



Comparing measures of urban food security in Accra, Ghana

Cascade Tuholske¹ · Kwaw Andam² · Jordan Blekking³ · Tom Evans⁴ · Kelly Caylor¹

Received: 1 October 2018 / Accepted: 9 January 2020 / Published online: 23 January 2020
© The Author(s) 2020

Abstract

The urban population in Sub-Saharan Africa is projected to expand by nearly 800 million people in the next 30 years. How this rapid urban transition is affecting household-level urban food security, and reverberating into broader food systems, is poorly understood. To fill this gap, we use data from a 2017 survey ($n = 668$) of low- and middle-income residents of Accra, Ghana, to characterize and compare the predictors of household-level food security using three established metrics: the Household Food Insecurity Access Scale (HFIAS); the Household Food Insecurity Access Prevalence (HFIAP); and the Food Consumption Score (FCS). According to HFIAP, 70% of sampled households are food insecure, but only 2% fall below acceptable thresholds measured by FCS. Only one household reported sourcing food from modern supermarkets and fewer than 3% produce food for consumption through gardening, farming, or fishing. Instead, households rely on purchased food from traditional markets, local stalls and kiosks, and street hawkers. Results from a suite of general linear models show that household assets, education, and demographic characteristics are significantly associated with food security outcomes according to HFIAS and HFIAP. The poor correlation and weak model agreement between dietary recall such as FCS, and experience-based food security metrics, like HFIAS and HFIAP, highlight limitations of employing historically rural-centric food security measurement approaches within the urban context. Given that Sub-Saharan Africa's future is urban, our results add empirical evidence in support of the growing chorus of scholars advocating for comprehensive urban-oriented food security research and policy agendas across Sub-Saharan Africa.

Keywords Food security · Urbanization · Sub-Saharan Africa · Ghana · Urban food security

1 Introduction

The urban population in Sub-Saharan Africa (SSA) is projected to balloon from 376 million in 2015 to over 1.25 billion people by 2050 (UN DESA 2018). How this rapid urban transition is affecting urban food security, and how it is reverberating into broader food systems, is unclear. Most food security studies across the region have concentrated on

rural areas and the few case studies that have examined urban food security in SSA have depended on metrics designed to study rural food security (Maxwell et al. 2000; Battersby 2012, 2013; Jones et al. 2013; Seto and Ramankutty 2016; Haysom and Tawodzera 2018). Achieving the United Nations (UN) Sustainable Development Goals (SDGs) 2 and 11—zero hunger and the development of sustainable cities—requires accurate and consistent tools that capture the multidimensionality of household-level food security in SSA's rapidly growing cities (Battersby 2017). But no studies have explored the relationship among established household-level food security metrics in the SSA urban context in a multivariate framework. As such, how urban household demographic, socioeconomic, environmental, and spatial characteristics may vary across established household-level food security metrics is unknown.

Food security is a theoretical construct predicated on complex, multiscale spatiotemporal processes that encompass a broad range of human and environmental variables (Jones et al. 2013; Vaitla et al. 2017). It cannot be measured by a single metric. While orthodox methodologies break food security into manageable components, household-level food

✉ Cascade Tuholske
cascade@geog.ucsb.edu

¹ Department of Geography, University of California, Santa Barbara, CA 93016, USA

² International Food Policy Research Institute, Washington, DC 20005, USA

³ Department of Geography, Indiana University, Bloomington, IN 47401, USA

⁴ School of Geography and Development, University of Arizona, Tucson, AZ 85721, USA

security measurement remains rooted in rural-centric conceptualizations of food security (Battersby 2013; Haysom and Tawodzera 2018). Furthermore, some development agencies still advocate for policies centered on rural food security, encouraging approaches that use the urban transition as a lynchpin to buttress rural producers. For example, in the 2017 State of Food and Agriculture Report, FAO advocates that growing demand from urban consumers can be a major force for rural inclusion and bolster rural food security but makes no mention of urban food security (FAO 2017). Such rural-centric paradigms not only fail to account for the food security needs among the growing number urban poor, but also ignore the fact that we currently lack tools specifically designed to measure food security in the urban context.

Indeed, the nascent body of urban food security research from SSA illuminate how the region's rapid urban transition is presenting new challenges for food systems and requires new, urban-oriented approaches to measure household-level food security (Haysom and Tawodzera 2018). For example, evidence indicates that the urban poor in SSA rely on purchased food for 90% of their calories and spend up to 70% of their income on food (Maxwell et al. 2000; Jayne and Mason 2009; Frayne et al. 2010). This suggests that local price stability is a key component to urban food security. Urban food prices face greater exposure to external market forces and commodity price shocks can increase food insecurity among urban households while at the same time boosting prices and increasing food security among rural producers. During the 2007/8 global commodity price shock urban households across SSA reported being less food secure, whereas food security among rural households improved (Verpoorten et al. 2013). With urban household's food security dependent on price, food security metric designed to capture caloric intake or dietary diversity among rural households may not accurately measure food security among urban households (Haysom and Tawodzera 2018).

Food preferences and retailing options are also different for urban consumers compared to rural households across SAA. Changes in diet and lifestyle historically associated with urbanization are burdening health systems by creating a dual burden of disease of both over- and undernourished poor households (Popkin et al. 2012; Tzioumis and Adair 2014). In some cases, shifting food preferences among urban consumers can transform rural production toward large-scale agribusiness in SSA countries, which can be detrimental to smallholders (FAO 2017). Finally, the urban transition is also transmogrifying food retail systems, specifically leading to an increase in the number of supermarket retail outlets (Reardon et al. 2003; Traill 2006). It is unclear, however, how this shift in diets and food retailing affects food security among the urban poor, nor how if this shift is accurately captured by current food security metrics (Haysom and Tawodzera 2018; Battersby and Watson 2018).

In summation, understanding urban food security in SSA requires tools that measure economic access, nutrition, and urban food retailing, as well as municipal-level limitation such as water and sanitation, governance, and road infrastructure (Haysom and Tawodzera 2018). To this end, this paper has four aims: (i) we compare the food security status of households from nine low- and middle-income residential areas in Accra across three established food security metrics; (ii) we identify where households source food; (iii) we explore the household-level demographic, socioeconomic, environmental, and spatial predictors of urban food security; and (iv) we examine how these predictors vary across three indicators of household food security. With an ever-increasing number of Africans poised to live in cities, and, given that many of these new residents will be poor, understanding *who* is food (in)secure in cities, *where* food (in)security exists, *why* diets may be changing, and *how* urban food security will affect broader food systems, is paramount for countries across SSA to accurately measure their progress toward achieving UN SDGs 2 and 11.

2 Measuring food security in urban households

The most direct measurement of household-level food security that captures caloric and nutritional intake are either anthropometry measurements or detailed, multi-visit household expenditure or dietary recall logs (Jones et al. 2013). But acquiring accurate data through such methods is time-intensive, invasive, and expensive. Instead, household food security is generally assessed via proxy metrics derived from questions concerning one of three broad categories: (1) single-visit dietary recalls; (2) coping strategies; and (3) psychosocial and physical experience-based (Haysom and Tawodzera 2018). All three categories stem from a historical rural-centric bias and, if used individually fail to capture the multidimensionality of household food security. (Battersby 2012; Ballard et al. 2013; Jones et al. 2013; Haysom and Tawodzera 2018). Indeed, aggregate pairwise comparison of 8000–30,000 households from a wide range of developing countries showed that established dietary recall metrics have weak correlation with coping strategies and experience-based food security metrics (Vaitla et al. 2017). As such, using a single metric focused on dietary diversity may show that a household is food secure in terms of diversity of food consumed, but does not capture a household's ability to cope with food insecurity. What is more, unless collected over time, all these metrics fail to capture any temporal changes in household food security.

The few existing household-level urban food security assessments are largely from Southern African cities and have measured food security according to two interrelated experience-based metrics, the household food insecurity

access scale (HFIAS) and household food insecurity access prevalence (HFIAP). The data were collected from sub-populations of urban dwellers and tend not to be representative of the city's population. Nonetheless, all of these case studies suggest that low-income households regularly experience instances of food insecurity across a range of African cities. Surveys conducted by the African Food Security Network (AFSUN) in low-income areas of 11 Southern African cities found that household-level food insecurity measured by the HFIAP range from 56% to 98% of sampled households and that poverty significantly correlated with food insecurity (Frayne et al. 2010). A different survey from Tshwane, South Africa, found lower levels of food urban insecurity, with 61.3% of 507 sampled households characterized as food secure by HFIAP (Akinboade and Adeyefa 2018). In Nairobi, Kenya's capital, 85% of households in two major slums reported being food insecure according to HFIAP (Kimani-Murage et al. 2014). During the 2007/8 global commodity price spike, food insecurity measured among over 3000 randomly selected households in Ouagadougou, Burkina Faso, increased from 66.7% to 78.0% (Martin-Prevel et al. 2012), indicating that rising global commodity prices can affect local prices and increase household-level food insecurity in SSA cities. Last, also using HFIAP, a recent survey of households in two medium-sized cities in Northern Ghana found over half of households were food insecure (Ayerakwa 2017).

