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REVIEW OF GHANA'S FOOD ENVIRONMENT: DRIVERS OF AVAILABILITY, BARRIERS TO HEALTHY FOOD ACCESS, AND IMPACT OF INTERVENTIONS AND POLICIES

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ABSTRACT

Food environments exert a significant effect on population dietary choices and health outcomes. Policies that influence the food environment, can have a significant impact on individual and population dietary choices. This rapid review assessed the nature and interaction within the Ghanaian food environment, and the impact that existing school, workplace, and national food policies have on dietary intake and nutritional outcomes. Online databases and university repositories were searched for relevant articles and documents. A total of forty articles and documents were included in the review. Majority of the reviewed papers (85%) used a cross-sectional design. The findings show that traditional outlets (open markets) constitute the main food source among the Ghanaian populace, while convenience stores serve as an important source of processed foods. Prepared local foods are often consumed outside the home and are mainly sourced from street food vendors. Street foods are perceived as less expensive, convenient, and delicious. The food environment was found to influence dietary acquisition, intake, and nutritional outcomes. Although most nutrients provided by the School Feeding Programme (SFP) are below recommended intake standards, the SFP contributes positively to improved diets and nutrition status of school-age children. Children attending SFP-implementing schools experience higher intakes of protein, iron, zinc, calcium, vitamin A, folate, and have higher haemoglobin, and lower prevalence of stunting, underweight, and thinness than children in non-SFP implementing schools. Availability of a private room for breastfeeding mothers improved breastfeeding frequency. Ghana's fatty meat restriction policy has reduced the availability and sale of fatty meat on the Ghanaian market. Reported drivers and barriers to healthy foods consumption include socio-economic factors, media information, food storage facilities, cultural perception, fruit seasonality, knowledge on the nutrient value of fruits and vegetables, safety profile of fruits and vegetables, and contribution of household production to dietary intake. In conclusion, the food environment review reveals the drivers of availability, barriers to healthy food access, and impact of interventions and policies on the Ghanaian food environment.

Key words: Ghana, Food environment, policies, nutritional impact, health impact

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BACKGROUND

Population health, well-being, and development are linked intimately with the physical environments they live, work, play, eat, and interact [1]. The food environment constitutes the domain or conditions within which people acquire, prepare and consume food. Food environments are important because they significantly influence dietary choices beyond intra-personal characteristics such as age, sex, and religion [2]. Although its characteristics are complex, consensus exists that there are five interrelated components of the food environment: food affordability, availability, acceptability, accommodation, and spatial accessibility [3]. Of these, affordability and availability are known to have the strongest impact on food choice [4, 5].

Globally, there is concern that the food environment has become predominantly unhealthy because of the increasing abundance, access, and consumption of cheap, ultra-processed, low nutrient-profile foods, which are widely distributed, aggressively advertised, and sold at unusually cheap prices [6, 7]. Simultaneously, there is diminishing availability and reduced market share of healthy foods [8], which are relatively expensive and inconvenient to access. Obtaining a healthy diet in an unhealthy environment is challenging. Ultra-processed foods are those made mostly from substances extracted from foods, such as fats, starches, added sugars, and hydrogenated fats. Such foods may also contain additives like artificial colors and flavors or stabilizers. Examples include frozen meals, soft drinks, hot dogs and cold cuts, fast food, packaged cookies, cakes, and salty snacks.

Several interconnected factors have been associated with the changing food environment globally. Firstly, modernization, urbanization, economic development, and increased wealth are key predictors of shifts in the transition of diets to becoming more energy-dense [9]. Rapid unplanned and poorly controlled urbanization can increase unemployment, create/enlarge urban slums, and limited availability and accessibility to healthy foods [10]. Secondly, global trade liberalization has become an important driver of energy-dense foods distribution, increasing foreign direct investments in the production, advertisement, and sale of such foods [11, 12, 13]. Developing countries mainly bear the adverse effects of such trade practices since they currently account for the highest global increases in sales and expansion of such foods [14].

Attention to addressing the food environment as a significant risk factor for poor dietary intake and adverse health outcomes is recent [15, 16]. The shift from individual-level factors, which seek to empower, usually through education, individuals to make the right dietary and physical activity decisions, have been necessitated by the realization that optimal food selection takes place within a complex and adaptable environment [17]. Furthermore, epidemiological studies have demonstrated a strong association between proximal environmental characteristics and population disease distribution. Again, the growing obesity and diet-related Non-Communicable Diseases (NCDs) trend among both adults and children [18, 19, 20], micronutrient deficiencies, growth retardation, and stunting are also associated with a poor diet. These have been

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linked to unhealthy food environments, replete with obesity-causing foods [21, 22, 23]. These have called for interventions designed to promote healthy diets to incorporate strategies for maintaining a healthy food environment, replete with foods that meet both macronutrient and micronutrient needs at a reasonable cost, while limiting the availability and accessibility of processed or ultra-processed food [24, 25]

Although food selection involves sub-conscious processes that drive consumers' decisions about what to purchase [26], the physical location of food affects dietary decision-making. In developed countries, supermarkets can provide a wide variety of healthy food options. Thus, their availability or proximity to neighborhoods can lead to healthy dietary patterns [27, 28, 29, 30]. Although supermarkets can increase access to healthy foods options like fruits and vegetables, they often at the same time stock a wide variety of ultra-processed foods that are potentially health-limiting [31]. Another important aspect of location is that people may need to travel long distances, out of their neighborhoods, to take advantage of lower price offers [32]. In such situations, road linkages and travel services such as the availability or non-availability of affordable public transport are also important in the food acquisition process [33].

Measurements of food environments are not standardized [34, 35]. Most measures of the location used for food environment assessment incorporate geographic information systems, shelf space measures, and market basket surveys. Geographic positioning systems involve the collection of spatial locations of food outlets in the neighborhood using computerized applications. However, perceived food environment reports seem more reliable than GIS assessment [34, 36, 37]. Food availability and cost significantly influence dietary choice in regulated environments such as schools and workplaces, where movements are restricted. Thus, cafeterias, lunch programmes, and policies on these services can significantly affect dietary intake and nutritional status [38]. For instance, adults can spend about 50% of their waking time at work and, hence, consume most of their foods at work [39, 40]. Schools and workplaces are therefore important environments for healthy food interventions [41, 42], and nutrition interventions in these contexts have improved healthy food selection [43, 44], improved nutritional status and a reduction in chronic diseases among adults [45, 46].

The food systems and environment of developing country settings in Africa are predominantly informal. The role of supermarkets in Sub Saharan Africa began relatively recently, in the early 1990s, and was mainly limited to southern and northern Africa [47]. In Africa, the traditional informal food system of open markets and community-based small-scale food vendors continues to serve as a prominent source of fresh and staple foods for most population groups [48]. Formal food distribution chains may have well-regulated systems that can be targeted by a policy to improve diet quality. However, the informal food system is linked to the formal food system and is involved in sourcing from the formal system for retail. This explains why access to ‘unhealthy’ food is common even in countries with strong informal food systems. Although Ghana's food environment remains understudied, the traditional informal food system supplying fresh and staple foods predominate. Supermarkets are expanding fast, and large multinational food corporations have been on the rise in the

last one or two decades, resulting in an influx of unhealthy foods [49]. Like in most sub-Saharan Africa, Ghana's increasing prevalence of obesity and related NCDs has been partly attributed to the changing food environment. This review synthesizes evidence from research published in Ghana to leverage national, home, school, workplace, and neighborhood food environment policies and strengthen existing policies.

