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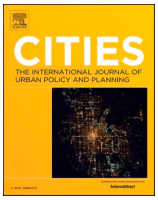

Persistence of open-air markets in the food systems of Africa's secondary cities

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ABSTRACT

In a rapidly urbanizing sub-Saharan Africa (SSA), changing urban food systems are expected to affect the ways in which households access food. While significant research and policy efforts address food production to support food security in the context of city-region food systems, the complex nature of urban food systems has received less attention, particularly in secondary cities across the globe. Using household survey data collected in 2019 across 4 cities in Kenya and 14 cities in Zambia, we examined patterns of household food acquisition from key food retail locations. Households predominantly purchased food from open-air markets and vendors, and only a subset of households bought food from supermarkets. Variations in urban population size, area, and connectivity across the 18 cities presented a clustering of four city types that shape household food access and purchasing patterns at food retail locations. Despite a growing narrative that supermarkets and western diets will dominate SSA's urban food systems, our findings suggest that low- to middle-income households will continue to purchase food at open-air markets in SSA's secondary cities in the coming years. Attention to these urban household purchasing patterns can inform urban planning and governance priorities to ensure that SSA's food systems can meet urban food security needs.

1. Introduction

Cities across the globe have grown rapidly in recent decades, especially in Asia and Africa. In sub-Saharan Africa (SSA), one billion people will be living in urban areas by 2050, which is a substantial increase from the region's current urban population of 350 million (UN-DESA, 2014). Although much of this urban growth has occurred in primary or mega-cities, such as Lagos in Nigeria or Cairo in Egypt, secondary cities now host a growing proportion of urban dwellers globally and represent an important component of the African urbanization process (Satterthwaite, 2017; Satterthwaite et al., 2010). Since definitions of secondary and tertiary cities can vary, we use the term 'secondary cities' in this paper to broadly encompass the range of tertiary and secondary urban areas with populations between 5000 and 500,000 people. Secondary cities comprise 26.5% of the world's overall population (Chai & Seto, 2019) and over half of the global *urban* population (Buettner, 2015).

Urban food systems planning becomes particularly crucial when considering these demographic forecasts in the coming decades (Béné et al., 2020; Kraemer et al., 2016). Food systems broadly encompass the interactions between and within the biogeophysical and human environments, where a suite of activities span food production to food consumption, including food processing, packaging, distribution, retail, and waste management (Ericksen, 2008). At the city scale, urban food systems comprise a hybrid mix of market and non-market food sourcing strategies, and formal and informal food retail environments (Battersby & Watson, 2018; Tefft et al., 2017). As urbanization increases, supermarkets across Africa, Asia, and Latin America are projected to increase in prevalence, particularly where there is growth in the number of moderate-income households (Pingali, 2007; Reardon et al., 2003; Reardon & Timmer, 2014).

A common narrative tied to urbanization and the rise of

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supermarkets suggests that supermarkets can offer products of consistent quality at low costs due to economies of scale. Some scholars have argued that these modern retailers may soon replace traditional food retail outlets in SSA, such as open-air markets and vendors, which is a trend that has occurred in Latin America and East and Southeast Asia (Balsevich et al., 2003; Reardon et al., 2005). However, much of the supermarket development that has occurred in SSA has taken place in larger cities and in specific countries, most notably in South Africa, Kenya, Zambia, and Zimbabwe (Reardon et al., 2003; Weatherspoon & Reardon, 2003). Yet, supermarkets may have less influence in secondary cities in SSA. For example, households in two secondary cities in Nigeria predominantly procure food through open-air markets and informal means (Resnick et al., 2019).

Understanding how and why urban residents obtain food from supermarkets, open-air markets, and other retail options is important for the study of food security in an urban planning context. Pursuing sustainable urban food systems as an urban planning strategy can facilitate urban food security, environmental security, and social welfare outcomes (Ericksen, 2008; Melesse et al., 2020). However, achieving this level of urban food systems sustainability will require integrated policies and urban planning initiatives based on empirical data and analyses of urban food systems (Battersby & Watson, 2019; Tacoli, 2019). One key motive for urban food systems planning and the study of urban food systems is to address growing challenges with urban food insecurity, which has been exacerbated by the COVID-19 pandemic and the associated economic crisis (Béné, 2020; Devereux et al., 2020; Moseley & Battersby, 2020). Food security exists "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 2009). Yet, the context and challenge of food security differs between rural and urban settings (Haysom & Tawodzera, 2018). For example, the Food and Agricultural Organization's (FAO) survey of 146 countries in 2014–2015 found that 50% of urban households in the least developed countries were food-insecure, compared with 43% in rural areas. The situation is even worse in informal urban settlements, with rates of food insecurity reaching 70–95% of the population (Tefft et al., 2017).

Yet, from an urban planning perspective, the problems of hunger and malnutrition in cities are often neglected relative to "more urgently visible problems" such as housing or sanitation (Maxwell, 1999). Low-income households also tend to employ diverse strategies to cope with food insecurity, which can render the urban food security problem invisible to local government officials (Battersby, 2017a; Maxwell, 1999). Moreover, local governments in smaller cities often do not have the resources and governance capacities needed to address urban food systems challenges (Sonnino et al., 2019). Mandates for addressing food security typically sit with the national departments that are responsible for ensuring that rural agricultural production meets the demands for food availability and supply. With this national focus, the challenges surrounding food access at the urban scale are often overlooked in food systems planning and governance (Battersby & Marshak, 2017; Crush & Frayne, 2010; Crush & Riley, 2018).

There is also a global need for studying urban food systems for urban planning purposes that is not just attributed to a set of cities or a region. International attention to urban food systems planning has thus far largely been partial, contingent, and, at times, poorly aligned to local realities. For instance, in a systematic survey of 170 Asian cities in 21 countries, Acharya et al. (2021) found that only 8% of cities intervene in their urban food systems in forward-looking, holistic, and inclusive ways. Moreover, due to a lack of food systems policy and governance, the majority of these cities are only in the early stages of developing urban planning policies, and many respond to urban food systems problems reactively (Acharya et al., 2021). In the SSA context, urban food systems planning has largely been shaped by a modernization agenda in which governments favor formal food retail, leading to tensions with the traditional and informal food sectors. For example, the removal of street vendors and the upgrading or relocation of open-air markets has caused conflict between vendors and local government authorities in cities in Zambia and Ghana (Asante, 2020; Asante & Helbrecht, 2019; Battersby & Muwowo, 2018).

While the Sustainable Development Goals (SDGs) include both "zero hunger" and "sustainable cities and communities" (Goals 2 and 11, respectively), neither has targets or indicators that explicitly address urban food systems (Battersby, 2017b; Crush et al., 2020). The United Nations' 2017 New Urban Agenda prioritizes food planning and governance dimensions that predominantly focus on regional scales and rural-urban linkages, but does not explicitly engage with the role that urban food systems planning can play in facilitating food security and nutrition in smaller cities (Battersby & Watson, 2019). These efforts fail to adequately reflect the challenges and realities of contemporary urban food systems and have paid little attention to spatial planning, retail logistics, and governance of the urban components of food systems (Battersby & Watson, 2019). Several translocal networks, such as the Milan Urban Food Policy Pact, C40 Cities, and ICLEI-Local Governments for Sustainability, are now directing the focus of local governments towards urban food systems (Moragues-Faus, 2021). However, few research initiatives have investigated how the structural dynamics of cities shape food provisioning and household food procurement patterns in urban areas (Milan Urban Food Policy Pact, 2015).

Our study contributes to this growing literature and global policy dialogue on urban food systems planning with an analysis of how household food purchasing patterns vary across different retail locations in SSA's secondary cities. A fundamental challenge experienced by urban governments in SSA and in developing countries globally is a lack of data and standardized methodologies for characterizing trends in urban food systems, which results in missed opportunities to articulate strategies for integrated urban food systems planning. Thus, with a large-N sample of urban households in Kenya and Zambia, we present the first multi-city analysis of urban food systems in secondary cities in SSA. This systematic data collection approach offers a baseline for understanding the nature of household acquisition of food in smaller cities more generally. The motive of our research is to promote the development of a standardized methodology that scholars and practitioners can use to study and compare urban food systems in cities of all sizes.

Our analysis also addresses a knowledge gap regarding how household-level food acquisition varies across cities, especially in SSA. While some analyses have found inter-city variation with respect to food consumption patterns and associated environmental impacts across nine large Indian cities (Boyer et al., 2019), less is known about how household-level food acquisition varies across urban food systems in secondary cities. By comparing household food acquisition across several cities, our quantitative, multi-city approach also complements the qualitative, case study-based approach of the Hungry Cities Partnership and the Africa Food Security Urban Network (Haysom & Fuseini, 2019). We categorized the secondary cities in our sample into four types based on their size and/or connectivity, namely: 1) smaller cities, 2) remote mid-sized cities, 3) connected mid-sized cities, and 4) larger cities. We then assessed the relationship between these secondary city types and the prevalence of household food purchases made at different food retailers, including open-air markets, vendors, local shops, and supermarkets.

Finally, we identified some reasons for why households in SSA's secondary cities purchase food from certain retailers over other retailers and discuss the household- and urban-scale factors that shape these behaviors. While scholars of urban food systems have tended to focus on the ultimate outcome of household-level food security, either measured with food insecurity indices (Blekking et al., 2020; Legwegoh & Riley, 2014; Tuholske et al., 2020) or biometric indicators (Demmler et al., 2017; Khonje et al., 2020), we take an alternative approach by identifying household- and city-level factors that explain where and why households tend to access food in an urban food system. We found that most households in our sample source their food from open-air markets.

Hence, we discuss the relative persistence of open-air markets in different types of secondary cities and the implications of this for urban food systems planning in SSA and globally.

2. Background: urban food systems

Understanding the nature and diversity of the urban food retail environment and household food sourcing strategies is important for dissecting the systemic challenges of urban food security and for developing urban planning strategies that support sustainable urban food systems. To begin, the urban food retail space is a critical component in the study of urban food systems, because urban households overwhelmingly purchase, rather than produce, their food (Crush et al., 2012; Haysom & Fuseini, 2019; Seto & Ramankutty, 2016; Smit, 2016). Major urban food retailers in SSA generally include open-air markets, street vendors, local shops, and supermarkets, and households typically obtain food from a mix of these retailers. For example, a household may buy vegetables from an open-air market, meat from a local butcher, and milk and bread from a supermarket. Restaurants and fast-food outlets can also play an increasing role in household food sourcing strategies in some cities. In other cities, households may supplement purchased food with food obtained from urban or peri-urban agriculture, food sharing and remittances, and civil society organizations (e.g., non-government organizations or religious groups).

