compare regional	Ghana	C	1,968	The sample included male and female adult	Multiple linear

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
(2009)	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.	Burkina Faso			population aged 40 – 60 years from Navrongo in Ghana and Nanoro in Burkina Faso.	regression (Sex-stratified hierarchical models)
Razak et al. (2015)	To determine the prevalence and distribution of BMI	LMICs including west african	C	7,948	Women aged from 20 to 49 years	Logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	lower than 16 and its change in prevalence over time in women in LMIC.	countries				
Smith et al. (2017)	To determine the association between ABO blood group and BMI in a Ghanaian population	Ghana	C	412	Sample included 238 male and 174 female students from KNUST university in Ghana. They aged from 18 – 46 years	-
Sodjinou et al. (2008)	To assess the rate of obesity and other cardiovascular disease (CVD) risk factors in a random sample of 200 urban adults in Benin	Benin	C	200	Sample included males and females born-Beninese adults aged 25 to 60 years	Multiple linear regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	and explored the associations between these factors and socio-economic status					
Stringhini et al. (2016)	To examine the association of education and wealth with several NCD-Risk factors in young adults	Ghana	C	500	Young adults from 25 to 45 years in rural Ghana	Ordinary Least squares
Tuoyire et al. (2018)	To explore the association between TV exposure and overweight/obesity among Ghanaian	Ghana	C	4158	Only women 15 years old and above	Binary logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	women.					
Tyrovolas et al. (2016)	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	Ghana	C	1,975	Sample included both males and females aged 65 years old and above	multivariable regression
Ukegbu et al. (2017)	To assess prevalence of overweight and obesity and associated factors in a group of university	Nigeria	C	1610	Sample were from five tertiary institutions in south-eastern states of Nigeria. It included both males and females and excluded pregnancy or lactation in women, presence of any form of	Chi square test

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	undergraduates in south-east Nigeria				physical disability and suffering from any form of chronic illness.	
Wahab et al. (2011)	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	Nigeria	C	300	Male and female adults with a mean age of 37.6 ± 10.6 years	logistic regression
Yaya et al. (2018)	To establish the pattern of the risk factors of NCDs in sub-Sahara	Benin, Burkina Faso Cameron,	C	199,540	Only women form the participating countries were included in the studies. Their ages ranged from 15 to 49 years old and were from both	Multinomial logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	Africa region	Ivory Coast Gambia Ghana Guinea Mali Niger Nigeria Liberia Senegal Sierra Leone and Togo			rural and urban settlements in the selected countries.	
Ziraba et al. (2009)	To describe trends in overweight and obesity among urban women; and examine how these trends vary by	Burkina Faso Ghana Kenya Malawi Niger Tanzania Senegal.	C	-	Comprised women aged ≥15 years	Multivariate ordered logistic regression

Author (year)	Aim	Study setting	Study design	Sample size	Sample characteristics	Primary analysis /Model(s) used
	education and household wealth					

C – Cross-sectional study

Table 4: Independent and dependent variables measured and the study findings

Author (year)	Determining variables measured	Obesity specification	Findings
Abdula (2010)	Weight Household size Mother/ Child's age Mother's marriage status Mother's education Ethnicity Mother's occupation Food consumption TV Viewing	WHO BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Mothers' education, employment status and ethnicity are associated with obesity
Addo et al. (2015)	Ages Sex educational level marital status	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2)	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 %

Author (year)	Determining variables measured	Obesity specification	Findings
	Years with institution Sedentary work Alcohol intake	Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	CI = 1.23–6.33, p = 0.01), and age (OR = 1.10, 95 % CI = 1.01–1.20, p = 0.036) were associated with obesity and overweight
Addo & Leon (2009)	Age Physical activity Level of education Employment grade Current wealth Pre-adult wealth Alcohol consumption Smoking status Ethnicity Place of birth	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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.
Ajayi et al. (2016)	Sex Age Education level	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–	Female predicted 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

Author (year)	Determining variables measured	Obesity specification	Findings
	Marital status Cigarette smoking Number of cigarettes in past 24h Wealth status Current smoker	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Uganda (AOR =27.80, CI =7.13 – 108.41) and South Africa (AOR =2.17, CI: 1.19 – 4.00). Increasing age predicted 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 predicted BMI≥ 25kg/m^2 only in peri-urban Uganda (Married – AOR=4.49, CI: 1.74 – 11.57).
Akarolo-Anthony et al. (2014)	Age Sex Religion Marital status Education Occupation Socio-economic status Sugar sweetened beverages Physical activity	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	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.