Review questions

The review sought to answer questions on sources of food purchased by rural and urban people, foods commonly consumed outside the home, relationship between neighborhoods food retail access, and diet quality, intake and weight status, national approaches and policies on food and nutrition, and their impact, and socio-cultural barriers and enablers to different population groups achieving healthy diets

Search strategy

This review included peer-reviewed articles, published documents, students' theses and policy papers that were conducted in Ghana or of relevance to Ghana as far back as possible and with no date restrictions. Google Scholar, PubMed, Cochrane, science direct, and JSTOR databases were searched for appropriate papers. Ghanaian University databases and repositories including the Kwame Nkrumah University of Ghana, University of Ghana, University of Cape Coast and University for Development Studies institutional repositories were also searched to find relevant theses. The Open Access Theses Dissertations (OATD) database was also searched to assess full articles of relevant students' theses. The search for papers was done in English with the following keywords; Food shopping AND Ghana, Food acquisition AND Ghana, Buying food AND Ghana, Food environment and Disease AND Ghana, Food environment, diet quality, and disease AND Ghana, Food consumed outside the home AND Ghana, Street food consumption AND Ghana, School food environment, nutrition, weight 'AND' Ghana, School feeding programme, Nutrition 'AND' Ghana, food policies, nutrition weight, AND Ghana, Workplace food environment food consumption AND Ghana, Workplace food policies AND Ghana, Barriers to healthy food consumption AND Ghana. Google scholar was searched between 13/03/2020 and 28/03/2020; Cochrane and PubMed databases were searched on 28/03/2020. JSTOR and Science Direct databases were searched on 29/03/2020. University databases were searched on 02/04/2020.

Inclusion and exclusion criteria

This rapid review presents data on Ghana, and includes studies conducted in or of relevance to Ghana. All published papers and thesis reports that collected data on the food environment in any neighborhood, workplace or school in Ghana, and/or nutrition policies in any neighborhood, work or school environment were included in this review. Papers that assessed the impact of the food environment on obesity and other chronic disease outcomes were also included. Students' thesis was excluded if published peer reviewed journal articles based on the data from the theses were available; in such cases, the journal articles were included.

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Evidence synthesis

Figure 1 shows the regional distribution of studies while figure 2 shows the study selection process for this review. Six hundred and eighty-five thousand, seven hundred and six (685,706) papers were retrieved online. Out of these, 685, 570 were rejected based on their titles, or being duplicates. Of the 136 papers read, 96 papers were rejected during abstract screening or were not meeting a priori inclusion criteria. Forty documents met the inclusion criteria for this review. Synthesis of papers was done based on the frequencies of the study characteristics such as the region in which the study was conducted, outcome measures, and major findings. The majority of the studies (85.0%) used a cross-sectional design. One used a longitudinal design, and two were experimental studies. Most (8) of the studies were conducted in the Greater Accra region. Three (3) each were conducted in the Ashanti, and Eastern regions, four in the Northern region, four studies were nation-wide ten studies were conducted across two or more regions. Central and Volta regions were sites for two multi-region studies, while 1 study was conducted in the Brong Ahafo and Western regions. Another study also analysed a national policy document [50]. Two studies assessed the food environment by measuring food and nutrient provision and types of food outlets available in the food environment. A total of 57.9% of the documents assessed dietary outcomes using 24-hour recall, food frequency, weighed food record, and dietary diversity scores. The most frequently reported nutrition outcome was Body Mass Index (BMI) for adults (7.9%) and weight-for-age, height-for-age, weight-for-height, and MUAC-for-age for children and adolescents (31.6%).

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Two or mor regions=10 studies
Nationwide=5 studies
NB: Volta and Central were sites for multiregional studies

Figure 1: Regional distribution of selected studies

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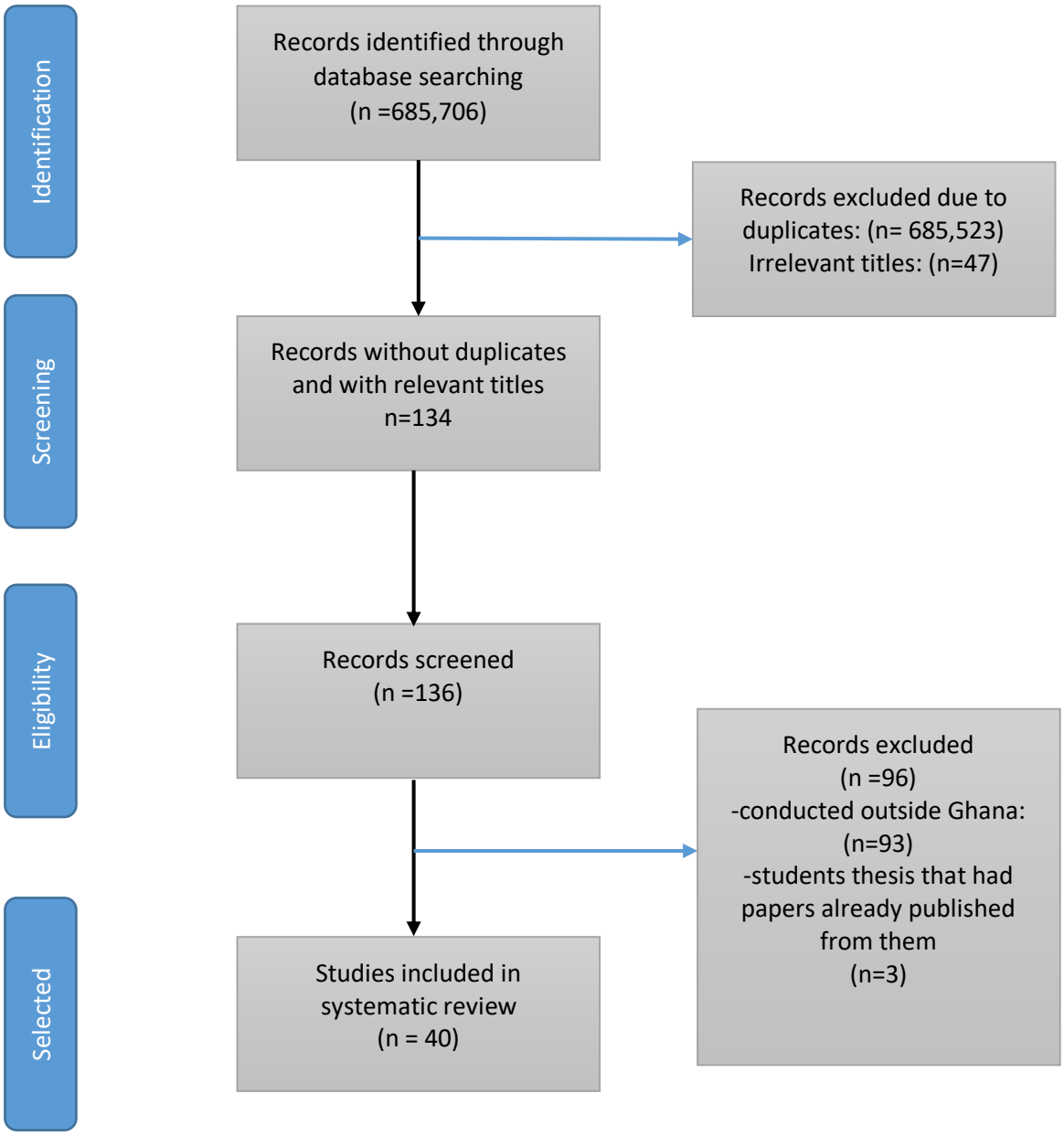

Figure 2: Study selection process for the review

Data extraction

Data extracted from the included studies were author, year of publication, region or district in which studies were conducted, sample size, mean, median or age range of study participants, methods and data on food environment. Table 1 presents summary of details for each paper reviewed.

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Quality assessment
The quality of studies was assessed based on a number of checklists as specified by Kmet, Cook and Lee [50]. The checklists consist of fourteen items for quantitative studies and items for ten qualitative studies (Tables 2 and 3). Each criterion on the checklist had a maximum point of 2 and a minimum of 0.Thus, for quantitative studies, the total maximum point was 28, while for qualitative studies, it was 20. For quantitative studies, longitudinal research, experimental and case-control studies were awarded the highest points, followed by cross-sectional and simple comparative studies. Studies with a higher sample size > 500 were awarded two points, while those with a smaller sample size were awarded one point. The synthesis and interpretation of the study's findings, based on results, were also marked with well explained and synthesized results being awarded the highest points. For instance, studies that assessed the impact of the school feeding program but did not collect baseline data nor matched cases with controls were awarded less points. Where there was randomization, higher points were awarded, compared to purposive sampling. Qualitative studies were assessed based on the description of the study objective, connection to a theoretical framework, and other criteria for quantitative studies.