One line of scholarly work on urban food systems has examined the tensions and competition between the traditional or informal food sectors (i.e. street vending, open-air markets, and locally owned shops, called 'Spazas' in South Africa), which have long dominated food retail in African cities, and the rise of formal shops, particularly large, modern supermarkets (Berger & van Helvoirt, 2018; Crush & Frayne, 2011; Owusu-Sekyere et al., 2016; Reardon et al., 2021). As supermarkets have increasingly spread throughout SSA (das Nair, 2020), they tend to be favored by urban governments over informal food retail because they bring in tax revenue and are thought to stimulate local economies (Skinner, 2016). These larger supermarkets are often envisioned as symbols of modernity, and are associated with cleanliness, quality, and economies of scale (Abrahams, 2009; Battersby, 2017a; Zhong et al., 2019).

Despite these purported benefits of supermarkets, their role in SSA's urban food systems has been met with some reproval by some local urban populations. For example, supermarkets tend to target wealthy consumers, which does little to alleviate food insecurity among the urban poor (Battersby, 2019; Battersby & Watson, 2018; Berger & van Helvoirt, 2018; Nickanor & Kazembe, 2017; Peyton et al., 2015). Supermarkets can create unfair competition with small, locally-owned shops as well as the informal sector as they are able to undercut prices, particularly when it comes to non-perishable food items but increasingly also for fresh produce (Minten et al., 2010; Minten & Reardon, 2008). This monopoly on non-perishable items has suggested that supermarket expansion is contributing to a transition in African cities towards a more westernized diet, which introduces greater risks of obesity and malnutrition due to higher consumption of low-nutrient, highly processed foods (Battersby, 2019; Battersby & Peyton, 2016; Demmler et al., 2017). This is especially true when households are located close to supermarkets and fast-food restaurants (Otterbach et al., 2021).

Beyond modern retail locations, the informal food retail economy continues to be a key source of household food procurement, particularly for low-income households (Giroux et al., 2020; Skinner, 2016). Several studies from SSA have found that a large proportion of the urban poor rely substantially on open-air markets to access food (White et al., 2018). For example, a survey of 11 southern African cities found that 70% of households frequently obtained food from open-air markets (Frayne et al., 2010). This may be attributed to the fact that many secondary cities in SSA have not yet seen the introduction of supermarkets, who naturally target areas with higher market densities and incomes for new store investments. However, even in SSA's larger sized secondary cities, open-air markets are an important food source for many households (Crush & Frayne, 2010; Smit, 2018).

Similar to studies of the 'supermarketization' trend in the Global South, urban agriculture has received significant attention in the urban food systems literature (De Zeeuw et al., 2011; Frayne et al., 2014; Prain & Lee-Smith, 2010; Thornton, 2020; Zezza & Tasciotti, 2010). Some benefits of urban agriculture include its contribution to household food consumption, income generation, urban greening, and social cohesion (Lee-Smith, 2010; Nkrumah, 2018; Thornbush, 2015; Toriro, 2018). Urban agriculture can also provide a buffer for households that are vulnerable to food insecurity in the event of economic stress or shocks (Lee-Smith, 2010; Nkrumah, 2018; Smart et al., 2015; Thornbush, 2015; Toriro, 2018). However, multiple barriers (e.g., available land, productive resources, and tenure security) prevent low-income households from engaging in urban agriculture in SSA (Davies et al., 2020).

Beyond the retail sector and urban agriculture, some urban households also have farm holdings outside of the city, which may be managed by themselves or by relatives (Cattaneo et al., 2021). Further rural-urban linkages of food acquisitions occur through cash remittances and food transfers between rural and urban households, where urban households can collect food produced in peri-urban and rural locations from familial or social connections (Crush & Caesar, 2017; Crush & Caesar, 2018; Crush & Ceasar, 2020; Mabrouk & Mekni, 2018). Food transfers play a particularly important role in contributing to food supply among migrant households (Frayne & Crush, 2017; Tawodzera & Crush, 2016), and social networks can be a crucial strategy for improving food security within urban communities (Claasen & Lemke, 2019). The urban food system shapes the culmination of these household food acquisition strategies that range from retail food purchases to urban agriculture to food transfers. Key attention to the study of the nature of how urban residents navigate these urban food systems across cities is warranted for urban food systems planning.

3. Materials & methods

3.1. Research setting

We conducted our study in 18 secondary cities in Kenya and Zambia (Fig. 1). Situated on the coast of eastern Africa, Kenya has a population of approximately 52 million, with 27% of people living in urban areas. Zambia, in contrast, is a landlocked country with a population of nearly 18 million and roughly 45% of people living in urban areas (World Bank, 2020). Agriculture and livestock dominate livelihoods in both countries (FEWSNET, 2011; FEWSNET, 2014), and rural-urban and urban-urban food transfers are common, especially among households most vulnerable to food insecurity (Andersson Djurfeldt, 2015; Frayne, 2010).

Studying urban food systems across secondary cities in Kenya and Zambia presents an opportunity to compare how households are navigating urban food systems in two SSA countries that have undergone various urban food system transformations. For example, Karatina in Kenya is home to one of the largest open-air markets in Central and East Africa, serving as a central node in facilitating economic exchange between urban and rural areas, and as a crossroad for trade across the entire region (Mbataru, 2017). Retail modernization in Kenya has been viewed as a market tool to combat food insecurity. However, the promotion of supermarket development at the expense of existing open-air markets has been challenged for primarily serving higher-income consumers (Berger & van Helvoirt, 2018). While traditional markets and informal traders remain the main sources of fresh produce, some scholars have observed that the development of supermarkets in Kenyan cities has led to a nutrition transition, as households are more readily able to buy packaged and processed food (Battersby & Watson, 2018; Opiyo & Agong, 2020).

Secondary cities form important transportation and market links between local agricultural producers and urban consumers. However,

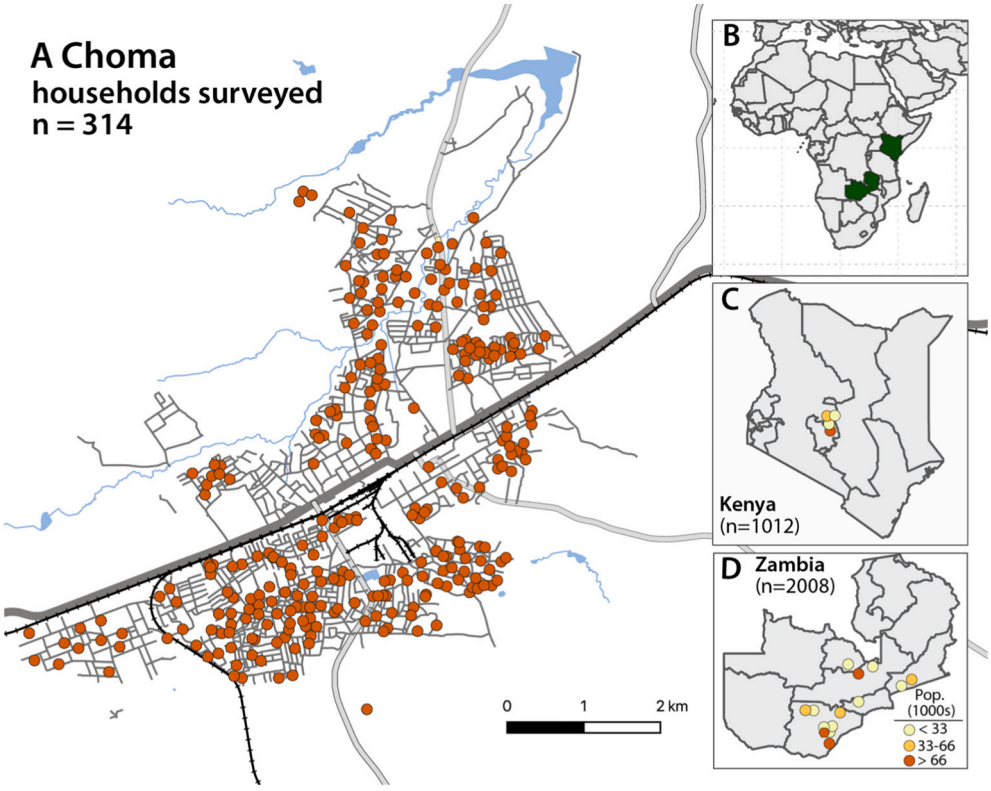

Fig. 1. Study site locations in Kenya and Zambia with an example presentation from Choma, Zambia, of how households were sampled across residential areas in each city.

Zambia relies more heavily on these in-country food flows, importing fewer food products (i.e., 7% of merchandise products in 2019) compared to Kenya (i.e., 15% of merchandise products in 2019) (World Bank, 2020). Zambia has also been transitioning to a more formalized approach to urban food systems governance by banning informal street trading and attempting to confine street vendors to open-air markets (Blekking et al., 2017). However, street vendors continue to play an important role in helping to overcome spatial disparities in food access and sourcing (Blekking et al., 2017; Giroux et al., 2020).

3.2. Household data collection

Our dataset consists of 3020 household surveys that were conducted in four Kenyan cities (n = 1012) and 14 Zambian cities (n = 2008) from May to August 2019, in partnership with Mpala Research Centre in Kenya and the Zambia Agriculture Research Institute in Zambia. The four cities in Central Kenya included Nanyuki, Karatina, Timau, and Naro Moru. The fourteen cities in Zambia include Batoka, Choma, Chongwe, Itezhi-Tezhi, Kapiri Mposhi, Maamba, Mazabuka, Mbabala, Mkushi, Mpongwe, Namwala, Nyimba, Pemba, and Petauke. We sampled more cities in Zambia than Kenya because the size of our field teams differed in the two countries. However, our selection of towns in both Kenya and Zambia constituted a census of towns for the regions sampled. In Kenya, we sampled within one region on the west side of Mt. Kenya, and in Zambia, we sampled across the Southern, Eastern, Central, and Copperbelt Provinces. Local enumerators who were fluent in local languages administered the survey using tablet computers. We obtained permission from municipal-level authorities and community leaders in both countries to conduct research activities in each urban area. We also obtained Institutional Review Board approval from the first author's home institution to conduct human subjects-based research via household surveys in Kenya and Zambia.