The AFSUN dataset offers insights into dietary diversity, provisioning, socioeconomic, and demographic associations with levels of household food security characterized by HFIAP (Frayne et al. 2010). But AFSUN's published data does not compare how dietary diversity correlates with food security measured by HFIAP, nor does it employ multivariate statistical models to assess demographic, socioeconomic, dwelling, and spatial predictors household-level food security. To date, only one case study from Sub-Saharan Africa has compared proxy measures of household food security in the urban context. A sample of over 3000 households in Ouagadougou found that both HFIAS and the index-member's dietary diversity score (IDDS) were significantly associated with household-level dietary and nutritional intake calculated from multiple visit full dietary recalls that weighted and measured of food portions and ingredients (Becquey et al. 2010). However, the Ouagadougou study, like the AFSUN dataset, did not assess how demographic, socioeconomic, environmental, and spatial characteristics relate across these measures of household-level food security.

In this study we employ three measures of household food security: HFIAS; HFIAP; and the food consumption score (FCS). The HFIAS was designed to produce a simple single statistical tool to monitor and evaluate food security that has been empirically validated for both population and individual level estimates of food security (Jones et al. 2013). Adopted

from a set of questions used to estimate prevalence of food insecurity in the United States, HFIAS produces a numeric score derived from nine subjective yes/no questions (Coates et al. 2007). The subjective questions gauge respondents' behaviors and attitudes related to household food security, including anxiety related to household food insecurity, perceptions of insufficient quality or variety of food, and reduction of food intake and subsequent physical consequences. If the respondent replies in the affirmative to any question, the enumerator asks about the frequency of occurrence. For example, if the respondent replies yes to "Did you or any household member go to sleep at night hungry because there was not enough food?", the respondent is then asked the frequency to which this occurred: rarely (1–2 in the past four weeks) scored as 1, sometimes (3–10 times in the past for weeks) scored as 2, or often (>10 times in the past four weeks) scored as 3. The HFIAS score is the summation of the frequency of occurrence of each question with a range of 0–27.

The HFIAS can be used to calculate the HFIAP, a categorical variable that employs a logic tree from the frequency responses to HFIAS questions. Households are labeled food secure or mild, moderate, or severe food insecure. It is important to highlight that HFIAS and HFIAP are used to measure access to food as a dimension of food security. But they are not intended to assess the causes of food insecurity, understanding coping strategies, cultural appropriateness, or nutritional knowledge or uptake.

The FCS is a composite score that uses a seven-day dietary recall that measures dietary diversity, food frequency and sourcing, and relative nutritional importance (World Food Program 2008). Respondents report the number of days out of the last seven days their respective household members have consumed locally appropriate food items. The items are grouped into overarching food groups, which are weighted based on the caloric values of those foods. The weighted values are then summed together to produce the FCS. A threshold is applied to determine if a household's food security situation based on consumption is poor (FCS of 0–21), borderline (FCS between 21.5–35), or acceptable (FCS greater than 35) food security. The FCS has been shown to correlate with per capita calorie consumption across divergent geographical and cultural contexts (Wiesmann et al. 2009).

3 Materials and methods

3.1 Study site

Ghana has experienced rapid urbanization seen in developing and emerging economies over the past few decades across Asia, Latin America, and now increasingly in SSA. In developing economies, the change from a rural agrarian economy to an economy less dependent on agriculture often includes

migration out of rural areas into secondary and primary cities. Ghana has been no different. While the urban share of the population was 36% in 1990, by 2014 the share had climbed to 54%, and is projected to reach 70% by 2050 (UN DESA 2018). This situation is somewhat unique among countries in SSA. According to the UN, the region is only 38.8% urban (UN DESA 2018). However, cross-country comparisons of urbanization rates must account for the different definitions of what counts as urban in each country (Richards et al. 2016). For example, in Ghana, towns with populations greater than 5000 are considered urban (Ghana Statistical Service 2012). This threshold may account for at least part of the difference between Ghana and other African countries.

That notwithstanding, urbanization is still a clear manifestation of Ghana's economic and demographic transition, especially when the populations of the largest cities are closely examined. Ghana's labor has moved out of agriculture to an economy dominated by services (Molini and Pierella 2015), and this shift has been accompanied by rural-urban migration since Ghana's independence. But this trend may be changing. Nationally representative data from 2014 shows that urban-to-rural migration and urban-to-urban migration exceeds than rural-to-urban migration (Ghana Statistical Service 2014).

In tandem with urbanization, Ghana is currently undergoing the nutritional transition (Popkin et al. 2012), with under-nutrition rates dropping and over-nutrition increasing. Nationally, obesity rates are increasing across rural and urban populations (Ghana Statistical Services 2015). Among women 14–49, nearly 50% of urban women and 30% of rural women are obese, compared to 23% and 8% of urban and rural men, respectively (Ghana Statistical Services 2015). Child undernutrition levels have decreased at the national level, though rural areas still have higher rates of stunting and wasting compared to urban areas. For example, in 2014, 22% of rural and 15% of urban children under were two standard deviations below recommended height-for-age ratio (Ghana Statistical Services 2015).

Accra has been recognized as one of the Africa's emerging mega-cities. The capital is growing faster compared to the country as a whole—the national population growth rate between 2000 and 2010 was 2.5%, the Accra region, which includes Ghana's capital, recorded a growth rate of 3.1% (Ghana Statistical Service 2012). The city had an official population of 2.6 million in the last national census (2010). Over half of Accra's residents are migrants (Ghana Statistical Service 2014), showing that much of this growth is not a result of natural increase within the city. Over 80% of migrants to Accra came from other urban areas (Ghana Statistical Service 2014). Although Ghana's main industrial activities are clustered in Accra, the services sector employs the lion's share of Accra's labor force. This includes formal sector activities like education and health, but also many informal activities such as trading, catering, manual labor, and transportation. According

to UN-Habitat, 38.4% Accra's residents live in neighborhoods characterized as slums, where urban poverty might be expected to be endemic (Ghana Statistical Service 2014). However, household-level socioeconomic conditions and health status in the city's slums tend to be highly spatially heterogeneous (Weeks et al. 2007; Jankowska et al. 2011; Weeks et al. 2012) and the official poverty rate, determined by the consumption threshold of US\$1.83 per day, is quite low at 2.2% in 2012/13.

Accra's retail food system is diverse. Along with a myriad of roadside shops and individual street hawkers, over 30 open-air markets serve the city (FAO 2016). But like other major cities in SSA (Battersby and Watson 2018), food retailing is evolving in Accra. From a baseline of only three supermarkets before 2005, Accra now boasts 37 large-format supermarkets according to an unpublished 2017 survey by International Food Policy Research Institute (IFPRI 2017). If supermarkets capture part of the market share from local retailers, then this shift in food retailing may have negative consequences for the urban poor who may not be able to afford the larger unit sizes of staples at supermarkets or access supermarkets at often distant locations (Battersby and Watson 2018).

A wide-variety of food products produced from Ghana's rural areas are sold across all retail locations. Traditional staples such as cassava, plantains and maize, and dried and frozen fish, fruits and vegetables are readily available. Like most West African countries, imports of rice and other commodities play a major role in food consumption. Meat—especially chicken and fish—and processed foods, are increasingly consumed in Accra, and convenience meals away from home are a major food source (Hollinger and Staatz 2015).