FINDINGS

Sources of food purchased and consumed by rural and urban people in Ghana
Of the eight studies that reported on sources of food purchased by Ghanaians [52-60, 92], most were of average quality. Two studies on shopping outlet choices mentioned traditional or open-air markets, mini markets, convenience stores, cold stores, hawkers, and bakeries [52, 56]. Of these outlets, traditional markets, convenience stores, supermarkets, and hawkers were the most important sources among the lot [52, 56]. Traditional or open-air markets serve as the main source of uncooked foods for most households, preferred by the majority of households (87%). Almost all (99%) of respondents reported purchasing foods from traditional markets regularly in a suburb of Accra [52]. In Another survey in Accra, Tarkoradi and Tamale, about 70% of households reported purchasing foods from traditional markets at least once a week [56]. Traditional markets remain a key source for perishable produce such as fruits, vegetables, yam, cassava, plantain, local rice, fish and beef [52, 55, 56]. Processed foods, such as corned beef, baked beans, and oil are frequently sourced from traditional markets. Purchase frequency from supermarkets ranged between 8.7-62.7% but the number of times of purchasing food from a supermarket in a week was lower [52]. Supermarkets were a key source of processed foods such as canned vegetables, potato chips, sugary drinks, exotic and out-of-season fruits and vegetables [52, 55]. Convenience stores provided a wide variety of processed foods and had a higher patronage frequency than supermarkets among urban-dwelling households in Accra, Tamale and Takoradi [52, 56]. On the other hand, Hawkers were a key source of ready-to-eat foods, fruits, and vegetables [53, 56].

Street foods play a significant role in Ghanaian food acquisition, especially among low-income households [54, 57-60, 78]. Mensah *et al*. [57] reported that in Kumasi, street food consumption frequencies were 21%, 17%, and 10% among low, middle and high

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income earners. Hiamey *et al.* [54] reported that among residents of Takoradi, the consumption of street foods was perceived as less costly. Other reasons given for the consumption of street foods included convenience, good taste, and limited time to prepare foods [54, 57]. Street foods play a significant role in the diet of both adults and children, for breakfast, lunch and supper, and include all types of meals and snacks. Millet porridge, boiled rice and tomato stew, wheat porridge, corn porridge, banku, fufu, tuo zaafi, soup, fried rice, fried yam, and soft drinks were frequently consumed street foods [54, 58]. About 50-80% of participants in cities consumed street foods, and the frequency of consumption ranged from once to twenty-one times a week [54, 58, 60]. Breakfast and lunch are the most common foods obtained from street food vendors [58, 59]. In a study among 2-5year olds in two rural communities in the Central region, [58] reported that 75.7% of street foods purchased for the children were complete meals and contributed to about 20% of protein, vitamin B_{12}, zinc and more than 50% of calcium intakes. Among poor urban adults in Accra, [60] it was reported that street food consumption was associated with a higher dietary diversity score.

Foods commonly consumed outside home

Seven studies, majority of which were of average quality, reported on the type of foods consumed outside the home [54, 57, 58, 61-64]. Among school-going adolescents in Cape Coast, aged between 13-19 years, foods consumed at school included waakye, kenkey with pepper and fried fish, fried rice and chicken. These were consumed by 42% of them. The rates of consumption of other foods were: carbonated drinks (13.0%), canned fruit drinks (11.7%), pastries (16.5%) and ice cream (13.7%) [62].

For children aged 2-5 years, in Central and Brong Ahafo regions, foods consumed outside the home included jollof rice, boiled plain rice, waakye, all with tomato sauce, grain-based porridges such as corn and millet porridge, kenkey, banku and akple with soup or stew, beans and gari, fried yam, doughnut, and fruits [58]. Grain-based porridges were the most frequently consumed outside the home.

Among adults aged 30-60 years in Kumasi and Takoradi, about 90% of whom were workers, the foods consumed outside the home in order of frequency, reported by the two studies, were rice with tomato or beans stew (23.5%), banku with okro or tomato stew or grounded pepper (17.5%), fufu or kokonte with palm nut soup or light soup (14.4%). Other foods consumed were fried yam, fried plantain, fried rice, and sugar-sweetened beverages [54, 57].

Relationship between neighbourhood food retail access, and diet quality, intake, and weight status

Two studies conducted in poor urban areas in Accra reported the relationship between neighborhood or community food environment and dietary and nutritional outcomes [65, 66]. One was above average quality while the other was average. Findings from the two studies indicate that the food environment impacts the dietary acquisition, intake, and nutritional outcomes. Typical meals available in the home environment were banku /fufu with soup, boiled rice and tomato stew, waakye, fried rice, and jollof

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rice. Convenience stores available in neighborhoods offered a wide range of processed foods [65]. This study did not indicate the level of processing of these foods. Lopéz-Carra *et al*. [66] reported that the availability of a traditional market within the neighborhood was associated with lower consumption of ultra-processed foods. Among persons who dwell in neighborhoods without large food markets, 90% consume processed foods; in neighborhoods with large food markets, <30% of respondents reported consumption of processed foods [66]. Dake *et al*. [65] on the other hand, reported that each additional out of home-cooked food vendor in the neighborhood was associated with a reduction in 0.1kg/m^2 BMI while an additional convenience store was associated with a 0.2kg/m^2 increase in BMI. Fruits and vegetable availability in the home environment was, however, not associated with population body mass index.

Availability of national policies and approaches on food and nutrition and their impact

Seventeen studies reported on school-based approaches, school environment, and interventions that affect food intake in the school setting and the nutritional status of school-aged children [62, 67-82, 83]. Of the sixteen studies, seven reported on the effect of school meals (both privately and government-funded Ghana School Feeding Program (GSFP). Six studies either compared the GFSP with private feeding programs or compared schools that are beneficiaries of the GSFP with non-beneficiaries [67, 71, 73, 75, 76, 80]. The quality scores for most of these studies were either high or average. Overall, results from the studies indicate that school-based dietary interventions, GSFP, and other school dietary programmes positively impact the nutritional status of school children. Children in schools implementing the GSFP or private school feeding programs have higher intakes of protein, iron, zinc, calcium, vitamin A, folate, higher haemoglobin and lower prevalence of stunting, underweight, and thinness compared to non-participants [67, 75]). Specifically, among rural children in the Northern region of Ghana, [67] reported that intake of protein (68g vs 54g), zinc (13.1mg vs 8.6mg), calcium (399mg vs 281mg), vitamin A (493µg vs 134.0µg), folate (245.8µg vs 134.0 µg), and vitamin C (47.1mg vs 8.6 mg) were higher among children exposed to school feeding of any kind. Haemoglobin concentration was also higher for children exposed to school feeding (103±15g/l) compared to those not exposed to school feeding (97±18g/l) ($p<0.001$). In Abizari *et al.'s[67]* study, 90% of the daily vitamin A and vitamin C intakes were provided via the school lunch program.

There were inconsistent findings regarding the association between school meals and nutritional status. Kwabla *et al.* [75] reported that, in the Eastern region, there was a higher prevalence of stunting among children not exposed to school feeding (17.2% vs 16.2%) but the difference was not statistically significant. In a longitudinal study conducted across all the ten regions in Ghana, Gelli *et al*. [71] reported that the GSFP positively impacted the height-for-age z-scores of girls and participants in the lower age brackets (5-8 years). In contrast, among school children in the Volta region, Laar & Kubi [77] found that the prevalence of stunting and thinness were higher among children benefiting from the GSFP; non-beneficiaries of the GSFP had a 38.3 less likelihood of stunting compared to beneficiaries. Still in the Volta region, there were no

observed difference in stunting, underweight, thinness and overweight among children benefiting from the GSFP and non-beneficiaries [76].