Author (year)	Determining variables measured	Obesity specification	Findings
	Television		
Akinyeniju et al. (2016)	Age Marital status Smoking Alcohol use Health status Education Mother's education Father's education Employment	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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). 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
Aladeniyi et al. (2017)	Sex Age Level of education Marital status	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2)	Female (AOR= 5.7 CI =4.7-6.9), 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=

Author (year)	Determining variables measured	Obesity specification	Findings
	Grade level Excessive alcohol consumption Engaging in physical activity Spending 8 or > hours in sitting Diabetes mellitus High blood pressure	Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	0.5-0.9) and hypertension (AOR=0.5, CI= 0.4-0.6) predict obesity
Engle-Stone et al. (2018)	Age Household socio-economic status Exposure to media Intake of fortified food Consumption of processed snack	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Household TV ownership (OR= 0.31 CI =0.11, 0.92)] and age (OR =0.38 CI =0.12, 1.20) were associated with obesity
Atuahene et al. (2017)	Age Sex Marital status	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–	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.

Author (year)	Determining variables measured	Obesity specification	Findings
	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	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Becquey et al. (2010)	Snacking score (frequent food consumption outside the main meals) Modern foods score (modernity of the type of foods consumed)	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00–	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])

Author (year)	Determining variables measured	Obesity specification	Findings
	Age Marital status Religion Ever attended school District	29.99 kg/m^2) Obese (≥30 kg/m^2).	
Ghose B. & Yaya S. (2018)	Frequency of reading newspapers Listening to radio Television (TV) viewing	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Watching TV almost every day 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.
Blankson & Hall (2010)	Half arm span Mid-upper arm circumference (MUaC) Age	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2)	BMI was strongly positively correlated with half arm span (r=0.999, P<0.001) and with MUaC (r=0.91, P<0.001).

Author (year)	Determining variables measured	Obesity specification	Findings
	Chewing tobacco Drinking alcohol Using walking aid	Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Boua et al. (2018)	Age Gender Ethnicity Marital status Highest level of education Employment Household asset status Smoking status Snuff use Chewing tobacco Alcohol intake Diet	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Age was inversely associated with BMI 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).

Author (year)	Determining variables measured	Obesity specification	Findings
	Physical activity Clinical history Self-reported diabetes status HIV positive TB positive		
Chigbu et al. (2018)	Gender Age Residence Urban class Marital status Education level Income status Ethnicity	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Men were less likely to be overweight (AOR 0.79; 95%CI 0.68-0.92) and obese (AOR 0.24; 95%CI 0.19-0.31) than women. Urban residents were more likely to be overweight (AOR 1.42; 95%CI 1.18-1.71) and obese (AOR 2.09; 95%CI 1.58-2.76) than rural residents. Each additional 1-year increase in age increased the risk of overweight by 1.012 (95%CI 1.005-1.018) and obesity by 1.03 (AOR 1.03; 95%CI 1.02-1.04). The low-income class was less likely to be overweight (AOR 0.694; 95%CI 0.507-0.951) and obese (AOR 0.44;

Author (year)	Determining variables measured	Obesity specification	Findings
			95%CI 0.28-0.67).
Chukwuonye et al. (2013)	Hypertension Diabetes mellitus	BMI (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2). Abdominal obesity (Waist circumference of 102 cm or more in men and 88 cm or more in women	The prevalence of abdominal obesity was higher (21.75%) than the prevalence of obesity based on BMI (11.12%) in the population.
Cohen et al. (2018)	Dietary intake Physical activity Health status perception Anthropometry variables	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2)	Being female, older, living in urban/suburban areas and valuing larger body size were independently associated with being overweight/obese, but not high-calorie diet

Author (year)	Determining variables measured	Obesity specification	Findings
	Perceptions of corpulence	Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	
Corsi et al. (2010)	Age Education Household wealth Neighbourhood of respondent	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Of the total variation in BMI, 17.6% was attributable to countries (SD 2.0, 95%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.