3.2 Data and analysis

The 2017 Accra Urban Food Security Survey, collected over a three-week period in July/August, surveyed 677 households in 9 long-established, low- and middle-income residential areas throughout Accra. Structured-area sampling was employed (Montello and Sutton 2013). Residential areas were chosen based on UN Habitat slum maps (UN-Habitat n.d.) and vernacular neighborhood maps that showcase finer-scale (census enumeration area) socioeconomic characteristics provided by San Diego State University (Weeks et al. 2007; Jankowska et al. 2011). We note that our sample should not be considered representative of all low- and middle-income households in Accra, as we did not survey informal or squatter low-income areas due to safety concerns. Local enumerators surveyed households at approximately even spatial intervals according to the density of houses to achieve complete spatial coverage of each residential area. The survey included question blocks related to household demographic, dwelling, labor, income, socioeconomic characteristics, food expenditures, and market preference as well as FCS, HFIAS, and HFIAP questions. Enumerators surveyed one consenting adult per

household with knowledge of the household finances and food procurement. However, enumerators collected demographic information for the entire household, as well as labor characteristics for up to five household members. Data was collected using Qualtrics mobile data collection platform on iPad tablets.

Four models were generated using 668 complete cases to assess how household demographic, socioeconomic, environmental, and spatial characteristics relate to the three household food security metrics, as well as how such predictors may vary across the three food security metrics. While the FCS is a bounded integer variable that can only take on values between 0 and 112, here FCS distribution is normal and thus an ordinary least squares (OLS) regression was performed for the FCS. In OLS regression, the estimate effect size linearly correlates with the dependent variable. For example, if the household size effect is estimated to be 1 and statistically significant, then an increase of one person in a household is associated with FCS increasing by 1, all else being equal.

The HFIAS is treated as a count variable because it is the summation of the frequency of occurrences in response to categorical questions. The number of zeros is inflated (Fig. 2b). Households who answer no to all HFIAS questions are categorized as food secure and receive a score of zero. But because the zeros are not assumed to be a result of a different underlying process, a negative binomial model is appropriate rather than a zero-inflated poisson regression (Long and Freese 2006). A second logistic regression was performed on a binary HFIAS variable that categorized households HFIAS scores as <0 or 0 (Martin-Prevel et al. 2012). In negative binomial model and logit models, statistically significant effects of an independent variable are associated with an increase in the log counts of the dependent variable. The larger the effect size, the greater the increase in log counts of the dependent variable.

Marginal effects ordinal logistic regression was performed on HFIAP. Results from a marginal effects model indicate the probability of a household switching from a given HFIAP food security category given a change in predictor variable, holding all else held equal. For example, if the marginal effect for households with no school is -0.15 , all else equal, household without any educated adult are 15% less likely to be in the secure category. All analysis and plots were performed in RStudio (version 1.1.143, RStudio Inc.). Maps were generated with QIS (version 2.18.20, QGIS Development Team).

Both categorical and continuous independent variables were selected to account for the range of demographic, socioeconomic, environmental, and spatial characteristics pertinent to households in our sample. We controlled for the possibility of free meals consumed by household members at work or school, as well as meals given away to non-household members, household language, and residential area of the household. We employed a slum index to characterize a wide-range

of dwelling characteristics found in highly spatially heterogeneity low- and middle-income residential areas of Accra (see Weeks et al. 2007). UN-Habitat designates a household as a slum if it lacks one or more of the five following characteristics: durable housing; sufficient living space; access to safe water; access to adequate sanitation; and secure land tenure (UN-Habitat 2016). The slum index is calculated by summing the number slum indicators a household is lacking and dividing it by five, whereby households with high slum index scores exhibit more slum-like conditions based on the household UN slum definition.

While the household survey attempted to gather monthly household income, we did not include this data in our models because of the high number of missing values and the known biases and unreliability of self-reported income. Alternatively, we constructed an asset index using similar procedures designed by the Demographic and Health Surveys Program to approximate household wealth (Rutstein et al. 2004). After normalizing the raw data, principal components analysis (PCA) was performed on a list of common household assets (Filmer and Pritchett 2001). To produce a continuous measurement of asset ownership by each individual household, PCA assigns each household a factor score by multiplying the first principle component of each asset by the household's normalized count of that asset and then summing the total across all assets owned by a household. Missing values for total household monthly food expenditures and distance traveled to primary food purchase location were imputed by bootstrapping random values from a Monte Carlo simulation based of the cumulative density function related to the distribution of two variables, respectively. Finally, because only one household in our sample reported ever shopping at a modern supermarket, we did not include the primary locations of food purchases. All other sampled households sourced food from local markets, neighborhood shops and kiosks, street vendors, or hawkers (Fig. 1). Likewise, we did not include self-production as independent variables because fewer than 3% of households reported gardening, fishing or farming for own consumption.

3.3 Descriptive statistics

Just over 50% of the 668 household in our analytical sample were headed by a male (Table 1). The average household consisted of four members. The mean age of the household head was 47 years. On average, 56% of household members were employed. Self-employment was the most common form of employment—on average, households had at least one self-employed adult. Both regular and casual wage employment are considerably rarer—one member out of every three surveyed households has regular wage employment and one member out of every six surveyed households has casual employment. Although not reported in Table 1, from the 424

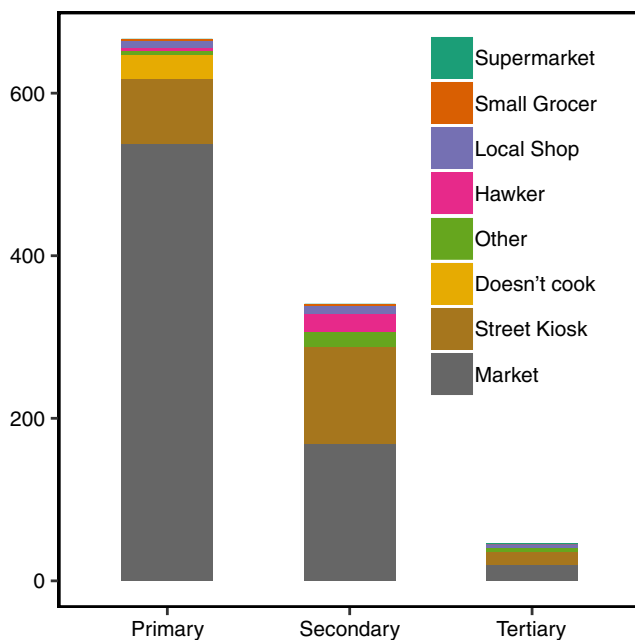


Fig. 1 Primary, secondary, and tertiary sources where sampled households purchase food. Only one household reported ever going to a supermarket (tertiary source) and fewer than 3% of households reported sourcing food from gardening, fishing, or farming. Households that reported ‘doesn’t cook’ purchase prepared meals from street vendors, kiosks, and restaurants

households that provided complete income information, the average monthly income from employment was 890 Ghana cedis (~4 Ghana cedis equaled 1 US dollar at the time of the survey).¹

One-third of all households had at least one adult who had attended or completed primary education. Nearly 40% of households had an adult that had attended or completed secondary education, and more than 20% of households had an adult who had received some form of post-secondary education. Only 5% of households had no adult with any formal education.

Our sample reflected the ethnic diversity of Accra. Asante Twi, originating from central Ghana, was the dominant language for 30% of our sample, but languages originating from northern Ghana were predominantly spoken in about 21% of the households. Ewe, the main language for people from the Volta region east of Accra, was the main language in 9% of the households. The second most common language spoken was Ga (29%), the language for the Ga tribe which is indigenous to Accra. Only 2% of households spoke English as their primary language.

In terms of food consumption, expenditure on prepared food away from home was nearly 12 Ghana cedi per household per day (~3 USD). This compares to an average monthly total household food expenditure of 555 Ghana cedi (~139 USD). Household members received on average 0.17 meals per capita at school or work per day. This may include public

¹ The exchange rate to the US dollar at the time of the survey was about 4 Ghana cedis.

food assistance. For example, Ghana has a School Feeding Program that provides meals to children in selected public schools, and currently reaches a third of school children in Ghana (Mwin 2017a, 2017b).

4 Results

4.1 Comparing measures of food security

Based on HFIAP, nearly 70% of households sampled are categorized as mildly to severely food insecure (Fig. 2a). Over the previous month, these households experienced anxiety related to food insecurity or were unable to access sufficient or preferred foods. But few households characterized as food insecure by HFIAP have high HFIAS scores (Fig. 2b). Those who answered “yes” to any of the nine HFIAS questions did not experience the problem frequently. Thus, our results indicate prevalent but low frequency of anxiety and experiences related to food insecurity among low- and middle-income households in Accra. In contrast, only 14 of the 668 households in the survey sample can be characterized as borderline or food insecure (FCS < 35) according to the FCS (Fig. 2c). This signals that households within our sample consumed sufficient calories over the previous seven days.