Seven studies provided details on types of food provided by school meals and three further reported the nutritional content of the foods [67-69, 73, 80, 82, 83]. The GSFP and private school feeding programs provided staple Ghanaian dishes such as banku and okro stew, rice and tomato sauce, waakye, tuo zaafi, and vegetable soup, gari and beans, banku and groundnut soup [67, 69, 73, 82, 80]. Three studies reported that nutrients provided by school meals in the Central, Upper West, Northern and Volta regions were less than one-third of the Recommended Nutrient Intakes (RNI) which is supposed to be met by the school feeding program [67, 68]. This was the case for both private school meals and meals provided by GSFP. However, private school meals had a higher nutrient profile [67, 68, 69, 80]. In a comparative cross-sectional study in the Volta region, Agbozo *et al*. [68] reported that all nutrients provided by the school meal were below recommendations, except for fat, vitamin A, and vitamin C. Calcium (62±18mg), magnesium (6.7±3.8mg) and potassium (31.25±15.8mg) provided via the school meals were extremely low. Fish was the most frequent animal protein, and the meals completely lacked dairy products [68, 73].

Two studies reported evidence of the impact of the school environment on the consumption pattern of pupils [62, 84]. Results from the two studies indicated that the school environment either supports unhealthy food consumption or makes it difficult to obtain healthy foods. Buxton [62] for instance, documented that among adolescent students in Cape Coast, a high proportion bought canned drinks (24.7%), pastries (16.7%) and ice cream (13.7%) in school during break time from food vendors. On the other hand, students in the Eastern region reported that options of foods available in the school are limited but they are not allowed to go out to purchase other foods [84].

One study reported on national policy on fatty meat restriction [50]. The policy specifies acceptable fat content for different types of animal flesh, either produced domestically or exported into the country. For instance, deboned pork, mutton, and beef are required to contain up to 25% of fat while dressed poultry is required to contain up to 15% of fat. Thow and colleagues [49] reported that the implementation of the Ghana fatty meat policy which took effect in the early 1990s reduced the importation, availability, and sale of fatty meat on the Ghanaian market. This was most evident for turkey tails. However, nutritionists interviewed indicated that the policy has not impacted fatty meat consumption as turkey tails have been replaced by processed meat such as sausages and fried pork [78]. No study reported evidence of policies or the impact of the workplace food environment on consumption or nutritional outcomes.

One study reported on the impact of the work environment on breastfeeding [74]. They found that, among lactating mothers who work in educational and health settings in Tamale, availability of private room for breastfeeding and refrigerator for storage of baby foods was associated with higher frequency of breastfeeding.

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Socio-cultural barriers and enablers to different population groups achieving healthy diets

Barriers to obtaining a healthy diet were reported by nine studies [53, 85-91]. The reported barriers and enablers included socio-economic factors, information from media, lack of storage facilities, cultural perception, fruit seasonality, lack of knowledge on the nutrient value of fruits and vegetables, concerns about possible contaminants in fruits and vegetables and limited own farm production. Among these factors, household socio-economic status determined by income levels, education level, marital status, number and characteristics of household members was the most reported barrier to the acquisition of healthy foods [53, 84-86, 89, 90]. For direct income measures, Florkowski *et al*. [53] and Amfo *et al.* [85], reported that low-income groups in the Greater Accra, Northern and Western regions spent a higher proportion of their income on vegetable purchases and had higher consumption levels compared to high-income households. Contrarily, high-income households were associated with higher consumption of fruits [53]. Meng *et al*. [89] also found that in Accra and Tamale, fruit, vegetable and peanut purchase was associated with high income after controlling for location. Annan *et al*. [86] also reported that price was a major determinant of meat choice in the Ashanti region, regardless of health knowledge. Although individuals perceived domestic chicken as healthier, they purchased imported chicken because it was cheaper.

Own farm production enabled households in the Northern region to meet about 50% of their grain needs, 60% of their groundnut needs, and 62% of their micronutrient needs [87, 88]. Crop diversity had a direct bearing on household dietary diversity; households with limited numbers of crops grown on their farms consumed less diverse diets [88].

In assessing barriers to adequate consumption of vitamin A and iron in the Ashanti and Brong Ahafo regions, Omari *et al.* [90] documented that lack of electricity and storage facilities were hindrances to the purchase and consumption of fish and meat. They further indicated that culturally, fruits were not perceived as part of main meals, and the population was not accustomed to consuming fruits regularly. Study participants (84%) further indicated that conflicting media reports on the health effect of consuming meat, served as a deterrent to their consumption.

A conceptual framework used to summarise the review findings is presented in Figure 3.

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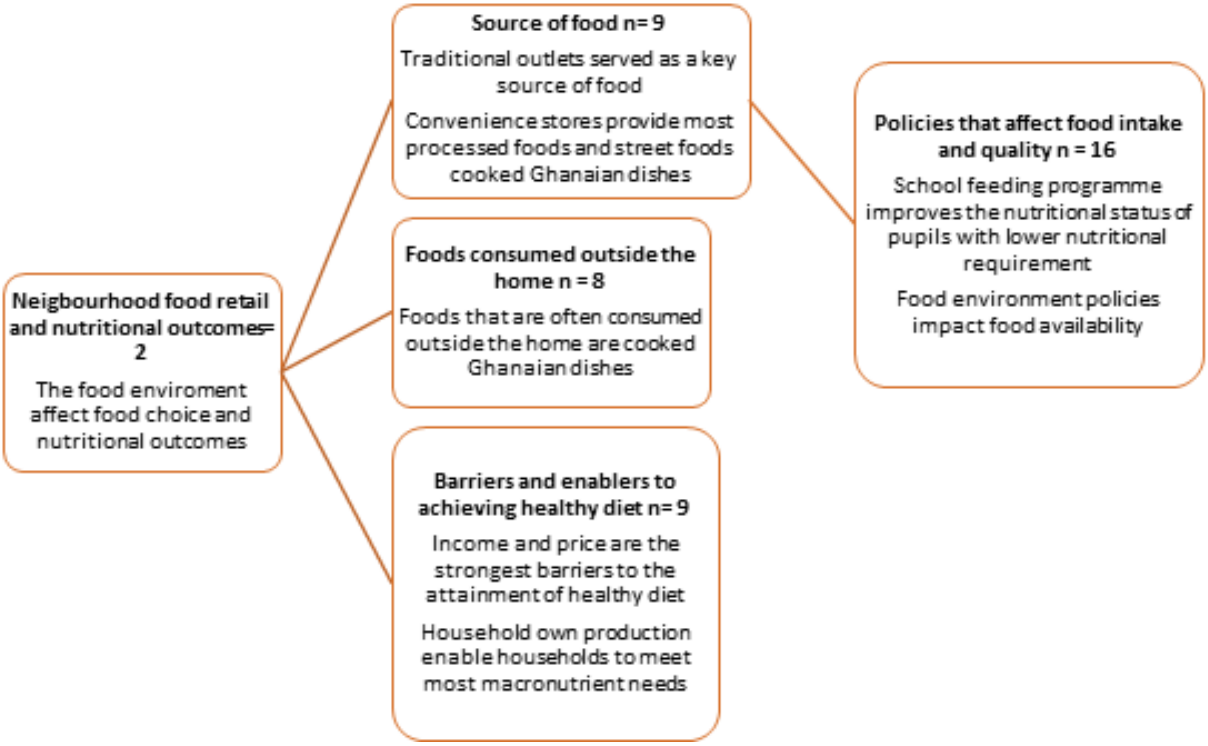

Figure 3: Conceptual framework of Ghana's food environment review findings

DISCUSSION

This systematic review reveals Ghana's food environment and provides evidence to leverage national, home, school, workplace, and neighborhood food environment policies and to serve as a basis for strengthening existing policies. Food-based dietary guidelines should consider issues around food availability and access as indicators of the ability of the population to follow the guidelines. This is why evidence on the nature of the food environment is a prerequisite for developing such guidelines. Characterizing the food environment is complex but comprises 3 main domains: physical, social, and person-oriented food environments, and these have several sub-domains and measures. To fully understand the food environment requires all three dimensions. The physical food environment domain measures the numbers, location, density, and proximity of food venues in defined geographical areas, food availability and access in the home, and school, work places and institutions. The social food environment measures the nature, levels and extent of available support to enable people make healthy food choices, including instrumental or tangible support, encouragement or reinforcement, food choices and eating behaviours of family members that can serve as role models, price promotions, and school, work, and institution-based policies. The person-oriented domain assesses the perception of the physical and social environment, measuring perceptions of availability, access, affordability of price, acceptability of the product, and cultural appropriateness and

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inclusiveness. It also measures perceived social norms, type and level of social support and perceptions of policies, practices or rules that impact behaviour.