Author (year)	Determining variables measured	Obesity specification	Findings
Dake et al. (2011)	Age place of residence region of residence level of education ethnicity religion occupation marital status parity household wealth quintile	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Women who had higher education were about two times more likely to be overweight compared to non-educated women; those from richer households were twice as likely to be overweight and about five times as likely to be obese compared to those from households of average wealth status. The likelihood of a woman being overweight or obese increased with increasing age.
Dake et al. (2016)	Characteristics of the food environment Age Sex Marital status Education level	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50– 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2)	The findings showed a 0.2kg/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 after controlling for individual socio-demographic characteristics, lifestyle behaviours and community characteristics.

Author (year)	Determining variables measured	Obesity specification	Findings
	Type of occupation Length of stay in the community Social cohesion Crime level Trust among community members Lifestyle behaviours	Obese (≥30 kg/m^2).	
Dake (2012)	GPS data (Spatial location, determined using the local spatial autocorrelation (LISA))	BMI measure of obesity; Underweight <18.50 kg/m^2 Normal range (18.50–24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	The results indicate that almost a quarter of clusters in Ghana contain women who are mostly overweight on average.
Damorou et al. (2013)	Age Gender	BMI ((Underweight <18.50 kg/m^2	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

Author (year)	Determining variables measured	Obesity specification	Findings
	Education level Dietary habits Total cholesterol Fasting blood sugar Blood pressure	Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2)). and waist circumference (WC): measured as >88cm for females and >102cm for males.	2.34 – 9.67, p =0.001) were significantly associated with obesity.
Dickson et al. (2016)	Maternal DDS Maternal parity Maternal age (in years) Number of household members Number of children under 5 years Education Employment status	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Women who consumed an additional unit of DD achieved an increase of 0.245 in BMI for those in the 90th quantile. 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

Author (year)	Determining variables measured	Obesity specification	Findings
	Household wealth Sex of household head Presence of co-wives		Ghana. Also, 0.237 units increased for those in the 90th quantile in Ghana.
Diendéré et al. (2019)	Age Marital status Residence Education levels Occupation Total cholesterol Blood pressure Alcohol use Smoking tobacco	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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 BP was significantly associated with obesity
Doku & Neupane (2015)	Age Education Parity Marital status Wealth index	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–	Older age was 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). Women with primary (OR = 0.44; 95 % CI = 0.22 – 0.88) or no education (OR = 0.22; 95 % CI = 0.11 –

Author (year)	Determining variables measured	Obesity specification	Findings
	Place of residence Survey year	29.99 kg/m^2) Obese (≥30 kg/m^2).	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.
Maruf & Udoji (2015)	Socio-economic status (occupational and educational indices.	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Participants aged 41–60 years (OR 4.29; 95%CI, 3.25–5.67) had higher odds for Obesity and those >60 years (OR 1.72; 95%CI, 1.21–2.43) had higher odds for overweight compared to those aged 18–40 years. Female was associated 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 odds 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 while skilled participants had about the same OR

Author (year)	Determining variables measured	Obesity specification	Findings
			for overweight as professionals, their OR for obesity (OR 1.27; 95% CI, 0.67–2.43) was fairly higher than that for professionals.
Fezeu at al. (2005)	Age Gender Household amenities quartile Occupation level Alcohol consumption Tobacco smoking Educational level Physical activity quartile	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	After adjusting for confounding variables, the odds of obesity (3.8, 1.8–7.8), and abdominal obesity (2.2, 1.3–3.6) were significantly higher for men in the high compared with the low occupational level.
Fezeu et al. (2008)	Age Alcohol consumption tobacco smoking, educational level.	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–	Age-standardized prevalence of BMI ≥25 kg/m^2 increased significantly in the rural area while the age-standardized prevalence of central obesity increased significantly in the urban population (+32% for women and +190% for men) and it persisted after adjustments