There is no correlation between FCS and HFIAS (Fig. 3a) or between FCS and HFIAP (3b). In contrast, HFIAS and HFIAP are more closely correlated, with each being computed from the same information (3c). The increase in variance in HFIAS scores as HFIAP categories moves from secure to severe suggests that some sample households may not have answered “yes” to less serious HFIAS questions. For example, such households may have responded ‘no’ to the question “Did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food”, but responded ‘yes’ to the question about a more serious situation, “Did you or any household member go to sleep at night hungry because there was not enough food?” Affirmative responses to questions such as these would place the respondent in the severe HFIAP category.

Across all three food security metrics, we find high spatial heterogeneity (Fig. 4). While cluster analysis was not performed due to the spatially discontinuous sampling between residential areas, no clear spatial pattern is visually evident in the point maps of all three measures of household-level food security. Overall, residential areas can be characterized as having a wide range of household-level food security outcomes across all three household-level food security metrics.

4.2 Drivers of food insecurity in Accra

The estimates across the suite of linear models are largely consistent for HFIAS and HFIAP, but differ for FCS.

Table 1 Descriptive Statistics of Household Characteristics (*n* = 668)

	Mean or Count	Standard Deviation or Percent	Min	Max
Age of household head, years*	46.87	14.27	17	95
Household size	4.01	2.03	1	13
Male head of household, 0/1	361	54.0%		
Asset Index	0.00	1.61	-2.34	9.47
Received remittances, 0/1	193	28.5%		
Slum Index	0.09	0.117	0	0.6
No school, 0/1 [†]	36	5.4%		
Primary school, 0/1 [†]	223	33.4%		
Secondary school, 0/1 [†]	253	37.9%		
Tertiary school, 0/1 [†]	156	23.3%		
Household members employed, percent	56	0.27	0.11	1
Self-employed, number	1.02	0.81	0	5
Casually employed, number	0.16	0.43	0	4
Regularly employed, number	0.33	0.60	0	3
Travel time to market, minutes	15.0	15.9	0	180
Free meals at school or work, 0/1	0.17	0.36	0	3
Meals given to non-household members	1.61	5.35	0	70
Daily Street food expenses, cedi	11.67	14.22	0	150
Total monthly food expenses, cedi	555.01	376.69	2	3000

*Four households recorded an average age below 5 and were omitted from summary statistics but were retained for modeling.

[†] The highest education attained by any working household member

Asset index normalizes the count data for each asset. Thus, the counts are centered at a mean of zero

Household demographic composition plays an important role in determining food security outcomes measured by HFIAS and HFIAP (Table 2, Table 3). Across HFIAP categories,

smaller households have a greater likelihood of being food secure. But the size of the household has no significant effect on FCS. The HFIAS logit model suggests that larger

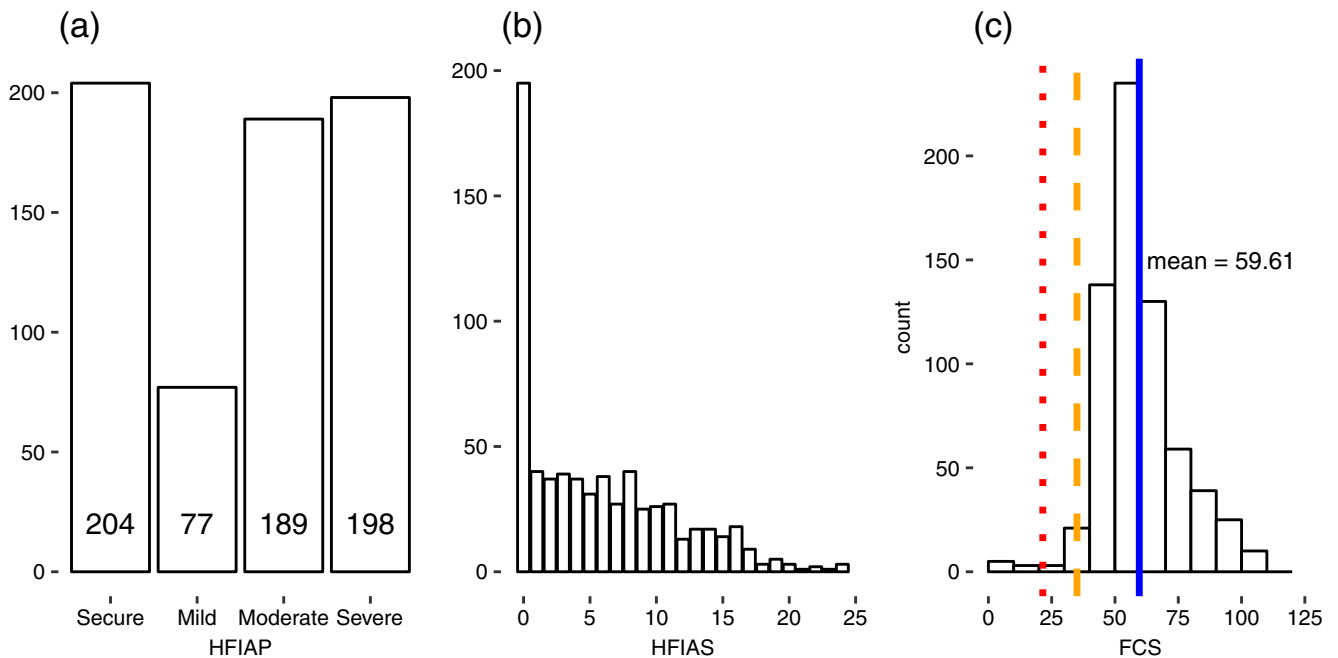


Fig. 2 Distribution of the FCS (a), HFIAS (b), and HFIAP counts (c). Households below the red dotted line dotted line in panel A are food insecure (FCS < 21.5) and below the orange line are borderline food insecure (FCS < 35)

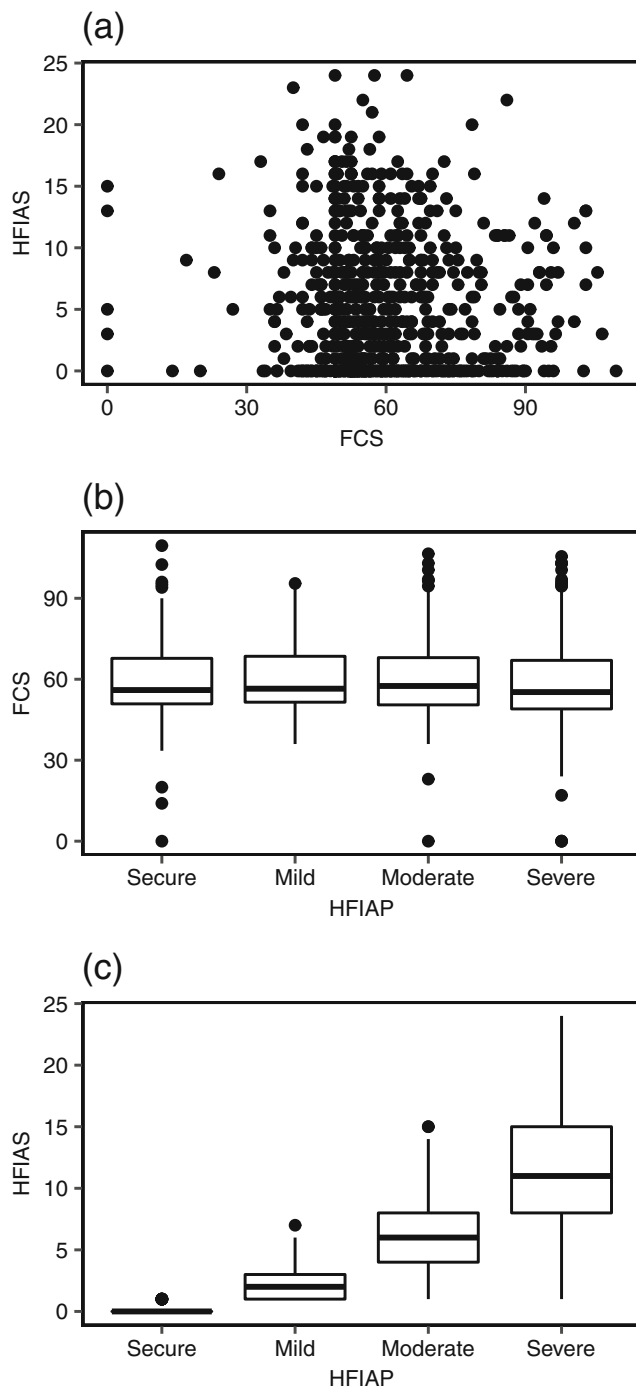


Fig. 3 Household FCS plotted against HFIAS (a), as well as boxplots of FCS and HFIAP (b) and HFIAS and HFIAP (c). There is no correlation between the FCS and the HFIAS (a), nor HFIAP (b). There is greater variance in HFIAS scores among more food insecure HFIAP categories (c)

households tend to have a greater likelihood of food insecurity. Though the effect size is near zero, households with an older head have a greater likelihood of being food secure according to HFIAP. The slum index has no significant effect across all four models, nor does the sex of the household head. The lack of a significant relationship between household

demographics, household composition, and slum conditions with FCS suggests that household diet and food consumption is sufficient across all households no matter the composition or quality of housing.