From the studies reviewed, Ghanaians buy both cooked and uncooked food from various sources, including traditional or open-air markets, mini markets, convenience stores, cold stores, hawkers or street food vendors, and bakeries. Traditional open-air markets are the key suppliers of fresh food, including fruits and vegetables, while convenient shops, rather than large supermarkets, drive the retail of most processed foods in both urban and rural areas, contrary to observations in more developed countries. They have a higher frequency of purchase completely outnumbering large supermarkets, which only started springing up in urban areas of the country in the past decade. Therefore, although large supermarkets or *food giants* are few in Ghana, unhealthy processed or ultra-processed obesogenic foods are commonly available and accessible through these numerous convenient stores. This means that to improve the healthfulness of food supply in Ghana, interventions should target the wide range of supply outlets recorded, but with special emphasis on convenient stores to curb the supply and promotion of processed food, while strengthening traditional open-air markets to continue supplying safe and fresh fruits and vegetables.

The review reveals that buying and consuming, for all meal times, local Ghanaian dishes from hawkers and table top vendors (street foods) contribute significantly to cooked food purchased for consumption by Ghanaian adults and children alike, especially among low income households. Quick fried foods such as fried yam, plantain, sweet potatoes, and sugar-sweetened beverages are also frequently consumed street foods**.** Poor knowledge, attitude and hygiene practices have been reported among street food vendors across Africa [93]. Poor practices of street food vendors include discarding waste water and garbage nearby, which provide nutrients for insects and other pathogens and increase contamination and disease risk [93, 94]. Bacteriological contamination of street foods was reported among street vendors in Trinidad, and poor microbial quality and contamination of street foods have been reported across Africa [95, 96]. Street foods are also expected to have lower nutrient quality, but higher in salt, sugar, oil, and additional undesirable substances like food additives [97, 98]. In this review, to the contrary, a study reported that street foods contributed to about 20% of protein, vitamin B_{12}, zinc and greater than 50% of calcium intakes among 2-5-year-old children in the Central Region, and a higher dietary diversity among poor urban dwellers in Accra. Street food consumers in the reviewed studies reported ‘low cost’, and to a smaller extent, good taste and convenience as reasons for consumption. This lower cost may be due to sub-quality used, and the excess sugar, salt and oil added may make such foods tastier. According to this review, street foods are more likely to be patronised by the urban poor just as observed in other countries. This implies that the poor are more able to afford and so have access to the less healthy street food, and may also explain why diet-related NCDs are more common among poorer urban dwellers. With the reported contribution of street food to nutrient intake in children, and dietary diversity, and still the safety concerns and excessive unhealthy commodities like salt, sugar and oil concerns, Ghana’s street food environment should be given closer attention for it to serve the good purpose, while limiting any possible adversities.

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That the food environment affects dietary decision making is commonly reported by studies in developed and LMICs. Poor food environment is associated with poorer food choices and intake and likewise, improvements in the food environment have led to improved dietary decision making, purchase, consumption and nutrition outcomes [98]. Two studies reported that the food environment impacted dietary acquisition, food choice, dietary intake, and nutritional outcomes in this review. Availability of a traditional market within a neighbourhood led to <30% consumption of ultra-processed food compared with 90% where there are many convenience stores and no traditional markets. They also showed that an additional street vendor reduced BMI by 0.1kg/m^2 compared with an increase in BMI by 0.2kg/m^2 with an additional convenience store. Of the policies that targeted the food environment, implementation of national policy on fatty meat standards led to reduced importation, availability, and sale of fatty meat on the Ghanaian market. Breastfeeding policy at a work environment that made available a private room for breastfeeding and refrigerator for storing baby foods was associated with a higher frequency of breastfeeding. Moreover, school feeding programmes improved the nutritional status of pupils with lower nutritional requirements**.** Our findings, therefore, strengthen the available evidence, and further support calls for formulation of policies, and enforcement of available ones.

In this review, the perceived socio-ecological barriers among Ghanaians to achieving healthy diets are information from media, lack of storage facilities, cultural perception, fruit seasonality, lack of knowledge on the nutrient value of fruits and vegetables, concerns about possible contaminants in fruits and vegetables and limited own farm production. The socio-economic barriers reported are income levels, education, marital status and household characteristics. This means that while the physical domain needs attention, the person-oriented domain should not be left out, whether these perceptions are real or apparent. These may require social behaviour change interventions.

Study limitations

This review has limitations. The reviewed papers do not address all the domains and subdomains and their interrelationship, but aspects of the physical and person-oriented environment, indicating the need for further studies to characterize Ghana's food environment better. The review only included published works and students' thesis, and may have missed data that exist on the other measures of the food environment. There is no nationally representative study on Ghana's food environment, as most of the studies were limited to specific regions. Few studies assessed the impact of school meals on children's nutritional status, and limited work exists on the impact of home and work food environment, neighborhood food environment, food marketing and advertising. The available data do not allow the calculation of the Food Environment Index, a scale of 0 (worst) to 10 (best), which weighs two indicators of the food environment: access to healthy foods and food insecurity.

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CONCLUSION

Ghana's existing physical food environment is driven by a wide range of food outlets, predominantly traditional open markets, convenience stores, and street food vendors. Ghanaians purchase food commodities from these sources, and low-income urban households regularly consume cooked food from street vendors. Convenience stores drive the availability and access to processed foods, and large supermarkets in urban areas are springing up. Outside the home, in schools and at work, traditional Ghanaian foods are commonly consumed and so are Sugar-Sweetened Beverages and other 'unhealthy foods'. Neighboring food access is associated with dietary intake and aspects of nutritional status, while policies on the food environment impact food availability and access, giving a strong argument for formulation and enforcement of policies that enhance the healthfulness of the food environment. Key socio-cultural and economic barriers for achieving healthy diets were identified. These should be considered in the development of the food-based dietary guidelines.

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Table 1: Summary of Findings Table for Ghana's food environment systematic review

Study title	Author	Sample size	Study site	Mean age if reported	Study design	Main study methods	Major findings	Quality assessment	QA
1. A School Meals Program Implemented at Scale in Ghana Increases Height-for-Age during Mid childhood in Girls and in Children from Poor Households: A Cluster Randomized Trial	Gelli *et al*. [71]	2626	All ten regions	5-15yrs	Longitudinal cluster randomized control trial	Height for age, bmi for age, questionnaire	School feeding exertes no effect on HAZ and BMI for age. School feeding increases HAZ by 0.12SD in children 5-8yrs but not in those 5-15yrs. School feeding increased HAZ in girls by 0.11 SDs, and BAZ only in boys aged 5-8y by 0.19 SDs. In boys aged 9-15yrs, school feeding reduced HAZ by 0.2 SDs (p=0.047).	22/28	9
2. Nutritional quality of meals served under the Ghana school feeding programme at the Upper West and Central Region of Ghana	Bigson *et al*. [69]	Two towns (720) respondents	Upper West and Central Region (Wa and Cape Coast)	Not reported	Cross sectional, weights of food measured for 5 days, questionnaire	-	Meals served under the school feeding programme included Rice and beans with tomato stew or groundnut soup Rice with tomato stew, Tuo Zaafi with green vegetable soup or dry okro soup Banku with okro soup or groundnut soup, Gari and beans Gari and beans, Banku and groundnut soup Gari with palava sauce or tomato stew, Jollof rice Rice and beans with tomato stew. Most nutrients in the foods did not meet the RDI. Fish was the commonly used source of	16/22	7