Author (year)	Determining variables measured	Obesity specification	Findings
		29.99 kg/m^2) Obese (≥30 kg/m^2). Central obesity: WC ≥80 cm for women and 94 cm for men	for age group, alcohol consumption, tobacco smoking, and level of education.
Goryakin et al. (2015)	Social globalization Political globalization Economic globalization Education Occupation Age Number of children	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	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.
Grey et al. (2006)	Socio-economic status Educational level Healthy lifestyle score	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	fat-free mass (kg) was significantly higher in males than females

Author (year)	Determining variables measured	Obesity specification	Findings
	Western influences	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Koussoh et al. (2019)	Physical activity Blood pressure Education level Socioeconomic level Age Marital status	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Age (p=0.006), marital status (p=0.002) and blood pressure (p=0.004) were significantly associated with obesity.
Lartey et al. (2019)	Age Sex Education level	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	Not meeting the recommended physical activity level among females was associated with higher odds of obesity (OR = 3.23; 95% CI: 1.13–6.23) and high central

Author (year)	Determining variables measured	Obesity specification	Findings
	Marital status Residence/location Household wealth smoking status alcohol consumption Fruit and vegetable intake Physical activity	24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2). Waist circumference and high central adiposity (determined using sub-Saharan Africa standards	adiposity (OR = 2.19; 95% CI: 1.32–3.63).
Luke et al. (2014)	Physical activity Age Gender Employment Education Participant and significant other's occupation Parental education	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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).

Author (year)	Determining variables measured	Obesity specification	Findings
	Household assets and amenities.		
Macia et al. (2010)	Age Gender Marital status Education level Ethnicity	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2). Waist circumference (WC) ≥80 cm for women and 94 cm for men Waist to Hip ratio (WHR)	Ages 30 – 39 (OR 8.02, CI 3.57 – 18.02, P <0.001), 40 – 49 (OR =22.51, CI =8.88 – 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. Female was also significantly associated with obesity (OR =17.91, CI =9.39 – 34.15, P <0.001) compared to male.
Chidozie et al. (2009)	Socioeconomic strata	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	SES was found to be inversely related (p < 0.010) BMI

Author (year)	Determining variables measured	Obesity specification	Findings
		24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Mogre et al. (2015)	Age Sex Food group Physical activity	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2). Waist to Hip Ratio (WHR): 0.9 or less in men and 0.85 or less in women.	BMI was less likely in students who engaged in vigorous physical activity (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% CI1.2 – 5.4, p = 0.015). Abdominal obesity was also less likely in male 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)

Author (year)	Determining variables measured	Obesity specification	Findings
Neupane et al. (2016)	Place of residence Socio-economic Status Maternal education	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^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.
Ngianga-Bakwin & Saverio (2014)	Geographic location Age Education level Religion Wealth index Ethnicity Place of residence	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Higher education level (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) were significantly associated with higher prevalence of obesity.
Nonterah et al. (2017)	Age groups in years Ethnicity	BMI: (Underweight <18.50 kg/m^2	Participants with the highest level of education and a high household socio-economic status had higher BMIs

Author (year)	Determining variables measured	Obesity specification	Findings
	Partnership status Highest level of education Employment status People-to-bedroom density Household SES categories	Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	than those in the lowest strata in both men (β = 0.074, p = 0.028 and β = 0.072, p < 0.001, respectively) and women (β = 0.174, p = 0.001 and β = 0.109, p < 0.001, respectively). Men (β = −0.050; p < 0.001) and women (β = −0.073; p < 0.001) of the Nankana ethnic group had a lower BMI than the Kassena ethnic group. Among men, alcohol consumption (β = −0.021; p = 0.001) and smoking (β = −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 (β = 0.022; p = 0.022) among men
Nuertey et al. (2017)	Sex Age Marital status	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	Hypertensive pensioners had 2.6 times odds of being obese compared to non-hypertensive pensioners (95%CI 2.3–2.9). Diabetics were associated with higher