The survey included questions about where the respondent's household spends the greatest proportion of their food budget, what types of food are purchased from these retailers, how much money was spent across all retail locations in the past week, and how often their household purchased food at these retail locations in the past two weeks. Responses for currencies were recorded in Kenyan Shillings and Zambian Kwacha, and then converted into USD based on the currency exchange rate at the time of data collection in 2019. We included an additional subset of questions aimed at understanding how households were embedded in the broader food system. These questions included the number of times a household obtained food from a rural source in the past year, the distance to the location where they purchase the most food, whether they were a recipient of food remittances from a rural or an urban source, whether they engaged in urban agriculture, and whether they owned a farm outside of the city.

We sampled secondary cities in each country, using the Global Human Settlement Population (GHS-POP) dataset for reference (Schiavina et al., 2019). We selected cities within our study sites that have populations ranging from 5000 to 200,000 people, which represents smaller secondary cities according to our definition. We focus on these smaller secondary cities, because nearly half of Africa's urban population is concentrated in urban settlements with fewer than 300,000 inhabitants (United Nations and Social Affairs, 2018). Setting our upper sampling threshold at 200,000 people allows us to systematically focus on the nature of food systems in these smaller secondary cities, where little to no empirical data collection has been pursued, especially across multiple cities.

We also selected cities that represent the closest market town for surrounding rural communities. In the field, we opportunistically surveyed additional towns not represented in the GHS-POP dataset. These ranged from micro-urban places of less than 1000 households (i.e., approximately 5000 people) up to secondary towns that are regional centers of commerce. Some of these cities also serve as administrative decision-making centers, providing governance oversight for the local

administrative units of counties in Kenya and districts in Zambia. Within each city, we sampled households in low- to middle-income residential areas to capture the characteristics of households that are most at risk of experiencing food insecurity. Most sampled cities did not have large wealthy residential areas that are typical of primary cities (e.g., Nairobi, Kenya and Lusaka, Zambia). Although moderate sized urban areas (with populations of 100,000+) had some stratification of residential areas by income, these wealthier areas make up a small proportion of the total population.

Finally, we used a systematic random sampling approach in each residential area to select households. We used a combination of satellite imagery on GPS-enabled tablet computers and guidance from research partners to sample households along roads. We skipped a set number of households relative to the size of the sampling area to ensure a representative and spatially distributed sample within each residential area. Apartment buildings located in the central business districts in Kenyan urban areas were treated similarly. We estimated the number of households living in one apartment complex, chose a random starting point and then surveyed every three to five apartments, depending on the size of the apartment complex. If an enumerator arrived at a house or apartment with no available or eligible respondent, then the enumerator continued to each successive house until they were able to successfully conduct a survey, and then again followed the procedure of skipping three to five households. In most residential areas the number of surveys conducted ranged from five to thirty, depending on the size and density of the residential area. For example, some smaller cities essentially had only one residential area. This yielded a sample size of 30 to 300 households sampled in each town. This data collection approach allowed for a spatially stratified random sample within the residential areas to get a spatially represented sample of households, where the household numbers sampled are estimated as proportional to city size.

3.3. City-level data

To understand how city-level characteristics (namely urban area, high density area, and connectivity) shape urban food systems and household food purchasing patterns in secondary cities, we incorporated additional city-level data from secondary geospatial datasets into our analyses. Following Tuholske et al. (2019), we derived urban area and population density using a two-step approach for 12 of the 18 cities. First, for each city, we overlaid urban area polygons derived from OpenStreetMap (OSM) with the 2015 GHS-POP gridded population database (Haklay & Weber, 2008; Schiavina et al., 2019). Then, we selected all grid cells that intersected with the OSM data with a population density exceeding 1500 people per km^2. Adjacent grid cells with population density values greater than 300 people per km^2 were added to the initial grid cell selection to account for suburban and peri-urban areas. These combined grid cells created an urban footprint for each city to represent the urban area in km^2. We approximated population density with a high density area variable by summing the number of pixels associated with the GHS-POP dataset for the year of 2015 in the urban footprint. OSM data was unavailable for six of the cities in our sample. Hence, we manually digitized the urban area extent in these cities based on satellite imagery and field notes to create the urban footprint, which was then used to generate the variables for urban area and high density area.

To approximate the connectivity of a city, we derived two proximity measures from the open-source gROADS database (CIESIN & ITOS, 2013): 1) the distance from the city to the closest main road, and 2) the average road distance from the centroid of the city to the centroids of the three closest urban centers. The neighboring urban centers came from a database of urban areas ranging from secondary cities to large primary cities across SSA (Zimmer et al., 2020).

3.4. Analytical approach

To address the research questions of where and why urban households in SSA shop at certain food retailers, we presented a series of quantitative analyses from the survey data. We supplemented these survey data with open-ended responses and observations from the field to clarify and contextualize our findings. Following common principles and practices in mixed-methods analysis (Fetters et al., 2013), we integrated these different types of information to elucidate coherence in the trends we identified in our findings.

We first presented descriptive statistics to illustrate where households across different cities in Zambia and Kenya purchase food, what types of commodities are purchased at food retail locations, and how often households purchase these commodities. Then, using a hierarchical cluster analysis, we identified four city types based on city size and connectivity. We used these city types to identify household characteristics that are associated with food purchasing patterns at food retail locations. We performed an additional set of regressions to examine where households spent most of their food expenditures relative to where they have recently purchased food. This allowed us to gauge which food retail locations are likely substitutes or complements to one another. We concluded our analysis with results that provide further insight for why households shop at specific retail locations. We presented information regarding household perceptions of retail locations, the relative demand for a retail location based on a willingness to pay exercise, and household preferences for food products with a hypothetical increase and decrease in food expenditures. The culmination of these findings provides a greater understanding for how households in SSA's secondary cities navigate their urban food systems.

4. Analysis & results

4.1. Overall trends

First, we asked household respondents to specify where their household typically spends the most money (i.e., the largest proportion of their food expenditure budget) on food purchases. Options in the survey included open-air markets, street vendors, local shops, supermarkets, or other locations (e.g., wholesale retailers, directly from farmers). Open-air markets are designated centers where traders sell goods to consumers. Municipal councils often oversee and regulate these markets via collection of daily levies, and many markets use formal governing mechanisms, such as a constitution or by-laws, to organize market activities. Vendors are the individuals who sell goods on tarps or makeshift kiosks alongside streets or roadsides. In contrast to open-air markets, vendor activities are largely unregulated by an external authority. Local shops are independently owned and operated retail locations that may be situated in a small, designated retail space in a city's central business district, a residential neighborhood, or directly attached to a household. Supermarkets are large, commercial, transnational, or regional chain outlets such as Shoprite, Choppies, Nakumatt, or Ukwala.

Across all cities, food purchases made at open-air markets and vendors dominated household-level purchases in terms of food expenditures (Fig. 2). Kenyan household respondents reported spending the most money on food at vendors (30%), open-air markets (28% of respondents), supermarkets (22%), and local shops (11%). In comparison, most household respondents in Zambia spend the most money on food purchases at open-air markets (78% of respondents), followed by local shops (12%), vendors (5%), and supermarkets (4%). Example locations in the “Other” category included wholesale markets, canteens, restaurants, prepared street food, mobile sellers, and traders.

Food purchasing patterns also varied by city size (Fig. 2), which we've approximated using a measure of high density area (i.e., the number of pixels in a city with population densities exceeding 1500 people per km^2 in combination with adjacent pixels of 300 people per km^2 to account for suburban and peri-urban areas). Households in larger

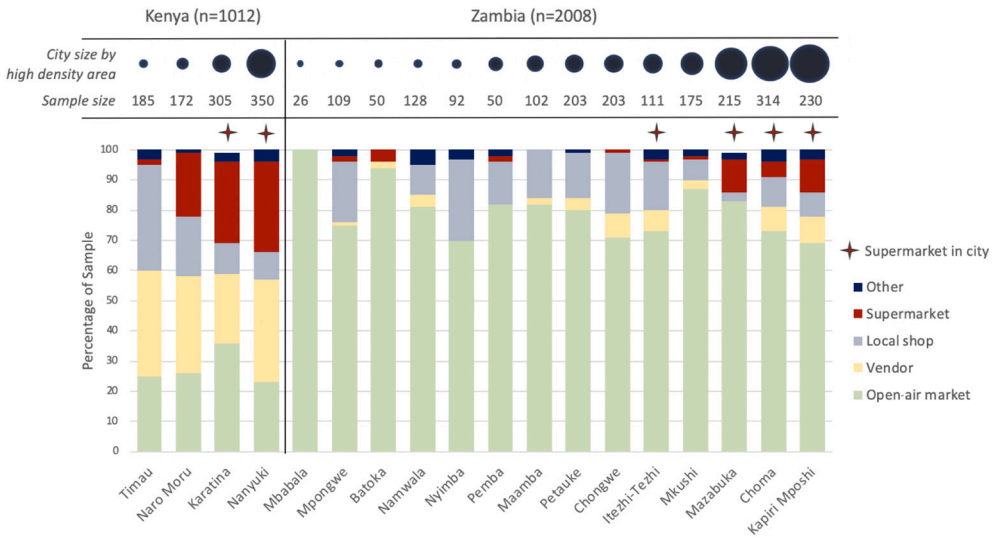

Fig. 2. Food retail locations where household respondents spend the most money on food purchases by city in Kenya and Zambia. Although we did not scale our sample size directly to the city size (i.e., high density area) in our sampling design, the number of sampled households is generally larger in cities that are larger in population. Cities with one or more operating supermarkets at the time of data collection are noted with a starred symbol, and we assume that each city has one or more open-air markets alongside several vendors and local shops.

cities spent the most money at supermarkets compared to households in smaller cities. Some smaller cities did not have any supermarkets, which may also explain why a high number of households in these cities purchased food at open-air markets and local shops.