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							animal protein and beans the commonly used plant protein.		
3. School feeding contributes to micronutrient adequacy of Ghanaian schoolchildren	Abizari, *et al.*[67]	4 schools (383 students in all)	Northern region	5-13yrs	Cross sectional study	Iron, status, weight, height, 24hr recall, weight food records, Hb, HHS, questionnaire	The school foods were prepared with these food items: jollof rice (rice cooked in tomato sauce); waakye (rice and cowpeas cooked together and served with tomato sauce); gari and beans (roasted cassava grits and boiled cowpeas usually served with palm oil); tuo zaafi . Home intake was slightly higher among non-school fed pupils for protein (P¼0·041), Fe (P¼0·011), Zn (P¼0·005) and vitamin A (p=<0.005. For vitamins A and C, however, .90% of the daily intake was contributed by the school lunch. SFP participants had 6g/l higher Hb concentration than non-SFP participants (P,0·001).	16/22	8
4. Ghanaian Junior High School Adolescents Dietary Practices and Food Preferences: Implications for Public Health Concern	Buxton, C. N.[62]	820	Central region (Cape Coast)	13-19 (mean not reported	Cross sectional	Questionnaire	Of students who usually bought a snack or food at school, 41.7 bought cooked food such as waakye kenkey, fried fish, fried rice and fried chicken. 16.5% bought pastries; (13.7%), ice cream; 13.0%, soft drinks; and 11.7%, canned/packaged fruit juice. About a third (35.0%) of them preferred a soft drink for snack. Others 25.4% preferred an ice cream, 21.6%, pastries, and 14.5%, a type of fruit. Majority (52.9%) of the respondents indicated that they drank soft drinks most often at school.	14/22	7
5. Nutrition intakes and nutritional status of	Owusu *et al.*[80]	364	Greater Accra	41±11 yrs for caregi	Cross sectional	Anthropometry, dietary	Compared to children in the Ghana School Feeding Program (GSFP), children in the private school feeding program (NSFP) had significantly	16/22	7

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	school age children in Ghana				vers, 10±2yrs for childr en		intake assessment, haemoglobin levels, questionnaire, weigh food record	higher intakes of energy (2413 ± 626 kcal vs. 1988 ± 627 kcal; P<0.001), protein (63 ± 17 g vs. 53 ± 19 g; P<0.001) and zinc (10 ± 3 mg vs. 9 ± 3 mg; P=0.004). Other micronutrients were similar in both groups. GSFP meals contributed 12% to 18.1% of the total energy and nutrient intakes of the children; whereas, NSFP meals contributed from 17% up to 30% of the total energy and nutrient intakes of the children.		
6.	A pilot study to determine the efficacy of consuming a highly Fortified groundnut nutritional supplement on the nutritional Status of school children	Steiner Asiedu and Salia [81]	Eight public schools (901) pupils	Ashanti and Northern Region	10.70 ±1.97 years for pupils and 40.72 ±10.41years for caregivers.	Quasi experimental design with fortified groundnut-based snack	Hb status, height for age, bmi for age, dietary assessment, questionnaire	The mean weight and height for the male participants in the intervention group improved significantly after the study weight (26.31±4.74kg to 28.53±5.51kg) and height (133.63±9.13cm to 137.70±9.74). A significant increase was observed in the mean haemoglobin concentration of all participants in the intervention group; males; 13.36±1.67g/dl to 14.31±1.71g/dl, females; (13.87±1.88g/dl to 14.34±1.63g/dl).	16/22	8
7.	Nutritional Status of Pupils Attending Public Schools with and without School Feeding Programme	Agbozo *et al.* [76, 68]	417 pupils, 14 primary	Volta region, Hohoe district	3-12 years	Cross sectional survey	Weight, height, MUAC, Questionnaire, weight	Differences in underweight, stunting, thinness and overweight observed were not significantly different among pupils attending schools with the Government School Feeding Program (GSFP) and those without GSFP. Pupils attending schools without the feeding programme were	14/22	7

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	in Hohoe Municipality, Ghana Nutrient composition and dietary diversity of on-site lunch meals, and anthropometry of beneficiary children in private and public primary schools in Ghana		scho ols				for age, height for age, BMI for age, MUAC-for age	found to have significantly higher height-for-age mean z-scores (-0.28±1.2) compared to those attending schools with the feeding programme (-0.64±1.0), p= 0.0057. Enrolment in schools implementing the Ghana school feeding programme did not significantly reduce underweight, stunting, thinness and overweight. Dairy products, eggs and meat were totally missing from the menus while very little fish was used. The meals were often eaten with tomato stew. The were no statistical differences in the nutrients provided by the lunch of private and public schools.		
8.	Comparative study of the nutritional status of school aged children enrolled on the ghana school feeding programme: a case of kwabre east and the tolon districts of ghana	Taricone [82]	300 pupil s	Ashanti and Norther n Regions , Kwabre East, Tolon districts	6-12yrs (Mean 9.9 ± 1.7)	Comparative Cross sectional	Height for age, weight for age, BMI for age, HB, 24-hour recall, FFQ, weighed food intake, question naire	The prevalence of stunting among the children was higher in the Tolon district (15.3%) than in the Kwabre East district (6%). Prevalence of anaemia was significantly higher in Tolon than Kwabre 20.5% vs. 7.3%; p=0.001. The rate of thinness was significantly higher in Kwabre East than the Tolon district in the study children (21.3% vs. 10%; p=0.026). Having a low dietary diversity score was significantly associated with being undernourished in both districts.	12/22	6

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9. Assessment of the school feeding programme in Ghana: A study of primary schools in the Abura-Asebu-Kwamankese district in the Central region of Ghana	Nyarko, n.d [79]	Five primary schools	Central region, Abura Asebu Kwamankese	Not reported	Cross sectional	Questionnaire,	Teachers of pupils responded to a likert scale on the impact of school feeding program (SFP) on children. Most agreed that the SFP has had a positive impact on the childrens' nutritional status.	10/20	5
10. Participation In Communal Day Care Centre Feeding Programs Is Associated With Higher Diet Quantity But Not Quality Among Rural Ghanaian Children	Harding [73]	193	Brong Ahafo Region, Two communities in Techiman	2-5 years	Cross sectional	Interviews Questionnaires, dietary assessment, weighed food record, 24-hour recall, DDS, HB	Children in the communal school feeding programme group tended to be heavier than non-participants (Table 2). The non-DCC group had almost 20% more children with anaemia, but there was no significant group difference in mean haemoglobin levels. Foods served were gari (ground dried cassava) and cowpea stew with red palm oil; jollof rice (rice cooked in a sauce made from tomato, chili pepper, onion and red palm oil); and boiled yam and kontomire (cocoyam leaves) stew prepared with red palm oil, ground groundnut, onion and chili pepper. The only Animal Source Food (ASF) included in the lunches was fish powder.	14/22	6
11. Evaluation of alternative school feeding models on nutrition, education, agriculture and other social outcomes in	Gelli *et al*. [72]	8407	All ten regions	2-15yrs	Randomised design.	Randomized allocation of children to	For children aged 5–15 yrs, the mean z-scores for the anthropometrics measures of height for age and BMI for age were −0.925 (SD 1.35) and −0.592 (SD 0.924). Haemoglobin levels, for the sub-sample (n=714) was 11.3 g/dL (SD 1.34).	16/22	8

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Ghana: rationale, randomised design and baseline data						groups, anthropometry, HB, questionnaire			
12. Nutritional status of in-school children and its associated factors in Denkyembour District, eastern region, Ghana: comparing schools with feeding and non-school feeding policies	Kwabla *et al.* [75]	359	Eastern Region, 2 public schools in Dekyembour District	5-12 years	Cross sectional	Questionnaire, anthros, height for age, BMI for age	Prevalence of stunting was higher in schools without the school feeding programme 17.2% vrs 16.2%. The prevalence of thinness was about twice higher (9.3%) in children with the school feeding programme. 1.9% of children in schools with the feeding programme were found to be overweight.	12/22	6
13. Nutritional status of school-age children in the Nkwanta South District - volta region of Ghana	Laar *et al.* [77]	650	Volta region, Nkwanta South	10-19 years	Cross sectional	Questionnaire, anthropometry, HAZ, BAZ	Prevalence of stunting and thinness was higher among children in schools on the feeding programme, while overweight was higher among children in schools not on the feeding programme. Feeding programme was significantly associated with stunting. If compared, the prevalence of overweight was higher among children in non-feeding schools (7.3%) than those in feeding schools (6.0%).	12/22	6
14. Consumer's Food Shopping Choice in Ghana: Supermarket	Meng *et al.* [56]	1,010	Northern, Western	39.2 years	Cross sectional	Questionnaire, Household	7.3% report shopping for food at supermarkets "more than once a week," 9.8 % "once a week," 8.4 % "every other week," 25.0 % "once a	16/22	8