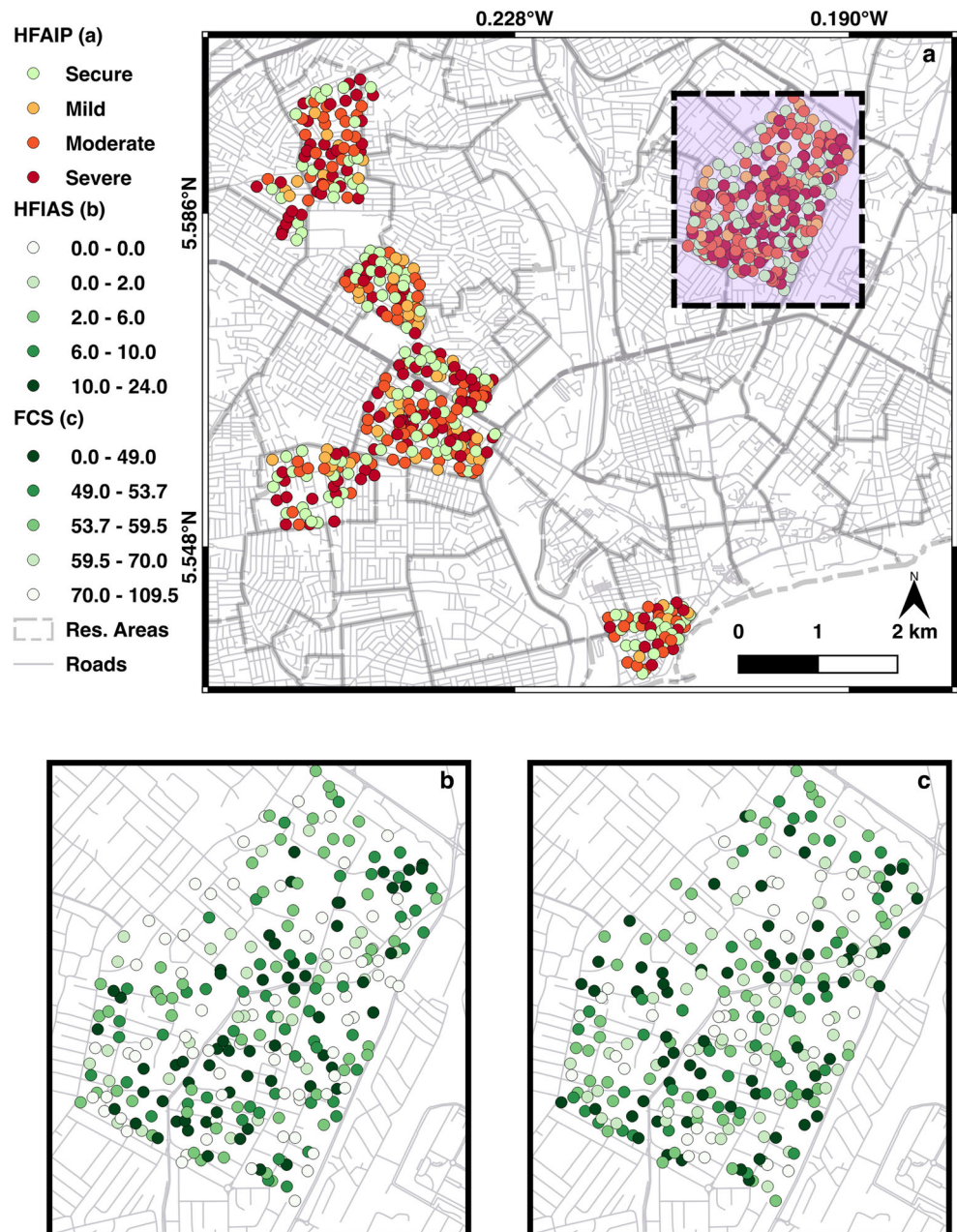
While the highest educational attainment of any member within a household is not a significant predictor of FCS, higher education significantly increases household food security measured by HFIAS and HFIAP (Table 2, Table 3). Households that have members who attended or completed tertiary education (23.3% of our sample) have a greater likelihood of being in the food secure HFIAP category. This is especially evident between households with no adult members who received schooling and those households with members who have some tertiary education, with the greatest effect size among severely food insecure households with no education in the HFIAP ordered logit marginal probabilities model. In contrast, educational attainment was not significantly correlated to a household's FCS.

A greater household asset index increases the likelihood of a household being food secure based on HFIAS and HFIAP (Table 2, Table 3), suggesting that household wealth is associated with household food security. However, the asset index is not significantly associated with FCS. Furthermore, household labor does not appear to play a role in determining the level of household food security. Both the labor type and the share of the household engaged in employment does not significantly affect food security across all four models.

Annual remittances are significantly associated with a higher FCS. Receiving remittances, all else equal, increases the FCS for a household by four score points. This highlights the potential for remittances and gifts as a mechanism to increase the quantity and diversity of a household's diet by raising disposable income to purchase higher-calorie foods or more diverse food types. Higher total monthly food expenditures also are associated with a higher FCS and with improved food security outcomes based on HFIAP. But the effect size is nearly zero. Total monthly food expenditures are not significantly associated with HFIAS.

Giving free meals to non-household members are significantly associated with a higher FCS. However, these variables are not significant determinants of HFIAS or HFIAP (Table 2, Table 3). The ability to give away meals may imply that those households have excess food. Longer travel times to markets are significant predictors of a higher FCS, as well as better HFIAP outcomes. We reason that household wealth may be the underlying driver here, suggesting that some households have the luxury of time to travel to more distant locations and thus have better food security outcomes. But the effect size of market distance measured in minutes is nearly zero. Finally, increased daily expenditures on prepared food purchased away from home from street food vendors, fast food outlets, or restaurants is significantly correlated with higher FCS, but also a greater likelihood of food insecurity based on HFIAS

Fig. 4 Spatial distribution of food security measured by the HFIAP for all sampled households (a). Household food security measured by the HFIAS (b) and FCS (c) also exhibited spatial heterogeneity as evident from zoomed in areas around Nima residential area of Accra. For the HFIAS and FCS intervals are derived from sample quintiles. Five households are excluded due to inaccurate GPS coordinates



and HFIAP models. However, the effect size is nearly zero across all models.

5 Discussion and conclusion

Low- and middle-income households in Accra may not suffer from insufficient calories according to dietary recalls such as FCS. The majority do, however, experience regular inability to access “sufficient, safe, and nutritious food to maintain a healthy and active life to access food to achieve”, per FAO’s definition of food security (FAO 2008). With 70% of our sample characterized by HFIAP as mildly to severely food

insecure, it is clear that households regularly worry about having enough food and, at times, cannot access sufficient food to meet their needs. By this measure, our results agree with the handful of similar case studies from cities in SSA that have also shown high levels of food insecurity among low-income residents measured with HFAIS and HFIAP (Frayne et al. 2010; Martin-Prevel et al. 2012; Kimani-Murage et al. 2014; Ayerakwa 2017; Akinboade and Adeyefa 2018).