The location of household food purchases also varied by commodity. As shown in Fig. 3A, respondents in Kenya primarily shop at open-air markets for vegetables and fruits, but purchase maize, meat, and fish at local shops. While some respondents in Zambia also use local shops for their maize, meat, and fish purchases, many respondents purchase all food commodities at open-air markets. Fig. 3B illustrates that most households in both Kenya and Zambia purchase vegetables frequently over the course of the month. Conversely, respondents in both countries

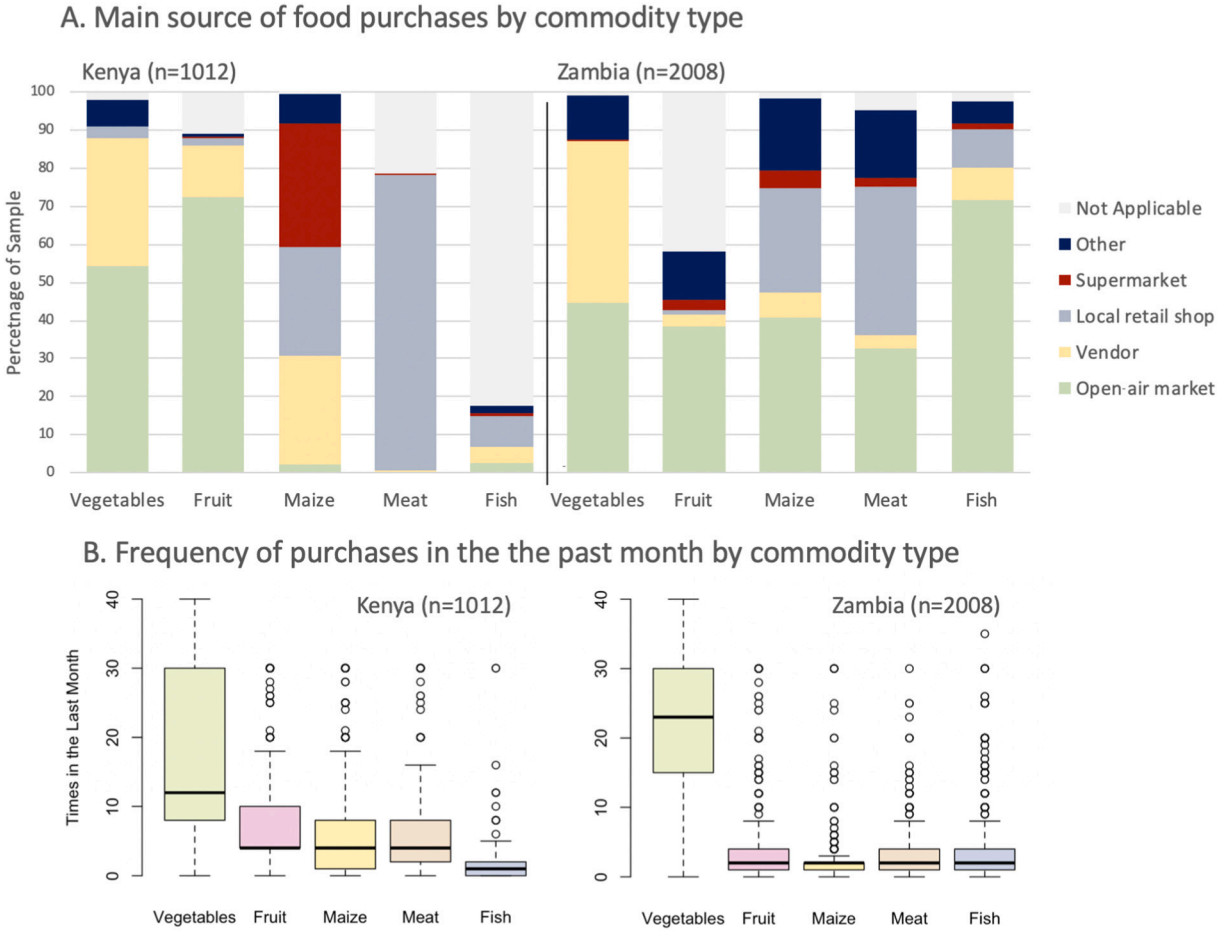

Fig. 3. Country-level plots for (A) the retail locations where households most often purchase different food commodities (i.e., vegetables, fruit, maize, meat, and fish) and (B) how many times households purchased these food commodities in the past month. 'Not Applicable' refers to households who do not purchase those products.

reported purchasing fruit, maize, meat, and fish less than ten times per month (Fig. 3).

Several factors may contribute to the greater proportion of households in Kenya purchasing maize meal in supermarkets. Kenya has a more developed retail sector than Zambia both in terms of supply chain networks and formal food retailers (supermarkets and retail shops). On average urban households in Kenya also have higher income levels than households in Zambia. Households that have the financial means buy maize in large quantities because the price per kilogram is lower than when purchasing in smaller quantities. In both countries, large quantity bags of maize meal are more available in supermarkets, whereas vendors at open-air markets and local shops typically sell a wider range of sizes of maize meal, ranging from 2 kg to 25 kg to accommodate the range of income earners. Since Zambia has a greater proportion of lower income households, there is a greater proportion of households that purchase maize meal more frequently in smaller quantities from open-air markets.

4.2. Understanding food system trends by city type

Secondary cities are often described as the intermediate urban agglomerations located along a gradient from rural villages to large primary cities (Andreasen et al., 2017; Vernon Henderson & Kriticos, 2018). However, we found diversity across different types of secondary cities. To explore this diversity by city type, we performed a hierarchical clustering analysis of our 18 cities and then explored whether those clusters correlate with household food purchasing patterns. We identified four unique city clusters based on four variables that capture: (1) city area, (2) high density area, and connectivity, which was measured by (3) distance to the main road, and (4) average distance to the three closest cities (Table 1). The combination of these four variables explains 86% of the variation in the cluster types. Appendix A in the Supplementary Materials provides a full description of the methods that we used in the clustering analysis.

Cities in the first cluster were small in geographic size and urban area density, within walking distance to the main road, and are well connected to other urban areas. Cities in the second cluster were of moderate geographical size and population density, however they were limited in their connectivity to other cities and the main road. Cities in the second and third cluster shared many similarities regarding geographical area and population size, however cities in the third cluster had better access to the main roads. Cities in the fourth cluster were densely populated cities close to the main road and were within average driving distance to the three nearest cities.

Consumer shopping patterns varied by city cluster type (Table 1, Fig. 4). Across all city cluster types in both countries, households spent a higher amount of money at supermarkets than other food retail locations, even though frequencies of purchases made at supermarkets were significantly less (Table 1). We found that in Kenya, a higher percentage of households in larger cities (City Cluster Type 4) purchased food from supermarkets than in smaller cities (City Cluster Type 1), with a relatively similar percentage of households purchasing from vendors and open-air markets in these two cluster types. In Zambia, a higher percentage of consumers residing in smaller cities (City Cluster Type 1) purchased food from open-air markets compared to households in the other three city types. Similarly, the proportion of households in disconnected cities and cities close to the main road (City Cluster Types 2 and 3) purchased food primarily from open-air markets, followed by local shops and vendors. A higher percentage of our sample spent the most of their food expenditures at supermarkets in Zambia's largest cities compared to other city types, but even so this percentage was nominal relative to the proportion of households purchasing food at open-air markets. The largest percentage of consumers spending money in local shops were in Kenya's small, connected cities (City Cluster Type 1) and Zambia's mid-sized cities, and the largest percentage of consumers spending money in supermarkets were in large densely populated cities (City Cluster Type 4).

For some cities that do not have a supermarket, some households indicated that they nevertheless made purchases at a supermarket (Table 1). While enumerators were trained to use the term “supermarkets” for large, commercial, transnational, or regional chain outlets, survey respondents held a variety of perceived notions regarding what constitutes a supermarket. For example, only six of our sampled 18 cities had at least one supermarket, as per our definition thereof. Yet one or more households in 16 of the 18 cities reported that there indeed was a supermarket in their city. These definitions of supermarkets among residents are subjective, and purchases made at a so-called “supermarket” could have included any formal food retail store ranging from a locally owned mid-sized outlet to a large-scale commercial supermarket. An additional reason for these incongruencies may be attributed to cases whereby a smaller city is located near to a larger city with relatively easier access to a supermarket, such as in the case of Batoka, which is close to Choma in Zambia.

4.3. Household characteristics related to food purchasing behaviors

To explore why households frequented open-air markets more often than other food retailers, we regressed a range of household characteristics on the type of retail location where households in each country spent the most money on food purchases. Bigsten et al. (2003) and Demeke et al. (2011) adopted similar approaches to identify features of households that correlate with poverty and food insecurity. At the city-level, environmental factors that influence food choices include variation in food prices by geography, store type, or nutritional quality of food items. Additional disparities exist in the ability of consumers to access food outlets that sell healthier options such as fruits and vegetables, and which are also located along public transportation routes (Caswell et al., 2013). Our approach offers another perspective by focusing on household food procurement patterns with respect to both retail and non-retail sources in the urban food system.

Our dependent variable for all regressions was the categorical variable of the locations where households spend the most money on food purchases (Fig. 2). We estimate two sets of regression models. The first set correlates where households generally spend the most money relative to the frequency of their food purchases at other food retail locations in the last two weeks. The second set of regression models identify how independent household characteristics are related to where households spend most of their money on food purchases. Since open-air markets were the predominant food retail location where households purchase food, we performed a multinomial logit model with open-air markets as the reference category. This approach allows us to understand why households would purchase food at vendors, local shops, supermarkets, and other food retail locations relative to open-air markets. We then developed a logistic regression model to understand why households would shop at open-air markets relative to all other food retail locations.

Since 93% of households in Kenya and 79% of households in Zambia purchase food at more than one type of food retailer, we first explored which retail types are substitutes or complements to one another. The first set of models serves as a correlation analysis to assess how likely households would be to spend most of their food budget at a given location relative to the frequency of purchases at other food retail locations (Table 2). From both the logistic and multinomial models in Kenya and Zambia, we find that households are significantly less likely to spend most of their money at other food retail locations if they have frequently purchased food at open-air markets in the past two weeks. Additionally, households in both Kenya and Zambia were significantly less likely to go to local shops than open-air markets if they had frequently purchased food at vendors in the past two weeks – a result that suggests local shops and vendors may be substitutes. Moreover, households who purchased food at local shops in the past two weeks were also more likely to spend most of their money at both local shops and supermarkets relative to open-air markets and vendors, suggesting that a subset of our sample size tended to purchase food more regularly

Table 1
Aggregated descriptive statistics for the four city cluster types based on the four variables that define the city cluster types (i.e., city area, urban area density, distance to a main road, and the average distance to the closest three urban centers). We also included variables that describe the food system from our survey data and estimated population sizes of these cities from the 2018 LandScan gridded population dataset. Cities with an asterisk have at least one supermarket.