Author (year)	Determining variables measured	Obesity specification	Findings
	Ethnicity Education level Social class Region of residence Religion Hypertension Diabetes	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	odds of being obese (OR 2.5 95% CI 2.0–2.0) compared to non-diabetics. Female pensioners were associated with three times the odds of being obese compared to the male pensioners
Chinedu et al. (2017)	Age Sex	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Age (r =0.612, p =0.000) was significantly associated with BMI of the subjects.
Obirikorang et al. (2016)	Physical activity Alcohol intake	BMI: (Underweight <18.50 kg/m^2	Taking meals late at night (OR 2.5 95%CI 1.1-5.7 p=0.0398)

Author (year)	Determining variables measured	Obesity specification	Findings
	Working under stressful hours	Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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.
Obirikorang et al. (2015)	Biochemical Assays measurements Blood pressure Occupation Type of family	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2). Percentage body fat (BF%) estimated using Adult body fat% = (1.20 × BMI) +(0.23 ×	Obesity risk factors by urban / rural residence remained significant after adjusting for gender and age

Author (year)	Determining variables measured	Obesity specification	Findings
		Age) -(10.8 × sex) -5.4.	
Okoh (2013)	Ethnicity Educational status Marriage status Frequency of watching television	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Results showed increased frequency of watching television, belonging to a particular ethnic group, having a tertiary education and increased parity as risk factors for increased BMI.
Olatunbosun et al. (2010)	Age Gender Marital status Salary grade Physical activity Smoking Alcohol Family history of hypertension	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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.

Author (year)	Determining variables measured	Obesity specification	Findings
	Family history of diabetes		
Ajayi et al. (2016)	Smoking habit Education Gender Age Marital status	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Female 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].
Osayomi & Orhiere (2017)	Sex Age Occupation	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	Physical proximity to fast food outlets was the only significant factor driving the spatial pattern of obesity (b = 0.645; R2 = 0.416).

Author (year)	Determining variables measured	Obesity specification	Findings
	Education status Ethnicity Marital status Household and neighbourhood characteristics (spatial risk factors)	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Oue´draogo et al. (2008)	Dietary practices Lifestyles	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	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
Oyebisi & Olumakaiye (	Age Sex Education Base Length of stay in school Upkeep allowance	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2)	There was a significant relationship between fast food consumption and obesity (r=0.47, p =0.0001).

Author (year)	Determining variables measured	Obesity specification	Findings
	Fast food consumption	Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	
Oyeyemi et al. (2013)	Physical Activity and Sitting Time Environmental Assessment. Socio-demographic Characteristics	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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).
Oyeyemi & Adegoke (2012)	Age, gender, marital status, ethnic group, educational level, employment status, monthly income (naira).	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2)	After adjustment for sociodemographic variables, overweight was associated with distant access to commercial facilities (OR 1.49; 95%CI1.02- 2.18), poor neighbourhood aesthetics (OR1.58; 95%CI 1.16-2.09),

Author (year)	Determining variables measured	Obesity specification	Findings
	Residential density, Access to commercial places, Access to non-residential places, Access to public transport, Presence of recreational centres, Presence of pedestrian pathways, Maintenance of pathways, Presence of beautiful things, Absence of unattended animals, Absence of garbage and foul odours, Seeing people active, Connectivity of street, Traffic safety for bicycling, Traffic safety for walking, Crime Safety during the day, Crime safety at night.	Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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. Low residential density (OR1.39; 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

Author (year)	Determining variables measured	Obesity specification	Findings
Pasquet et al. (2003)	Sex Age Education level Occupation length of residence in Yaoundé Ethnicity Parity Smoking practice Physical activity pattern	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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) influence early overweight and/or obesity
Peltzer et al. (2014)	Age Gender Wealth Country income classification Organized religious activity Social support	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2)	Females who are 22years or more are significantly associated with obesity (AOR =1.38, CI: 1.18-1.60). Female in high organized religious activity are significantly associated with overweight and obesity (AOR =1.22, CI =1.03-1.47).

Author (year)	Determining variables measured	Obesity specification	Findings
	Dietary variables Health risk behaviour	Obese (≥30 kg/m^2).	
Ramsay et al. (2009)	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	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Across Navrongo (R^2 = 0.20) and Nanoro (R^2 = 0.20), men with higher socioeconomic and educational level were associated with higher BMI.