As previously stated, our sample is not representative of all low- and middle-income households in Accra. We did not survey households in informal settlements and less than 5 % of sampled household heads had lived in Accra for fewer than five years. This in itself is striking. Even though these often-

Table 2 Predictors of household Food Consumption Score (FCS) and Household Food Insecurity Access Scale (HFIAS)

	Food Consumption Score (FCS)		Household Food Insecurity Access Scale (HFIAS)		Household Food Insecurity Access Scale (HFIAS)	
	Ordinary least squares model		Negative binomial model		Logit model	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
Age of household head, years	-0.078	0.043	0.637	0.004	-0.014	0.007
Household size	-0.087	0.543	0.007	0.046	0.308**	0.100
Male head of household, 0/1	1.876	1.260	0.100	0.106	-0.260	0.220
Asset Index	0.637	0.408	0.000	0.037	-0.406***	0.075
Receives remittances, 0/1	4.289**	1.307	0.735	0.110	0.063	0.228
Slum Index	2.704	5.200	0.228	0.438	1.054	0.935
No school, 0/1 [†]	-0.835	2.962	0.006	0.244	1.153	0.594
Primary school, 0/1 [†]	-1.305	1.759	0.594	0.149	0.583	0.298
Secondary school, 0/1 [†]	-0.681	1.609	0.298	0.137	0.224	0.264
Household members employed, percent	0.816	0.747	0.220	0.063	-0.197	0.133
Self-employed, number	0.960	1.018	0.264	0.086	-0.096	0.178
Casually employed, number	0.752	1.512	0.178	0.125	0.310	0.299
Regularly employed, number	0.676	1.227	0.299	0.104	-0.161	0.209
Travel time to market, minutes	0.092*	0.036	0.935	0.003	-0.006	0.006
Free meals at school or work, 0/1	-1.056	1.620	0.209	0.135	-0.259	0.267
Meals given to non-household members	0.356***	0.106	0.267	0.009	0.000	0.020
Street food expenses, cedis	0.088*	0.041	0.020	0.003	0.031***	0.009
Total food expenses, cedis	0.005**	0.002	0.430	0.000	0.000	0.000
Control for language	Yes	Yes	Yes	Yes	Yes	Yes
Control for residential area	Yes	Yes	Yes	Yes	Yes	Yes
Intercept	57.409***	3.643	0	0.306	0.954	0.637
Adjusted R-squared	0.181					

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ [†] Tertiary education is the reference category

vulnerable groups—recent migrants and residents of informal settlements—were not included in the sample, the results show high levels of food insecurity. As such, severity of food insecurity measured by HFIAP is likely higher among Accra's newest and poorest residents. Furthermore, the extreme spatial heterogeneity of household food security measured by all three indicators—FCS, HFIAS, and HFIAP—reveal that low- or middle-income residential areas have a broad underlying distribution of household-level food security outcomes (Fig. 4). Because cities like Accra are changing so rapidly, some households may be achieving economic and educational advancements ahead of their neighbors. As noted by studies of socioeconomic and health status in Accra (Weeks et al. 2007; Jankowska et al. 2011), blanket terms that characterize residential areas as slums can be misleading. Interventions should account for the distribution of food security situations within low- and middle-income residential areas.

The HFIAS and HFIAP model results show that educational attainment, household assets, and the demographics of a household all associate with how households perceive their ability to access food. As sampled households primarily rely on

purchased food to meet their needs—fewer than 3% of households source food from farming, gardening, or fishing—the ability to afford food ultimately underpins household-level food security in our sample. And while our results do not reveal the exact mechanisms in which these variables directly lead to higher or lower levels of experiences related to food security, higher educational levels, in case studies from around the world (e.g. Bigsten et al. 2003; Tilak 2007; Litschig and Morrison 2013), have been shown to strongly correlate with decreased levels of poverty. Thus, vis-à-vis educational attainment, greater wealth increases a household's economic access to food, decreases anxiety related to procuring food, and may increase resiliency should prices increase.

Due to the poor correlation and model agreement between the HFIAS/HFIAP and FCS, we echo recent calls to develop multifaceted metrics specifically designed to measure food security in the urban context of SSA (Battersby and Watson 2018; Haysom and Tawodzera 2018). This is the first study to empirically confirm a weak correlation between dietary recalls, such as FCS, and experience-based metrics like the HFIAS and HFIAP, in the urban African context. These results do,

Table 3 Ordered logit marginal probabilities of a household being in a specific Household Food Insecurity Access Prevalence (HFIAP) food security category

	Secure		Mild		Moderate		Severe	
	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error	Marginal Effect	Standard Error
Age of household head, yrs.	0.003*	0.001	0.001*	0.000	-0.001*	0.000	-0.003*	0.001
Household size	-0.040**	0.015	-0.008*	0.003	0.010*	0.004	0.039**	0.014
Male head of household, 0/1	0.060	0.033	0.013	0.007	-0.014	0.008	-0.059	0.033
Asset Index	0.061***	0.012	0.013***	0.003	-0.015**	0.005	-0.059***	0.012
Receives remittances, 0/1	-0.033	0.034	-0.007	0.008	0.007	0.007	0.033	0.035
Slum Index	-0.213	0.137	-0.045	0.030	0.051	0.035	0.206	0.133
No school, 0/1 [†]	-0.171***	0.045	-0.058*	0.023	-0.025	0.037	0.254*	0.102
Primary school, 0/1 [†]	-0.099*	0.043	-0.023*	0.012	0.018*	0.008	0.104*	0.049
Secondary school, 0/1 [†]	-0.062	0.042	-0.014	0.010	0.013	0.009	0.063	0.043
Household members employed, percent	0.030	0.020	0.006	0.004	-0.007	0.005	-0.029	0.019
Self-employed, number	0.013	0.027	0.003	0.006	-0.003	0.006	-0.012	0.026
Casually employed, number	-0.077	0.042	-0.016	0.009	0.018	0.011	0.075	0.041
Regularly employed, number	0.032	0.032	0.007	0.007	-0.008	0.008	-0.031	0.031
Travel time to market, mins	0.003**	0.001	0.001*	0.000	-0.001*	0.000	-0.003**	0.001
Free meals at school or work, 0/1	0.039	0.043	0.008	0.009	-0.009	0.010	-0.038	0.041
Meals given to non-household members	-0.001	0.003	0.000	0.001	0.000	0.001	0.001	0.003
Street food expenses, cedis	-0.004***	0.001	-0.001**	0.000	0.001**	0.000	0.004***	0.001
Total food expenses, cedis	0.000*	0.000	0.000*	0.000	0.000*	0.000	0.000*	0.000
Control for language	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Control for residential area	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ [†] Tertiary education is the reference category

however, parallel the results of Vaitla et al. (2017) in their much larger aggregate study that do not separate urban from rural households. Given the association between educational attainment and household wealth and HFIAS and HFAIP outcomes, our results indicate that the HFAIS and HFIAP do accurately capture, at least in part, household-level urban food insecurity related to ability access food. Poorer, less educated households may meet baseline caloric requirements measured by the FCS. But such households regularly experience situations and anxieties related to the inability to access food. Should food prices increase, all else being equal, these households' food security situation will likely worsen.

The HFIAS and HFIAP do have limitations when used alone. These metrics do not provide insights into how sourcing of food nor seasonality may play a role in decision making related to food security in cities. The HFIAS and HFIAP also do not explain the range of households' dietary preferences. One possible approach would be to capture multiple metrics that cover different aspects of household food security—e.g. dietary diversity, experiences, coping, and poverty—for each household and combine them into a single food security index, such as the World Food Program's Consolidated

Approach to Reporting Indicators of Food Security (WFP 2015). But even metrics designed to specifically measure household-level food security in urban areas may not shed light on the broader urban food system, including infrastructure challenges, travel, food safety, and market governance (Haysom and Tawodzera 2018).

Our results further buttress the need for a greater understanding of how the food security challenges of the urban growing poor will cascade into broader food systems and affect governance (Battersby 2012; Seto and Ramankutty 2016; Haysom and Tawodzera 2018). In spite of the growing importance of ensuring urban food security, development organizations are advocating for approaches geared toward enhancing rural livelihoods through off-farm employment as a means to stem the influx of migrants to cities while, at the same time, improving local agricultural output and sustainability (FAO 2017). This rural-centric focus neglects to fully account for the food security challenges of the growing urban poor (Battersby 2013). Indeed, recent study conducted by the World Bank and FAO shows that on a global scale 50% of urban households can be characterized as food insecure while only 46% of rural households fit that criteria using an

experience-based metric similar to the HFIAS and HFIAP (Battersby and Watson 2018).

Local governments do have options to shore up household urban food security. Our results showcase that ensuring access to high-quality education opportunities for all urban dwellers may strengthen food security in the long-term, as the results from the HFIAP models show that higher level of education are associated with fewer experiences food insecurity. But proven overarching urban policies—such as transportation and water and sanitation infrastructure improvements—in the medium term can reduce poverty-levels and disease-risk and may reduce vulnerability to food insecurity among low- and middle-income households. As our results suggest that household wealth correlates with higher levels of food security, local governments can also strengthen household food security directly by reducing the economic burden of procuring food. For example, expanding free school lunch programs for children may reduce the overall costs of purchasing food, especially for large households who have a greater likelihood of being food insecure based on our results.