City Cluster Type 1 (n = 485) – smaller cities Timau, Naro Moru, Mbabala, Batoka, Pemba	Min	Max	Mean	Median	Std. dev.
City area (sq. km)	0.82	3.51	2.29	2.32	0.96
High density area (number of pixels)	4	18	9.6	7	5.77
Distance to main road (km)	0.7	29.36	9.2	1.46	12.49
Avg. distance to next three cities (km)	22.16	39.72	28.88	24.33	8.34
Estimated population from LandScan 2018	231	2670	1384.4	1075	1169.95
Food expenditures in the past week (USD) – all retail locations					
Open-air market	0	49.02	6.03	3.92	6.9
Vendor	0	53.92	3.62	1.96	5.34
Local shop	0	58.82	3.41	1.54	6.49
Supermarket	0	186.27	2.35	0	10.85
Number of food purchases in the past two weeks					
Open-air market	0	14	7.71	4	5.21
Vendor	0	14	7.64	7	5.89
Local shop	0	14	3.16	2	4
Supermarket	0	14	0.46	0	1.67

City Cluster Type 2 (n = 450) – remote mid-sized cities Mpongwe, Namwala, Maamba, Itezhi-Tezhi*	Min	Max	Mean	Median	Std. dev.
City area (sq. km)	3.77	8.72	6.31	6.37	2.02
High density area (number of pixels)	5	34	17.25	15	13.77
Distance to main road (km)	42.69	88.74	70.71	75.7	22
Avg. distance to next three cities (km)	79.07	130.77	96.63	88.33	23.19
Estimated population from LandScan 2018	1122	4966	3807.25	4570.5	1826.19
Food expenditures in the past week (USD) – all retail locations					
Open-air market	0	76.92	6.67	3.85	9.01
Vendor	0	9.23	0.51	0	1.12
Local shop	0	30.77	2.2	0.77	3.57
Supermarket	0	115.38	0.45	0	5.96
Number of food purchases in the past two weeks					
Open-air market	0	14	6.58	5	4.99
Vendor	0	14	1.89	0	3.59
Local shop	0	14	2.07	1	2.97
Supermarket	0	2	0.04	0	0.24

City Cluster Type 3 (n = 675) – connected mid-sized cities Nyimba, Petauke, Chongwe, Mkushi	Min	Max	Mean	Median	Std. dev.
City area (sq. km)	6.1	14.44	11.7	13.13	3.86
High density area (number of pixels)	8	45	28.5	30.5	15.29
Distance to main road (km)	0.27	13.64	5.7	4.43	5.82
Avg. distance to next three cities (km)	59.64	124.39	86.28	80.55	27.72
Estimated population from LandScan 2018	900	8170	4229.25	3923.5	3188.36
Food expenditures in the past week (USD) – all retail locations					
Open-air market	0	115.38	5.51	3.85	5.96
Vendor	0	15.38	0.94	0	1.54
Local shop	0	46.15	2.49	1.15	4.29
Supermarket	0	15.38	0.07	0	0.88
Number of food purchases in the past two weeks					
Open-air market	0	14	4.99	4	4.09
Vendor	0	14	2.78	1	4.05
Local shop	0	14	1.96	1	2.78
Supermarket	0	5	0.02	0	0.01

City Cluster Type 4 (n = 1417) – larger cities Karatina*, Nanyuki*, Choma*, Kapiri Mposhi*, Mazabuka*	Min	Max	Mean	Median	Std. dev.
City area (sq. km)	4.16	23.55	15.2	15.21	7.28
High density area (number of pixels)	29	137	89.2	91	41.51
Distance to main road (km)	0.89	16.11	8.33	4.43	5.82
Avg. distance to next three cities (km)	20.7	89.45	43.72	29.75	27.69
Estimated population from LandScan 2018	13,107	56,902	27,467.6	20,841	17,576
Food expenditures in the past week (USD) – all retail locations					
Open-air market	0	98.04	6.13	3.92	7.47
Vendor	0	44.12	3.07	1.15	4.95
Local shop	0	68.63	3.29	1.76	5.35
Supermarket	0	98.04	4.92	0	10.92
Number of food purchases in the past two weeks					
Open-air market	0	14	4.71	3	4.53
Vendor	0	14	6.19	4	5.97
Local shop	0	14	3.33	2	4.2
Supermarket	0	14	1.1	0	2.27

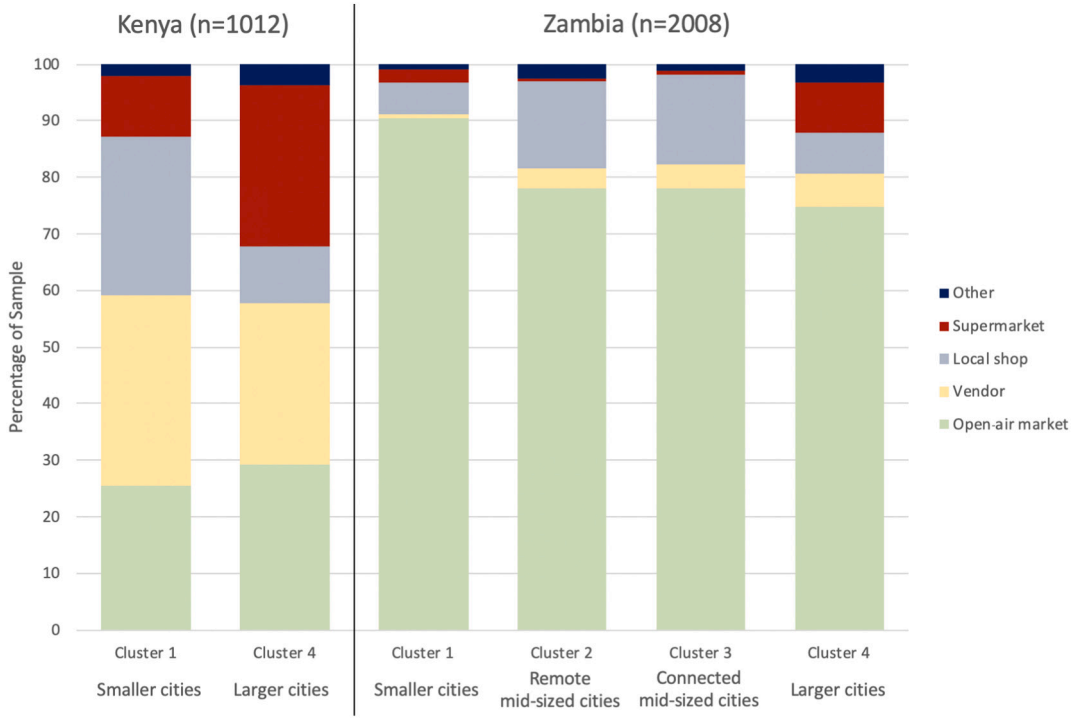

Fig. 4. Food retail locations where household respondents spend the most money on food purchases (i.e., the largest portion of their food expenditure budget) by city cluster type in Kenya and Zambia.

Table 2
Endogenous multinomial logit with open-air markets as the reference category and logit model comparing open-air markets to all other categories. Relative risk ratios are presented with the significance values and standard errors are shown in parentheses. Holding all other variables constant, risk ratios greater than one indicate that households are more likely to shop at a given food retail location relative to the reference location (i.e., all other locations in the logistic regression model and open-air markets in the multinomial logit model). Conversely, risk ratios less than one suggest that households are less likely to purchase food at a given food retail location. Risk ratio coefficients that are higher or lower than one indicate a stronger degree of risk or likelihood in either direction.

Dependent variable	Kenya					Zambia				
Percent of sampled households spending the most money	Open-air market	Vendor	Local shop	Supermarket	Other	Open-air market	Vendor	Local shop	Supermarket	Other
	28	30	16	22	3	78	5	12	4	2
	Logistic	Multinomial logit				Logistic	Multinomial logit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Open-air market purchases in past two weeks	1.109***	0.890***	0.882***	0.916***	0.909*	1.194***	0.530***	0.894***	0.740***	0.858***
	(0.016)	(0.021)	(0.030)	(0.021)	(0.050)	(0.017)	(0.082)	(0.019)	(0.055)	(0.041)
Vendor purchases in past two weeks	0.980	1.155***	0.922***	0.975	0.950	1.005	1.202***	0.884***	0.921*	0.922
	(0.013)	(0.020)	(0.020)	(0.016)	(0.032)	(0.016)	(0.024)	(0.027)	(0.048)	(0.050)
Local shop purchases in past two weeks	0.951***	0.938**	1.239***	1.063***	1.015	0.805***	1.019	1.304***	1.060	1.264***
	(0.018)	(0.026)	(0.025)	(0.022)	(0.049)	(0.020)	(0.050)	(0.022)	(0.059)	(0.040)
Supermarket purchases in past two weeks	1.006	0.615***	0.525***	1.162***	1.002	0.738***	0.489**	1.100	2.120***	1.197
	(0.033)	(0.092)	(0.129)	(0.040)	(0.101)	(0.045)	(0.345)	(0.084)	(0.079)	(0.147)
Constant	0.371***	0.603**	0.805	0.936	0.247***	2.576***	0.177***	0.178***	0.087***	0.041***
	(0.169)	(0.253)	(0.245)	(0.201)	(0.381)	(0.099)	(0.209)	(0.130)	(0.228)	(0.264)
Observations	970					1883				
Log Likelihood	−554					−879				
Akaike Inf. Crit.	1118	2395	2395	2395	2395	1767	2473	2473	2473	2473

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

at formal retail locations.

In the second set of regression models (Table 3), we included household-level variables that are likely determinants of where people spend most of their money on food purchases (Caswell et al., 2013). The variables are summarized in Appendix B. To test the model's robustness, we included several household-level demographic characteristics, namely: household size (number of members), household density (people per room), tenure status (owning or renting), whether the household was headed by a female, and monthly transportation expenditure, but our results remained unchanged. We also included interactions with the household characteristics and city clusters, but our results remained qualitatively unchanged. Hence, our final model includes the city clusters as binary control variables with the largest cities (i.e., cluster four) as the reference city for which to interpret how

Table 3
Multinomial and logistic regression models to assess the relationship of household characteristics and household urban food systems independent variables with the dependent variable of which food retail location households spend the most money on food purchases. Relative risk ratios are presented with the significance values and standard errors are shown in parentheses. Holding all other variables constant, risk ratios greater than one indicate that households are more likely to shop at a given food retail location relative to the reference location (i.e., all other locations in the logistic regression model and open-air markets in the multinomial logit model). Conversely, risk ratios less than one suggest that households are less likely to purchase food at a given food retail location. Higher or lower risk ratio coefficients from one indicate a stronger degree of risk or likelihood in either direction.