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	or Traditional Outlets?			, and Greater Accra Tamale, Takoradi, Accra			ld survey	month. 70 % of responding urban households report shopping at least once a week in open-air markets Convenience foods and some food snacks sold by hawkers are more likely to be purchased by households of a lower socio-economic status. 17% of households purchased food in supermarkets at least weekly.		
15.	Agricultural transformation and food and nutrition security in Ghana: Does farm production diversity (still) matter for household dietary diversity?	Ecker, [88]	11, 217	Nation wide	Not reported	Cross sectional	Nationwide survey	Farm production diversification is positively associated with household dietary diversity. The regressions for the pooled sample show that cultivating one additional crop group increases the number of consumed food groups by 0.111.	16/22	8
16.	Street foods contribute to nutrient intakes among children from rural communities in Winneba and Techiman municipalities, Ghana	Micah, [58]	172	Central and Brong Ahafo, (Winneba and Techiman)	2-5 years 35±1.2 for caregivers	cross sectional	Questionnaire, FFQ, weighed food record	80% of caregivers in the two study areas had purchased street foods for their children at least once in the previous seven days. Porridges made from rice, millet, maize, or wheat were the most commonly purchased street foods. The majority of street foods (75.7%) were consumed by children as complete meals. Most of the caregivers purchased street foods for their children in the morning (75%); and evening (3.0%). Street foods contributed 35.7% to Animal Source Food (ASF) consumed by children in the Techiman communities and 4.2% in the Winneba area (P<0.01).	12/22	6

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17. Food retail assessment and family food purchase behavior in Ashongman Estates, Ghana	Aryeetey *et al.*[52]	94, 19 food vendors and 75 Households	Accra, Ashongman	Not reported	Cross-sectional, Household survey,	Questionnaire,	Only five of the 13 supermarkets identified offered fresh produce. 98.7% of respondents buy from traditional outlets. More than two-thirds of respondents purchased weekly from traditional outlets (71%). 65% purchased food from supermarkets once or twice a month. The traditional market is the main source of staple foods. Households purchased from outlets that are close to them.	14/22	7
18. Are we indeed what we eat? Street food consumption in the Market Circle area of Takoradi, Ghana	Hiamey *et al.* [54]	220	Western region, Sekondi Takoradi	35-55 years	Cross sectional	Income, Questionnaire	Street foods eaten included rice with tomato stew or bean stew 23.5% Banku/stew with tomato stew, okro stew or pepper sauce 17.5% Fufu or kokonte with light soup or palm fruit soup 14.4%. Carbohydrate staples were most purchased. Males consumed street foods 8 times a week while females consumed it 6 times a week. Street food consumption was higher for low income earners.	14/22	7
19. Urban Household Characteristics and Implications for Food Utilization in Accra	David Okutu, [60]	452	Accra	20-50+years	Cross sectional	Questionnaire, seven-day recall	Out of home foods contribute a greater proportion of dietary diversity. 53.4% of the households consumed foods prepared outside the home, and 46.6% consumed foods prepared at home. 13.4% of households depend on their harvests from fishing and farming. Foods eaten outside the home were associated with higher DDS.	12/22	6

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20. Household dietary practices and family nutritional status in rural Ghana	Nti, 2008 [59]	400 women	Eastern Region, Manya Krobo	28.3years	Cross sectional	Questionnaire, anthropometry, dietary data,24-hour recall, FFQ, Weight, height, BMI	Breakfast and lunch were the two main cooked meals usually purchased from food vendors, with supper being the least purchased outside the home. About 13% of the households always cooked their meals at home and never purchased food from food vendors.	12/22	6
21. Food and nutrient gaps in rural Northern Ghana: Does production of smallholder farming households support adoption of food-based dietary guidelines?	de Jager *et al*. [87]	329 Households	Northern Region, Karaga	11.6(8.2) months for child in the households	cross-sectional	Weight for age, length for age, BMI-for-age, weight for height, questionnaire, 24- hour recall, dietary diversity score	Households cultivated 5 hectares of land with four different crops. Most households produced grains (97%) and legumes, nuts and seeds (84%) but only 8% of households produced vegetables. Own food production allowed about 60% of households to cover their needs for maize and groundnut, less than 40% for rice and sorghum, and less than 5% for cowpea. 62% of the total quantity of micronutrients required by households was met by their production.	12/22	

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22. Mapping Obesogenic Food Environments in South Africa and Ghana: Correlations and Contradictions	Kroll *et al.* [55]	309 Households	Ashanti region, Kumasi	Not reported	Cross sectional	FFQ, GPS of food outlets, questionnaire	One quarter of households consumed diets high in obesogenic foods, and only 23% consuming high amounts and varieties of protective food. Small shops play a greater role in providing access to the key foods. Stalls typically located in traditional markets served as sources for vegetables, fruits, legumes and fish while formal outlets were sources of sugary drinks. Informal stores were sources of bread, confectionery and sugar.	14/22	7
23. Analysis of Street Food Consumption Across Various Income Groups in the Kumasi Metropolis of Ghana	Mensah *et al.* [57]	210	Ashanti region, Kumasi	31-60 years	Cross sectional	Questionnaire,	High income groups spent 9.56% of their total food expenditure on street food as compared to those in the middle (17.03%) and low (21.73%) income groups.	12/22	6
24. Examining the Role of Urban Food Spaces: A neighborhood Level Exploration of Food Geographies in Accra, Ghana	Anna Carla Lopéz-Carr *et al.* [66]	31 women	Greater Accra, Nima, Cantonments, Jamestown	Not reported	Qualitative cross-sectional study	Interviews	Households in Nima had easy access to the large food market. Households without access to a neighborhood market were more likely to consume highly processed foods. In Nima, the purchase of processed foods was low. In Cantonments and Jamestown, where there is no access to a neighborhood market, 90% of households purchase processed foods regularly. Lack of refrigeration facilities was a barrier to obtaining healthy foods.	12/22	6
25. The Local Food Environment and Body Mass Index	Dake *et al.* [65]	657	Greater Accra, James	31 years	Cross sectional	Weight, height, BMI,	There was an abundance of out of home cooked foods, convenience foods but little access to fruits and vegetables. The most common types of	18/22	9

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among the Urban Poor in Accra, Ghana			Town, Usser Town, Agbobloshie			Physical activity level assessment, DDS, spatial mapping of the food environment	out-of-home cooked foods available were plain boiled rice, rice boiled with refined vegetable oil, fried rice*, waakye., and jollof rice-Additional out-of-home cooked food place located in the neighbourhood decreases BMI by approximately 0.1 kg/ m^2 while each additional convenience store increases BMI by about 0.2 kg/m^2.		
26. Factors Influencing Food Choices: Perception of Public and Private Junior High School Adolescent Students in Asiakwa in the Eastern Region of Ghana	Janet Agyarkwaa Oti [84]	215	Eastern Region, Asiakwa	11-19 years	Cross sectional	Quantitative and qualitative data	Students buy food frequently from the school canteen. Though most foods sold at the school canteen are not varied, students are not allowed to go out to buy food. Fruits were perceived as expensive by students and some could not afford it.	12/22	
27. Expenditure on Fresh Vegetables, Fresh Fruits, and Peanut Products in Urban Ghana: Does Location Matter?	Meng *et al.* [89]	1010	Greater Accra, Northern Region	Not reported	Cross-sectional	Questionnaire	Accra households have significantly higher fresh vegetable expenditure than the household in Tamale. High income households consume more vegetables and fruits. After controlling for socio-demographic factors, the location factors did not have significant effects on the fresh fruit expenditure. Household numbers, marital status,	18/22	