Finally, governance plays an important role in the creation and structure of food systems within urban areas (Battersby and Watson 2018). Both informal and formal governance arrangements of food retailing influence household food purchases and food security (Blekking et al. 2017). Tackling the problems of diverse governance requires a nuanced approach that balances the modernization of food retailing with the needs of low-income consumers and local vendors. Only one household within our sample reported ever purchasing food from supermarkets, despite the substantial influx of modern grocery stores. Thus, local governments should support policies that do not limit a household's access to traditional markets, street vendors and hawkers, and prepared street food to keep costs as low as possible for consumers (Battersby and Watson 2018). This can include infrastructure improvements for local markets and vendors, as well as avoiding incentivization of multinational supermarkets over local retailers.

Ghana's urban transition has outpaced its neighbors, and, despite economic growth, our results add to the growing body of research indicating that many low- and middle-income urban households regularly experience instances of food insecurity. Policymakers across SSA should heed notice. International policy resonates with national leaders and thus initiatives such as the sustainable development goals often set national policy objectives and donor funding. The SDGs, notably, do not interlink the Goals 1 and 2—zero hunger and zero poverty—with the Goal 11, the development of sustainable cities (Battersby 2017). This is despite the fact that the planet is now more urban than rural, and that urban poverty and economic inequality are at record highs. Our paper showcases that tracking SDGs 2 and 11 requires employing consistent and accurate tools to measure food security in urban areas.

Sustainable cities in SSA will depend on ensuring that the ever-expanding urban poor are food secure, at all times. Reports of widespread hunger stemming from the ongoing economic crisis in Venezuela, a country that is 88.2% urban, highlight the potential dire consequence of not ensuring stable economic access to food for all urban dwellers (FSIN 2018; UN DESA 2018). If the future of Sub-Saharan Africa lies primarily within cities, then to feed the future, policy and research agendas that focus on ensuring urban food security must be pursued.

Acknowledgements The U.S. Borlaug Fellows in Global Food Security Program, funded by the United States Agency for International Development (USAID), the Earth Research Institute at the University of California, and NSF grant number #1801251 provided the primary funding for this paper. Financial support for Kwaw Andam came from USAID through funding for the Ghana Strategy Support Program (GSSP) and the Food Security Policy (FSP) project, as well as the CGIAR Research Program on Policies, Institutions, and Markets (PIM) led by the International Food Policy Research Institute (IFPRI). Maps of Accra, generously provided by San Diego State University, were produced in part by grant number R01 HD054906 from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) (“Health, Poverty and Place in Accra, Ghana,” John R. Weeks, Project Director/Principal Investigator). Additional funding was provided by Hewlett/PRB (“Reproductive and Overall Health Outcomes and Their Economic Consequences for Households in Accra, Ghana,” Allan G. Hill, Project Director/Principal Investigator). The 2003 Women's Health Study of Accra was funded by the World Health Organization, USAID, and the Fulbright New Century Scholars Award (Allan G. Hill, Principal Investigator). The Health and Welfare Study of Accra (HAWs) was funded in part by a grant from the Department of Economics, Harvard University. Finally, the authors would like to thank the Ghanaian enumerators and field manager who conducted the field surveys. The content is solely the responsibility of the authors and does not necessarily represent the official of the NICHD (or its parent organization the National Institutes of Health), PIM, IFPRI, CGIAR, or USAID.

Compliance with ethical standards

Conflict of interest The authors declared that they have no conflict of interest.

Informed consent Informed consent was obtained from all individual participants included in the study.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Akinboade, O. A., & Adeyefa, S. A. (2018). An analysis of variance of food security by its Main determinants among the urban poor in the City of Tshwane, South Africa. *Social Indicators Research*, 137(1), 61–82.
- Ayerakwa, H. M. (2017). Urban households' engagement in agriculture: Implications for household food security in Ghana's medium sized cities. *Geographical Research*, 55(2), 217–230.
- Ballard, T. J., Kepple, A. W., & Cafiero, C. (2013). *The food insecurity experience scale: Development of a global standard for monitoring hunger worldwide*. Rome: FAO.
- Battersby, J. (2012). Beyond the food desert: Finding ways to speak about urban food security in South Africa. *Geografiska Annaler: Series B, Human Geography*, 94(2), 141–159.
- Battersby, J. (2013). Hungry cities: A critical review of urban food security research in sub-Saharan African cities. *Geography Compass*, 7(7), 452–463.
- Battersby, J. (2017). MDGs to SDGs—new goals, same gaps: The continued absence of urban food security in the post-2015 global development agenda. *African Geographical Review*, 36(1), 115–129.
- Battersby, J., & Watson, V. (2018). Addressing food security in African cities. *Nature Sustainability*, 1(4), 153.
- Becquey, E., Martin-Prevel, Y., Traissac, P., Dembélé, B., Bambara, A., & Delpeuch, F. (2010). The household food insecurity access scale and an index-member dietary diversity score contribute valid and complementary information on household food insecurity in an urban west-African setting, 2. *The Journal of Nutrition*, 140(12), 2233–2240.
- Bigsten, A., Kebede, B., Shimeles, A., & Tadesse, M. (2003). Growth and poverty reduction in Ethiopia: Evidence from household panel surveys. *World Development*, 31(1), 87–106.
- Blekking, J., Tuholske, C., & Evans, T. (2017). Adaptive governance and market heterogeneity: An institutional analysis of an urban food system in sub-Saharan Africa. *Sustainability*, 9(12), 2191.
- Coates, J., Swindale, A., Bilinsky, P. (2007). Household food insecurity access scale (HFIAS) for measurement of household food access: Indicator guide (v. 3). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development, August 2007.
- FAO. (2008). An Introduction to the Basic Concepts of Food Security [Internet]. Retrieved May 24, 2018 from <http://www.fao.org/docrep/013/al936e/al936e00.pdf>
- FAO. (2016). *Street food vending in Accra, Ghana*. FAO: Accra.
- FAO. (2017). 2017 the state of food and agriculture: Leveraging food Systems for Inclusive Rural Transformation. FAO: Rome. Retrieved May 24, 2018 from <http://www.fao.org/3/a-17658e.pdf>
- Filmer, D., & Pritchett, L. H. (2001). Estimating wealth effects without expenditure data—Or tears: An application to educational enrollments in states of India. *Demography*, 38(1), 115–132.
- Frayne, B. et al. (2010). “The State of Urban Food Insecurity in Southern Africa.” Urban Food Security Series No. 2. Queen's University and AFSUN: Kingston and Cape Town.
- FSIN. (2018). Global Report on Food Crisis 2018. Retrieved July 31, 2018 from http://www.fao.org/fileadmin/user_upload/fsin/docs/global_report/2018/GRFC_2018_Full_report_EN.pdf
- Ghana Statistical Service (2012). 2010 population and housing census: Final results. Accra, Ghana.
- Ghana Statistical Service (2014). Ghana living standards survey round 6. Accra, Ghana.
- Ghana Statistical Service (GSS), Ghana Health Service (GHS), and ICF International. (2015). Ghana demographic and health survey 2014. Rockville, Maryland, USA: GSS, GHS, and ICF International.
- Haysom, G., & Tawodzera, G. (2018). “Measurement drives diagnosis and response”: Gaps in transferring food security assessment to the urban scale. *Food Policy*, 74, 117–125.
- Hollinger, F. & Staatz, J.M. (2015) Agricultural growth in West Africa market and policy drivers. African development Bank and food and agriculture organisation. Report, FAO, African Development Bank, Rome, Italy.
- IFPRI (2017). Survey of food retail outlets. Unpublished data.
- Jankowska, M. M., Weeks, J. R., & Engstrom, R. (2011). Do the most vulnerable people live in the worst slums? A spatial analysis of Accra, Ghana. *Annals of GIS*, 17(4), 221–235.
- Jayne, T. S., & Mason, N. M. (2009). Staple food consumption patterns in urban Zambia: Results from the 2007/2008 urban consumption survey.
- Jones, A. D., Ngure, F. M., Pelto, G., & Young, S. L. (2013). What are we assessing when we measure food security? A compendium and review of current metrics. *Advances in Nutrition*, 4(5), 481–505.
- Kimani-Murage, E. W., Schofield, L., Wekesah, F., Mohamed, S., Mberu, B., Ettarh, R., et al. (2014). Vulnerability to food insecurity in urban slums: Experiences from Nairobi, Kenya. *Journal of Urban Health*, 91(6), 1098–1113.
- Litschig, S., & Morrison, K. M. (2013). The impact of intergovernmental transfers on education outcomes and poverty reduction. *American Economic Journal: Applied Economics*, 5(4), 206–240.
- Long, J. S., & Freese, J. (2006). *Regression models for categorical dependent variables using Stata* (pp. 250–253). Stata press.
- Martin-Prevel, Y., Becquey, E., Tapsoba, S., Castan, F., Coulibaly, D., Fortin, S., ... & Savy, M. (2012). The 2008 food Price crisis negatively affected household food security and dietary diversity in urban Burkina Faso, 2. *The Journal of Nutrition*, 142(9), 1748–1755.
- Maxwell, D., Levin, C., Armar-Klemesu, M., Ruel, M., & Morris, S. (2000). Urban livelihoods and food and nutrition security in Greater Accra, Ghana. *Research report/International Food Policy Research Institute*; 112.
- Molini, V., & Pierella, P. (2015). *Poverty reduction in Ghana 2015: Progress and challenges*. Washington, DC: World Bank.
- Montello, D., and Sutton, P. (2013). An introduction to scientific research methods in geography 2ed. Sage.
- Mwin, D.O. (2017a April 22). Sustaining the Ghana School Feeding Programme - Providing equal opportunities and increasing enrolment. Graphic Online. Retrieved Aug. 16, 2018 from: <https://www.graphic.com.gh/features/opinion/sustaining-the-ghana-school-feeding-programme-providing-equal-opportunities-and-increasing-enrolment.html>
- Mwin, D.O. (2017b April 22). Sustaining the Ghana School Feeding Programme - Providing equal opportunities and increasing enrolment. Graphic Online. Retrieved Aug. 16, 2018 from: <https://www.graphic.com.gh/features/opinion/sustaining-the-ghana-school-feeding-programme-providing-equal-opportunities-and-increasing-enrolment.html>
- Popkin, B. M., Adair, L. S., & Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition Reviews*, 70(1), 3–21.
- Reardon, T., Timmer, C. P., Barrett, C. B., & Berdegue, J. (2003). The rise of supermarkets in Africa, Asia, and Latin America. *American Journal of Agricultural Economics*, 85(5), 1140–1146.
- Richards, P., Reardon, T., Tschirley, D., Jayne, T., Oehmke, J., & Atwood, D. (2016). Cities and the future of agriculture and food security: A policy and programmatic roundtable. *Food Security*, 8, 871–877.
- Rutstein, S. O., Johnson, K., & MEASURE, O. M. (2004). *The DHS wealth index*. ORC Macro, MEASURE DHS.
- Seto, K. C., & Ramankutty, N. (2016). Hidden linkages between urbanization and food systems. *Science*, 352(6288), 943–945.
- Tilak, J.B. (2007). Post-elementary education, poverty and development in India. *International Journal of Educational Development*, 27(4), 435–445.
- Traill, W. B. (2006). The rapid rise of supermarkets? *Development and Policy Review*, 24(2), 163–174.
- Tzioumis, E., & Adair, L. S. (2014). Childhood dual burden of under- and overnutrition in low- and middle-income countries: A critical review. *Food and Nutrition Bulletin*, 35(2), 230–243.
- UN DESA. (2018). World Urbanization Prospects 2018. Retrieved May 24, 2018 from <https://esa.un.org/unpd/wup/Download/>