Dependent variable	Kenya					Zambia				
Percent of sample spending the largest proportion of their budget at retail locations	Open-air market	Vendor	Local shop	Supermarket	Other	Open-air market	Vendor	Local shop	Supermarket	Other
	28	30	16	22	3	78	5	12	4	2
	Logistic	Multinomial logit				Logistic	Multinomial logit			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Recipient of food from an urban source in past year (1 = yes, 0 = no)	1.739***	0.750	0.295***	0.596**	0.415*	0.550***	1.080	2.290***	2.567***	1.541
	(0.178)	(0.209)	(0.296)	(0.239)	(0.517)	(0.120)	(0.253)	(0.157)	(0.299)	(0.329)
Recipient of food from a rural source in past year (1 = yes, 0 = no)	0.883	1.423	0.635*	1.200	1.144	1.440**	1.119	0.678**	0.475*	0.638
	(0.184)	(0.217)	(0.274)	(0.237)	(0.474)	(0.148)	(0.295)	(0.190)	(0.412)	(0.431)
Engaged in urban agriculture (1 = yes, 0 = no)	0.969	0.864	1.027	1.268	0.749	1.300**	1.273	0.638**	0.589*	0.921
	(0.187)	(0.226)	(0.263)	(0.244)	(0.543)	(0.127)	(0.251)	(0.175)	(0.294)	(0.340)
Farm owner outside of city (1 = yes, 0 = no)	1.065	0.706	1.395	0.953	1.538	1.634***	1.107	0.431***	0.495*	1.215
	(0.184)	(0.229)	(0.267)	(0.240)	(0.464)	(0.155)	(0.309)	(0.214)	(0.392)	(0.389)
Rural food sourcing in past year (no. of events)	1.096***	0.942	0.842***	0.920*	0.876	0.876***	0.905	1.258***	0.888	1.123
	(0.035)	(0.043)	(0.064)	(0.045)	(0.106)	(0.041)	(0.128)	(0.047)	(0.154)	(0.103)
Assets index (scale of 1–4)	1.259***	0.709***	0.709***	1.134	0.689**	0.917**	0.725***	1.200***	1.475***	0.879
	(0.076)	(0.086)	(0.102)	(0.109)	(0.183)	(0.042)	(0.103)	(0.054)	(0.119)	(0.119)
Log of income (USD)	0.925	0.868	0.994	1.516***	1.207	0.729***	0.719***	1.423***	2.975***	1.275
	(0.072)	(0.088)	(0.108)	(0.102)	(0.195)	(0.057)	(0.119)	(0.076)	(0.150)	(0.161)
Other income recipient (1 = yes, 0 = no)	1.489**	0.722	0.642*	0.610**	0.781	0.784*	0.665	1.445**	2.209***	0.934
	(0.178)	(0.214)	(0.268)	(0.236)	(0.469)	(0.128)	(0.302)	(0.165)	(0.297)	(0.368)
City Cluster Type 1 (1 = yes, 0 = no)	0.930	1.114	2.264***	0.636*	0.565	2.410***	0.093**	0.854	0.430	0.217
	(0.180)	(0.210)	(0.251)	(0.251)	(0.518)	(0.326)	(1.026)	(0.433)	(0.649)	(1.032)
City Cluster Type 2 (1 = yes, 0 = no)						1.031	0.534*	2.438***	0.069***	0.596
						(0.157)	(0.339)	(0.215)	(0.639)	(0.415)
City Cluster Type 3 (1 = yes, 0 = no)						1.147	0.789	2.110***	0.047***	0.346**
						(0.138)	(0.278)	(0.194)	(0.613)	(0.426)
Constant	0.207***	4.916***	1.897	0.148***	0.239*	10.999***	0.240***	0.018***	0.001***	0.024***
	(0.305)	(0.361)	(0.435)	(0.465)	(0.806)	(0.206)	(0.369)	(0.296)	(0.661)	(0.546)
Observations	810					1815				
Log Likelihood	−463					−912				
Akaike Inf. Crit.	945	2207	2207	2207	2207	1847	2568	2568	2568	2568

* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

households compare across the city clusters.

In both Kenya and Zambia, we found a positive association between household income and the likelihood of households spending most of their money at supermarkets (Table 3). As the log of household income increases, households were significantly more likely to spend money at supermarkets than any other food retail locations by 1.52 times in Kenya and 2.98 times in Zambia. While households were significantly less likely to purchase food at all other retail locations in Kenya based on income, households with higher incomes in Zambia were significantly more likely to purchase food at local shops or supermarkets by 1.42 times, which further suggests that local shops and supermarkets in Zambia are substitutes. These same food purchasing patterns held true for household assets in Zambia, with a significant likelihood of food purchases at local shops by 1.2 times and 1.48 times at supermarkets. Kenya differed in that with a one unit increase in the number of household assets, households were significantly more likely to purchase food at open-air markets by 1.26 times than any other location, which suggests that open-air markets were important across households regardless of wealth in Kenya.

Differences between the Kenyan and Zambian contexts arise regarding how households are embedded in their urban food systems by city type. Households in the smallest cities (City Cluster Type 1) relative to larger cities (City Cluster Type 4) were 2.4 times more likely to purchase food at open-air markets in Zambia, but this was not the case in Kenya. Instead, residents of these smaller cities were 2.64 times more likely to purchase food at local shops. Both results were statistically significant at the 5% level. Relative to larger cities (City Cluster Type 4), households in both mid-sized cities with lesser and greater connectivity (City Cluster Types 2 and 3) were significantly more likely to purchase food at local shops.

4.4. Additional reasons underlying household food purchasing patterns

We posed additional questions in our survey to further elucidate why households preferred to spend most of their food budget at a given retail location. First, we asked a subset of questions aimed at understanding the tradeoffs and price sensitivity of purchasing tomatoes across different food retail locations. We chose the example of tomatoes to frame these questions because tomatoes are widely consumed in both Zambia and Kenya, and given their perishability, they are also purchased frequently.

We found that most households in our sample would choose to buy their tomatoes at open-air markets and vendors, even if the prices were identical across these retailers, local shops, and supermarkets (Table 4). Freshness was cited as a main reason for continuing to purchase tomatoes at open-air markets in Kenya, while respondents in Zambia preferred open-air markets for their negotiable prices and proximity. Most respondents in Zambia associated the freshness of tomatoes with

Table 4
Percent of household respondents indicated their preferred location and reason for purchasing four medium tomatoes among open-air markets, vendors, local shops, and supermarkets, given the assumption that the price of four medium tomatoes is the same across all food retail locations. Respondents could select more than one reason, and customer service was included in the Kenya survey based on the consumer context of Central Kenya.

Kenya (n = 1010)	Open-air market (n = 610)	Vendor (n = 294)	Local shop (n = 112)	Supermarket (n = 29)
Preferred location	60	29	8	3
Clean	2	2	0	59
Closest	8	74	79	14
Freshness	63	4	10	28
Negotiable prices	26	10	8	0
Customer Service	11	7	16	3
Other reason	16	12	5	24

Zambia (n = 2007)	Open-air market (n = 1159)	Vendor (n = 478)	Local shop (n = 112)	Supermarket (n = 258)
Preferred location	58	24	6	13
Clean	5	3	20	81
Closest	44	82	78	1
Freshness	18	6	5	67
Negotiable prices	64	23	4	1
Other reason	22	3	1	4

supermarkets, but there were no concrete reasons underlying these country-level differences found in households' perceptions of tomato freshness. We expect that a combination of the local contexts of our cities and collective consumer behaviors drive these aggregated consumer preferences. Households who would choose to purchase identically priced tomatoes at vendors and local shops rather than at open-air markets or supermarkets explained that they would do so due to the close location of these retailers, while the main reason for choosing supermarkets was an association with cleanliness.

Additional reasons for purchasing food at open-air markets and vendors included cultural norms or having a family history of buying at a certain location, a location's convenience, and having a wide variety of food options. Respondents in Kenya and Zambia also valued instances when vendors gave extra tomatoes, the ability to buy larger quantities, the enjoyment or "adventure" of buying from vendors, and supporting the livelihoods of local vendors and farmers. A final key benefit underlying open-air markets and vendors were opportunities to purchase food with credit based on good relationships and trust with vendors.

Next, we conducted a simple experiment to assess the respondent's willingness to pay for four medium tomatoes at a supermarket or a local shop. We asked respondents whether, given the actual prices of tomatoes at open-air markets and vendors, they would be willing to buy four medium tomatoes at a local shop or a supermarket if prices were higher at these retail locations by 75 and 125% in Kenya, and 50 and 75% in Zambia. To measure the responsiveness of demand for purchasing food at local shops and supermarkets over open-air markets, we calculated the price elasticity of demand for purchasing tomatoes at a supermarket or local shop. Our base prices were obtained from the household survey, where we asked respondents what price they paid for four medium tomatoes the last time they purchased tomatoes. We calculated the price elasticities using the median price of four medium tomatoes in each country, which was 20 Ksh (0.20 USD) in Kenya and 4 ZK (0.31 USD) in Zambia during the 2019 field work survey.

We did not observe a systematic difference in the prices of four medium tomatoes purchased at open-air markets compared to local shops and supermarkets in our study sites. Overall, the demand for supermarkets and local shops was limited in both countries, where only a small portion of each country's sample size would purchase tomatoes at supermarkets and retail shops over open-air markets (Table 5). In Kenya, the price demand is relatively inelastic, suggesting that those who are willing to buy tomatoes at supermarkets or stores are not price sensitive.

Table 5
Price elasticity of demand for purchasing food at local shops and supermarkets relative to open-air markets in Kenya and Zambia.