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							older age, education, and income associated with fruit and vegetable consumption.		
28. Nutrition knowledge and food consumption practices and barriers in rural Ghana: the case of foods for preventing vitamin a and iron deficiencies	Omari R, [90]	300	Ashanti Region, Brong Ahafo, Region	Not reported	Cross sectional	Qualitative study, Focus group	Barriers that affect availability and consumption of animal products were lack of storage facilities, irregular supply, lack of money and conflicting media reports on effects of meat consumption on health. The main reason for the low consumption of fruits was traditional Ghanaian food culture where fruits are not considered as food or part of the meal. Other barriers as shown in included lack of knowledge on the nutritional value of fruits (72%), laziness in washing and peeling (60%), and contamination with agrochemicals (80%).	14/22	
29. Fruit and Vegetable Consumption Frequency by Urban Households in Ghana – Implications for Postharvest Handling	Florkowski *et al*. [53]	1076	Western, Greater Accra, and Northern Region, (Takoradi, Accra, Tamale)	Not reported	Cross sectional	Questionnaire, FFQ	Income is influential in relation to fruit and vegetable consumption, especially for fruit. Also, the presence of children in the household is important for fruit consumption. Shopping at supermarkets was less frequent. Fruit and vegetable purchase was positively associated with high income levels.	18/22	
30. The effects of income and food safety perception on	Amfo, [84]	300	Northern	Not reported	Cross sectional	Questionnaire,	The average monthly household food expenditure in Tamale is GH₵551.92. Vegetables and cereals account for more than	14/22	

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vegetable expenditure in the Tamale Metropolis, Ghana			Region, Tamale			Qualitative data	half of total food expenditure. Fruits and vegetables take 34.1 percent of the food budget. Income proportion spent on vegetables is significantly lower for high-income households than middle- and low-income groups.		
31. Development, implementation and outcome of standards to restrict fatty meat in the food supply and prevent NCDs: learning from an innovative food policy in Ghana	Thow *et al*. [49]	Not Applicable	Not applicable	Not applicable	Analysis of policy documents, policy analysis interviews, Health policy analysis triangle, trade data analysis	28 semi structured interview conducted FAOSTAT import data	Pork 'Deboned carcasses are to contain no more than 25% total fat when determined in accordance with clause 3 of GS 70. Pork carcass shall have a backfat thickness not exceeding 2.5 cm. Beef carcasses and cuts shall contain no more than 25% fat by mass when determined in accordance with clause 3 of GS 70. The policy reduced the availability of fatty meat especially turkey tail in the Ghanaian food environment.	18/22	
32. Urban Livelihoods and Food and Nutrition Security in Greater Accra, Ghana	Maxwell *et al*. [78]	559	Greater Accra	38±11.8	Cross sectional survey, Qualitative study	Food acquisition, SES,	Street food consumption is higher among low income households.	16/22	
33. Public awareness and perception of Ghana's restrictive policy on fatty meat, as well as preference and consumption of meat products among Ghanaian adults	Annan *et al.* [86]	337	Ashanti Region, Kumasi	18->50yrs	Cross sectional	Questionnaire, FFQ, body composition analysis, BMI	Price affects consumption choice of meat regardless of knowledge.	14/22	

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living in the Kumasi Metropolis									
34. The home school environment, physical activity levels, and adiposity of school-age children	Gaa *et al*. [70]	299	Northern Region, Tamale	9.3(2.14)	Cross-sectional	Questionnaire, Interview, physical activity questionnaire, Anthropometry	Sweet foods were available and sold in the school environment.	12/22	
35. Characterising the food and advertising environments of deprived neighbourhoods in African cities	Green *et al.* N.D [64]	621 food outlets or advertisements	Greater Accra and Volta region	N/A	Cross sectional	Neighborhood audits, outlet type classification, identification and characterization of neighbourhoods food advertis	The food environment in Jamestown was highly informal (80.5%) with the majority of the outlets being fruit or vegetable stands and table tops. Food outlets in Ho were more formalized and 43.9% of them were shops. Informal outlets had higher availability of healthy options compared to formal outlets. Foods sold in informal outlets included fruits and vegetables, staple foods, traditional dishes, poultry and eggs. Formal outlets sold predominantly processed foods such as sugar sweetened beverages and spreads, cakes and sweets.	16/22	

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						ement, GPS coordinates of outlets			
36. Dietary transitions in Ghanaian cities: leveraging evidence for policy and intervention to prevent diet-related non-communicable diseases	Holdsworth *et al.* [91]		Greater Accra and Volta region		Cross-sectional	Qualitative 24-hour recall	94% of study participants consumed energy-dense meals, 66.8% consumed fried foods, 55.8% consumed energy dense poor foods, 41% consumed nutrient poor foods, 38.5% consumed sweets, 36.2% consumed sweetened beverages. Financial constraint was a barrier to achieving a healthy diet.	14/22	
37. Dietary behaviours in the context of nutrition transition: a systematic review and meta-analyses in two African countries	Rousham *et al.* [63]	26 published studies involving 12605 persons	Nation wide	Not reported	Systematic review	Meta Analysis	13% of households in urban slums purchase cooked foods from street food vendors. 86% of university students purchase foods regularly from food vendors, of which 47% do so daily.	18/22	
38. Dietary patterns and associated risk factors among school age children in urban Ghana	Alangea *et al.* [61]	487	Greater Accra region	9-15years 12±1.5years	Cross-sectional	Food frequency questionnaire,	Four main food consumption patterns were identified: energy dense; starchy roots and vegetables; grain-based and poultry; and fish/seafoods. Starchy roots and vegetables explained 13.7% of the pupils' diet. The energy	14/22	

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						height, weight,	dense pattern identified in this study was characterized by the consumption of sugar sweetened beverages, candies, ice creams, fried foods, processed meats, spreads, toppings, and snacks like cakes, pies, doughnuts and other savory food. These foods are mostly sourced from the school environment.		
39. Street Food in Urban Ghana A desktop review and analysis of findings and recommendations from existing literature	FAO, [92]	Not applicable	Not applicable	Not applicable	Desktop review of documents, project reports, workshops and conference proceedings	Document review	The consumption of street foods is high. Consumption frequency is similar across all socio-economic strata.	18/22	
40. Workplace support for breastfeeding employees in educational and health settings in Ghana	Iddrisu, Abdul-Lateef, Hushie & Bashiru, [74]	128	Tamale	Not reported	Cross-sectional	Assessment of breastfeeding support systems at the workplace	Fridge for storing breast milk or other baby foods and availability of private rooms for breastfeeding were the least common forms of workplace support for breastfeeding.	12/22	

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Table 2: Checklist for assessing quality of quantitative studies

	Criteria	Yes (2)	Partial (1)	No (0)	N/A
1	Question / objective sufficiently described?				
2	Study design evident and appropriate?				
3	Method of subject/comparison group selection *or* source of information/input variables described and appropriate?				
4	Subject (and comparison group, if applicable) characteristics sufficiently described				
5	If interventional and random allocation was possible, was it described?				
6	If interventional and blinding of investigators was possible, was it reported				
7	If interventional and blinding of subjects was possible, was it reported?				
8	Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias?				
9	Sample size appropriate?				
10	Analytic methods described/justified and appropriate?				
11	Some estimate of variance is reported for the main results?				
12	Controlled for confounding?				
13	Results reported in sufficient detail?				
14	Conclusions supported by the results?				

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Table 3: Checklist for assessing quality of qualitative studies

	Criteria	**Yes (2)**	**Partial (1)**	**No (0)**	**N/A**
1	Question / objective sufficiently described?				
2	Study design evident and appropriate?				
3	Context of the study clear?				
4	Connection to a theoretical framework / wider body of knowledge?				
5	Sampling strategy described, relevant and justified?				
6	Data collection methods clearly described and systematic?				
7	Data analysis clearly described and systematic?				
8	Use of verification procedure(s) to establish credibility?				
9	Conclusions supported by the results?				
10	Reflexivity of the account?				

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