- UN-Habitat. (2016). Slum Almanac 2015–2016. 2016. Retrieved May 25 from <https://unhabitat.org/slum-almanac-2015-2016/>
- UN-Habitat. (n.d.). Participatory Slum Upgrading Programme (PSUP). Phase II Project Concept Notes. Retrieved May 25, 2018 from http://www.worldurbancampaign.org/sites/default/files/phase_2_-_ghana.pdf
- Vaitla, B., Coates, J., Glaeser, L., Hillbruner, C., Biswal, P., & Maxwell, D. (2017). The measurement of household food security: Correlation and latent variable analysis of alternative indicators in a large multi-country dataset. *Food Policy*, 68(C), 193–205.
- Verpoorten, M., Arora, A., Stoop, N., & Swinnen, J. (2013). Self-reported food insecurity in Africa during the food price crisis. *Food Policy*, 39, 51–63.
- Weeks, J. R., Hill, A., Stow, D., Getis, A., & Fugate, D. (2007). Can we spot a neighborhood from the air? Defining neighborhood structure in Accra, Ghana. *GeoJournal*, 69(1–2), 9–22.
- Weeks, J. R., Getis, A., Stow, D. A., Hill, A. G., Rain, D., Engstrom, R., et al. (2012). Connecting the dots between health, poverty and place in Accra, Ghana. *Annals of the Association of American Geographers*, 102(5), 932–941.
- Wiesmann, D., Bassett, L., Benson, T., & Hoddinott, J. (2009). Validation of the world food Programme's food consumption score and alternative indicators of household food security. International food policy research institute: 2009.
- World Food Program (2008). FCS Technical Guidance 5 February 2008. Retrieved May 25 2018 from http://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp197216.pdf
- World Food Program. (2015). Consolidated Approach to Reporting Indicators of Food Security (CARI). United Nations World Food Programme, Food security analysis (VAM). Retrieved Sep. 19 2018 from https://documents.wfp.org/stellent/groups/public/documents/manual_guide_proced/wfp271449.pdf.



Cascade Tuholske is a PhD Candidate in the Department of Geography at the University of California, Santa Barbara. His research focuses on the converging challenges of climate change, urbanization, and food security in sub-Saharan Africa. Prior to graduate school, he studied International Affairs at The George Washington University, worked on Capitol Hill, organized grassroots lobbying in his native Montana, and taught English in four countries, including in

Bulgaria under a Fulbright Scholarship. He completed his Master's degree in Geography from the University of California, Santa Barbara in 2016 and was subsequently selected as a U.S. Borlaug Fellow in Global Food Security to fund his dissertation research.



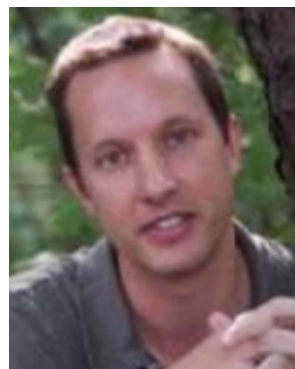
Dr. Kwam Andam is a research fellow with the Ghana Strategy Support Program in the Development Strategy and Governance Division. His research focus is currently on the competitiveness of livestock production and agro-processing in Ghana. Previously, he worked for the World Bank in Washington (2010–2014), leading an analytical study on rural development in Yemen and working on the Bank's lending operations in agriculture in Indonesia,

Mexico, Thailand, and Yemen. Prior to joining the World Bank, Kwam worked at IFPRI as a post-doctoral fellow in the Addis Ababa office (2008–2010). He holds a Bachelor's Degree in Civil Engineering from the Kwame Nkrumah University of Science and Technology, Ghana; a Master's Degree in Civil and Environmental engineering from the University of Vermont; a Master's Degree in Economics from Georgia State University; and a Doctorate in Public Policy from the Georgia Institute of Technology and Georgia State University.



Jordan Blekking is a PhD student in the Department of Geography at Indiana University. His primary research interest focuses on human-environmental interactions; specifically, the linkages between rural production and urban consumption and how this interplay affects urban food systems and food security in Southern Africa. Previously, Jordan received his Master's of Science degree, also from the Department of Geography at IU, where his thesis looked at the role of institutions

and governance on the availability and accessibility of hybrid maize seed for use by smallholder farmers in rural Zambia.



Prof. Tom Evans is a new faculty member at the Arizona University's School of Geography and Development (January 2018). His current work focuses primarily on agricultural decision-making, food security and environmental governance but have had past projects related to deforestation/reforestation, urban ecosystems, community resilience. His research generally involves some aspect of household-level analysis coupled with environmental data and

methodologically my projects usually involve use of spatial analysis, GIS, remote sensing and simulation modeling.



Prof. Kelly Caylor is Director of the Earth Research Institute and a Full Professor with appointments in the Bren School of Environmental Science & Management and the Department of Geography at the University of California, Santa Barbara. He received his PhD in Environmental Sciences from the University of Virginia, in 2003. His research seeks to develop improved insight into the way that land use and climate change are interacting to affect the dynamics and resilience

of global drylands. His primary research sites are in sub-Saharan Africa, where he is focused on understanding the vulnerability of pastoral and subsistence agricultural communities to current and future changes in hydrological dynamics.