	Kenya		Zambia	
Median price at open-air markets	20 Kenyan Shillings (Ksh)		4 Zambian Kwacha (ZK)	
Baseline price increase from median price	10 Ksh		1 Ksh	
Price increase from median price	15 Ksh	25 Ksh	2 ZK	3 ZK
% Change in price from baseline price	75%	125%	50%	75%
Baseline demand increase for supermarkets	168 households (17% of sample)		94 households (5% of sample)	
Demand increase for supermarkets	172	174	75	51
% Change in demand from baseline demand	2%	1%	−20%	−32%
Baseline demand increase for local shops	58 households (6% of sample)		38 households (2% of sample)	
Demand increase for supermarkets	56	54	15	7
% Change in demand from baseline demand	−3%	−4%	−61%	−53%
Price elasticity of demand for supermarkets over open-air markets	0.03	0.01	−0.40	−0.43
Price elasticity of demand for local shops over open-air markets	−0.05	−0.03	−1.21	−0.71

This result may be driven by the fact that supermarkets are more prevalent in Kenya and these households might be less price sensitive overall. In Zambia, on the other hand, respondents indicated a greater sensitivity to price differences. Only a very small fraction of households would be willing to pay more for tomatoes at a supermarket or local shop, and this amount dropped substantially as the hypothetical price difference increased. Thus, the willingness to pay higher prices to shop at a supermarket or a local shop is limited in both countries, but prices appear to play a larger role in Zambia, where supermarkets are less common. Given the intrinsic qualities of tomatoes (e.g., freshness, negotiable prices, supporting local economies) that were associated with tomatoes from open-air markets relative to tomatoes from other food retail locations (Table 5), this result is not surprising.

Finally, we introduced a set of two scenarios to explore how households would hypothetically spend money on food if they experienced a change in their weekly food expenditure budget. Given the purported growth of supermarkets and westernized diets in some locations in SSA (Reardon et al., 2021), we investigated what types of food households in our sample of secondary cities would prefer to buy with a higher food expenditure budget. In the first scenario, we asked respondents what food products they would buy more of if they had 400 Ksh or 50 ZK more to use towards food purchases each week. In the second scenario, we asked what food products they would buy less of if they had 400 Ksh or 50 ZK less to use towards food purchases each week.

Counter to evidence that African diets are shifting towards processed foods sold at supermarkets (Reardon et al., 2021), households in our study showed a predisposition towards non-processed, whole foods. Given a larger food spending budget, households tended to prioritize healthier, non-processed, and whole foods associated with commodities sold at open-air markets over processed foods that are associated with more western diets. With a hypothetical increase in food expenditure amount, respondents in both Kenya and Zambia stated they would spend more money on maize, meat, oil, and beans than processed foods and drinks (Fig. 5). Conversely, a decreased food expenditure budget per week led to respondents indicating they would spend less money on processed foods and drinks compared to all other food commodities. If given more money, a greater proportion of households in Zambia (i.e., 67%) would spend more of their food expenditure on meat relative to any other food commodity, while a smaller proportion of households in Kenya (i.e., 40%) would spend more on meat. These differences suggest that meat may have a higher income elasticity of demand, where meat purchases are more income-constrained, in Zambia compared to Kenya.

In Kenya, households cited that with more money, they would also purchase more vegetables, fruits, ground nuts, onions, potatoes, and cereals, such as rice and flour. Only six respondents (less than 1% of our

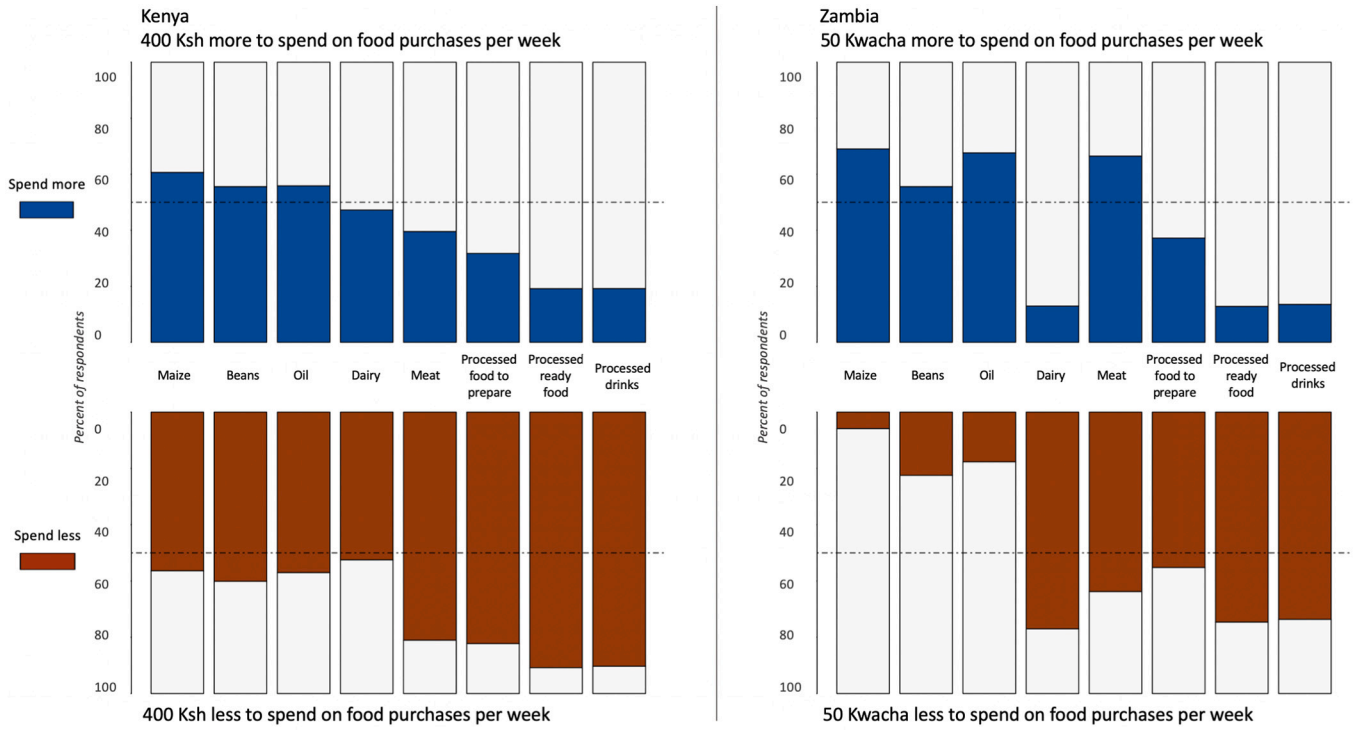

Fig. 5. Types of food products that households would buy more or less of with a hypothetical increase or decrease in food expenditure amounts per week.

sample) in Kenya said they would buy more sugar. In Zambia, respondents noted the same preference to spend more money on vegetables, fruits, ground nuts, onions, potatoes, and cereals, but also referenced tomatoes, sweet potatoes, Irish potatoes, cabbage, okra, chicken, fish, and additional meat products, such as goat, pork, sausage, and kapenta (dried fish). In terms of processed foods, less than 1% of respondents in Zambia would spend more money on bread and sugar. Several households in both Kenya and Zambia also noted that they would rather save the money than spend it on food purchases.

5. Discussion

5.1. Persistence of open-air markets

Our findings across 18 cities in Kenya and Zambia provide insights into how households in SSA's secondary cities navigate urban food systems. Namely, households in our sample spent most of their food budget at open-air markets and vendors, which reflects food purchasing trends elsewhere in SSA (White et al., 2018; Crush & Frayne, 2010; Smit, 2018). We expect that low- to middle-income households in the secondary cities of our study sites will continue to shop at open-air markets in the foreseeable future, because our results show that households intrinsically value these markets in terms of the relational experiences that they provide.

Open-air markets in our study sites also meet the dietary preferences of low- to middle-income urban households and offer product quality and availability that is not always matched at supermarkets and local shops, especially for fruits, vegetables, and whole foods. These food commodities appear to be a higher priority for our sampled households than processed foods, such as bread and sugar, which suggests an adherence to a more traditional African diet compared to a westernized diet. Similarly, the convenience, accessibility, and competitive pricing of open-air markets and vendors suggests that households are also likely to continue shopping at both open-air markets and vendors in the secondary cities in our study. Our findings are reflected in Goswami and Mishra (2009)'s study, which suggested that consumers in two small cities and two large cities in India would continue to shop at traditional retail locations in the short run, but with the caveat that traditional retailers (i.e., small local shops) would need to update their facilities to avoid being supplanted by cleaner and more organized modern retailers. Yet, the scale at which supermarkets are introduced to SSA's secondary cities would need to be significantly pronounced to overturn the important role that open-air markets and vendors play in the food purchasing behaviors of low- to middle-income households in our study.

The outcomes of our study deviate from earlier research on urban food systems in developing countries that have associated dietary shifts with the increasing dominance of modern food retailers in large cities (Battersby, 2019; Battersby & Peyton, 2016; Demmler et al., 2017; Otterbach et al., 2021; Reardon et al., 2021). We found that neither household food purchases at supermarkets, nor the preference for processed foods, were very widespread, even in our larger secondary cities (i.e., Karatina, Kenya and Choma, Zambia). This result leads us to question the dominant storyline that modern retail presence is associated with increased consumption of western food products. Informing this narrative, dietary research in Africa has narrowly focused on the relationship between supermarkets and dietary behaviors, even though the informal retail sector plays the most important role in Africa's urban food retail environment (Holdsworth & Landais, 2019). For example, Demmler et al. (2017)'s study in three cities in central Kenya demonstrates that food purchases at supermarkets contribute to higher body mass index with an increased probability of being overweight or obese. In Lusaka, Zambia, Khonje et al. (2020) found that the proportion of food expenditure shares spent at modern retailers such as supermarkets was associated with being overweight among adults.

Yet, our study moves beyond linking food purchases to biometric indicators. We assess the consumer demand for shopping for vegetables at supermarkets versus open-air markets and the underlying preferences of where consumers prefer to shop across multiple retail options. At the same time, however, our respondents may have indicated that they prefer healthy foods since that perspective may be perceived to be more socially desirable. While we cannot confirm from our data whether our study's respondents do indeed purchase the healthier wholefoods that

they have indicated a preference for, or if they had a higher food expenditure budget, our findings do suggest that the impact of incoming supermarkets on urban diets is complex. For instance, a qualitative study of food consumption in Malawi similarly demonstrated that dietary transitions are complex and nuanced and are more largely based on the socio-cultural factors that shape urban food systems (Riley & Dodson, 2016). Moreover, in a framework that identifies dietary behaviors among adults and adolescents in a typical African urban food system, the top individual-level factors that contribute to diet include food habits, preferences, and socioeconomic status (Osei-Kwasi et al., 2021). Thus, we may be observing a socio-cultural preference for healthier whole-foods and a consumer habit for purchasing food at open-air markets that is more suitable to the low- to middle-income households in our study.