Author (year)	Determining variables measured	Obesity specification	Findings
	alcohol intake pesticide use HIV and TB status Parity Menopausal stage		
Razak et al. (2015)	Demographic variables Socioeconomic variables	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Increased risk of mortality among those with a BMI lower than 16kg/m^2 exceeds the increased risk associated with being overweight or obesity.
Smith et al. (2017)	Age Gender ABO Blood groups	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	No significant associations were found between the determining variables and obesity

Author (year)	Determining variables measured	Obesity specification	Findings
	Rhesus factor	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	
Sodjinou et al. (2008)	Diet quality score Alcohol consumption score Smoking score Household amenities Physical activity score	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2). Abdominal obesity	After controlling for age and sex, the odds of obesity increased significantly with SES. The likelihood of obesity decreased significantly as while controlling for potential confounding factors.
Stringhini et al. (2016)	Smoking Physical activity	BMI: (Underweight <18.50 kg/m^2	Association between SES and obesity was direct

Author (year)	Determining variables measured	Obesity specification	Findings
	Weight Height Hypertension Socio-economic indicators	Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	
Tuoyire et al. (2018)	Presence of TV Frequency of viewing TV Demographic variables	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	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 after controlling for confounders
Tyrovolas et al. (2016)	Age Sex Education	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-	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

Author (year)	Determining variables measured	Obesity specification	Findings
	Wealth Current drinker Current smoker Physical activity Number of chronic conditions	24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	=1.80, CI =1.23 – 2.64) in the overall sample.
Ukegbu et al. (2017)	Age Gender Level in school Monthly allowance Number of meals Consumption of unhealthy snack foods Soft drink consumption Weekly alcohol consumption Hypertension	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5- 24.99 kg/m^2) Overweight (25.00– 29.99 kg/m^2) Obese (≥30 kg/m^2).	Consumption of unhealthy snack foods (X^2 =13.39, p=0.037), being female (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

Author (year)	Determining variables measured	Obesity specification	Findings
Wahab et al. (2011)	age, sex, current history of alcohol or tobacco use, hypertension and diabetes mellitus	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	female 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) were significantly associated with obesity
Yaya et al. (2018)	Age Residence Educational level Religion Marital status Wealth index Working Number of children	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–29.99 kg/m^2) Obese (≥30 kg/m^2).	Rural women were 1.25 times as likely to be underweight, compared with urban women (RR = 1.25; 95%CI = 1.22–1.28); 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 BMI compared with women from urban residence. Married women or those living with partners had 35%

Author (year)	Determining variables measured	Obesity specification	Findings
	Alcohol consumption Currently smoking Exercise Fruit consumption Vegetable consumption		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)
Ziraba et al. (2009)	Wealth index/ Amenities Time (in years) Woman's education	BMI: (Underweight <18.50 kg/m^2 Normal range (18.5-24.99 kg/m^2) Overweight (25.00–	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.

Author (year)	Determining variables measured	Obesity specification	Findings
		29.99 kg/m^2) Obese (≥30 kg/m^2).	

Significant associations indicate p-value<0.05

Table 5: Heterogeneous findings on environmental determinants of obesity

Authors	Variables	Effect size	95% CI.
Oyeyemi and Adegoke et al. (2012)	Distant access to commercial facilities	1.49	1.02- 2.18
	Poor neighborhood aesthetics	1.47	1.16-2.09
	Perceiving garbage and offensive odors	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	*

Authors	Variables	Effect size	95% CI.
	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 and Orhiere (2017)	Physical proximity to fast food outlets	0.645	*

Authors	Variables	Effect size	95% CI.
Bishwajit and Yaya (2018)	Watching TV almost every day	2.7	2.432 – 3.037
	Watching TV at least once a week	1.5	1.053 – 1.63
Goryakin (2015)	Economic globalization (second quartile)	0.117	*
	Economic globalization (third quartile)	0.147	*
	Economic globalization (fourth quartile)	0.139	*

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