While a rise in supermarkets has suggested a change in dietary behaviors and nutrition (Battersby, 2019; Battersby & Peyton, 2016; Demmler et al., 2017), this pattern may hold true for some households in some cities, but not in the secondary cities in our study, as our findings show. Mackay (2019) similarly found that residents in two Ugandan secondary cities tended to purchase food from open-air markets and local shops, regardless of gender, age, and class. Thus, the storyline that modern retail presence is associated with increased consumption of western food products does not necessarily hold true for all smaller secondary cities in Africa.

5.2. Trajectories of urban food systems transformation in secondary cities

The role of projected incoming supermarkets to secondary cities poses questions about the prospective trajectories of urban food system transformations in these cities. Urban consumers in the secondary cities in our study have indicated a preference for local foods and have even indicated that they also prefer to shop at open-air markets to support local farmers and businesses. Given these findings, we ask how much influence large supermarket chains will have on household food purchases in the food systems of secondary cities in the coming decades, relative to open-air markets and vendors. Further research is needed to understand these urban food systems to develop urban planning policies most suitable to secondary cities.

Indeed, some secondary cities currently have one supermarket, which is likely adequate given the population sizes of these cities. Supermarket retailers will also logically consider population densities and incomes before investing in the development of new stores and would therefore be unlikely to develop in smaller cities, especially those with populations as low as 5000. Our results suggest that even with potential rapid supermarket expansion in these smaller SSA cities, we expect that low- to middle-income households are less likely to purchase food at these supermarkets in the foreseeable future.

Of course, supermarkets and western food diets may eventually infiltrate further into the urban food systems of some secondary cities. Yet, open-air markets and vendors will hold their significance in food systems of secondary cities while supermarkets will play a more substantial role in primate cities. However, the pace, scale and location of supermarket adoption requires further research to improve our understanding of how secondary cities will address food insecurity in the context of their unique urban food systems in the future. At present, the necessary data available to investigate these processes remains scarce. However, our study offers an initial empirical understanding of urban food system profiles in secondary cities based on a standardized survey that could allow for future research on how these urban food systems could evolve in the future.

Theories of urban food systems transformation present a starting point to explain how city types shape urban food retail environments in SSA and the differences in urban food system characteristics across city types. In the first stage of transformation, food supply chains are short and food systems are comprised of small enterprises with low food processing; in the second stage, supply chains stretch from rural to urban areas with small to medium-sized enterprises driving most food systems activities and processed food purchases begin to rise; and in stage three, supply chains extend further to include international markets, where supermarkets emerge and processed foods become common (Reardon et al., 2019). Changes in consumer behavior and dietary preferences occur over these transformation stages, which broadly moves from consumers purchasing less processed, unpackaged foods to more processed, packaged foods and from purchasing food at smaller retail stores to purchasing from supermarkets (Reardon et al., 2021). These processes of transformation have been observed in Asia and Latin America (Reardon et al., 2003; Reardon & Timmer, 2014), but to what extent have these urban food systems transformations occurred in SSA's secondary cities?

Insights from our study show that Zambia's secondary cities may be at an earlier stage in the urban food system transformation process compared to Kenya. Households in Kenya purchased food across a more diverse range of food retail sources compared to Zambia, which reflects the greater diversity of retail locations, including supermarkets, in Kenya. In contrast, Zambia has experienced less of a food system transformation and open-air markets continue to serve a prominent role for household food purchases. Contextualizing the urban food systems of these smaller cities along the trajectory of urban food systems transformation can help urban planners to better understand where different types of retailers are more likely to persist, and to implement urban governance strategies in a way to support urban populations, including low- to middle-income households.

5.3. Planning for resilient and equitable urban food systems

The continual and rapid growth of cities in SSA means that urban planners have a critical hand in shaping urban food systems that are more resilient and equitable for populations living in secondary cities. Achieving this will mean grappling with the relationship between the spatial and political dimensions of retail expansion, which is often utilized by municipal governments as a tool for local economic development (Frimpong Boamah et al., 2020; Skinner, 2016). Yet, a desire among African policymakers to westernize cities in SSA has resulted in urban policies that favor modern retailers (i.e., supermarkets), but at the cost of marginalizing traditional retail sectors (i.e., open-air markets, street vendors, and local shops) (Giroux et al., 2020; Rousseau, Boyet, & Harroud, 2020). For example, imposing national-level bans on street vending may adversely impact people living in smaller and less connected urban areas, where supermarkets are currently not as prevalent and where the informal sector is essential for sustaining food security and local livelihoods (Crush & Frayne, 2011; Kazembe et al., 2019). Decisions made without appropriate food systems planning and engagement - such as market relocation or upgrading, and preferential zoning for supermarkets - risk overlooking the urban food security and socio-economic justice repercussions of these decisions (Battersby, 2017a).

Our findings have highlighted the persistence of open-air markets in secondary cities, which emphasizes the need for urban municipal governments to support these markets. One way in which open-air markets should be integrated into city planning procedures is by ensuring that they are allocated sufficient land near existing and planned low- and middle-income areas. Urban planners also need to consider how rural and urban farmers, vendors, and customers access markets to supply, sell, and purchase food. Ensuring that open-air markets are centrally located, within reasonable proximity to transportation networks, and embedded in the ways in which urban populations are socially and geographically organized is important for supporting the large consumer base that use these open-air markets in our secondary cities. Indeed, the development and large donor investment of new modern markets can fail when they are not positioned to support these social and spatial processes in the cities. Investments in transportation and market infrastructure are therefore equally essential for the sustainability of markets.

The diversity of food retail options that comprise the food systems of

secondary cities in SSA suggests that the type of governance support afforded to open-air markets should also extend to street vending and local shops. Our findings show that the range of retail sources, from open-air markets to supermarkets, is similarly essential to food access in urban areas. Urban policies that are neglectful of, or hostile towards, the informal food sector risk undermining its contribution to urban food security. Rather than sanctioning unregulated traders, which has been the case throughout Zambia and in parts of Kenya (e.g. Kisumu City) in recent years, policymakers should recognize the important links that vendors create between suppliers and consumers across informal and formal sectors (Giroux et al., 2020). For instance, based on our field observations, some vendors buy items in bulk from supermarkets (e.g., a 25 kg bag of maize meal or a dozen eggs), and then repackage them in smaller quantities to resell to customers who can only afford to buy small amounts on a day-to-day basis. Thus, while supermarket expansion can economically undermine and spatially marginalize unregulated vendors, supermarket growth can also create opportunities for other retail actors in the food system (Battersby & Watson, 2018).

Although restrictions on vendors have predominantly been implemented in primary cities, more attention will need to be paid to how vendors might be integrated into the food systems of secondary cities as these cities continue to grow. One of the challenges for local governments in smaller cities will be the degree to which municipal decision makers have the autonomy and capacity to manage and enforce restrictions on vendors. National or even county- or district-level decisions on vending regulations may not fit the contexts of smaller secondary cities. Moreover, the state's reach is largely peripheral and city officials may be more inclined to make their own authoritative decisions on vending regulations.

For instance, the four Kenyan cities in our study each had their own unique rules according to local conditions that regulated vending businesses. Vendors were restricted to what times of the day and in what locations they could conduct business so as not to compete with supermarkets, local shops, and open-air markets. City officials also required vendors to pay a small fee to occupy a public space, where vending outside of these parameters came with repercussions in the form of a warning, fine, or arrest. These secondary city-level governance institutions present an example of vending regulation that suits local municipal contexts without requiring national oversight.

However, in larger cities, such as in Kisumu, Kenya, the harmony between street vendors and other retailers are challenged with contested uses of space, hostility, and conflict (Racaud, 2018). Similarly, in Lusaka, Zambia, government authorities have pressured street vendors to relocate to designated council-run markets, or else face eviction. Despite a strong resistance from street vendors, a cholera outbreak in 2017 resulted in the implementation of even harsher regulations, including fines of up to K5,000 (US$500) for both vendors and their customers (Mwango et al., 2019). These government crackdowns on street vending have also been highly politicized, with vendors being used as voting fodder in election years (Resnick, 2019). Thus, in these larger cities, national legislation and oversight may be necessary and more appropriate for regulating the roles of vendors in SSA's urban food systems.

Yet, the balance of adhering to national laws while also promoting municipal authority presents a host of complex, yet understudied nuances in the implementation of urban food systems governance. For example, we observed in the field that while the laws banning street vending in Zambia technically apply nationally, food system governance in secondary cities is often limited by financial and personnel capacity, and the enforcement of regulations has therefore been less consistent in certain contexts. For example, Giroux et al. (2020) found that in the secondary city of Mumbwa, Zambia, street vendors are often warned multiple times about noncompliance with the law before they face repercussions such as fines or the confiscation of goods. Officials are also likely to confiscate only perishable goods that pose a food safety risk, and vendors are regularly encouraged (rather than forced) to operate from within designated markets (Giroux et al., 2020). We also found in our field observations that some street vendors in the city of Choma avoid harassment by selling their goods very early in the morning, or after 5 pm when the authorities have finished work for the day.

In this regard, policymakers should consider introducing regulations or protocols that allow vendors to continue their activities in ways that do not violate health and safety standards, create congestion, or negatively impact the operations of other food retailers such as open-air markets and supermarkets. These regulations can include allocating areas within the city or times of day that vendors can trade and investing in public facilities like toilets and water points. To ensure that these regulations fit local conditions, legislation needs to be clear and consistent at national, county or district, and city-levels of enforcement regarding the use of space for vending.

5.4. Policy considerations for urban food systems governance in secondary cities

We posed additional questions in -air markets, vendors, local shops, and supermarkets will likely meet the needs and expectations of a greater diversity of actors within the urban food systems of secondary cities. Implementing this “cohabitation” approach (Nickanor et al., 2019) will require policymakers to embrace the hybrid nature of urban food systems in SSA, and to work closely with city-level planners, donors, and private sector actors to ensure that city visions around food retail are shaped collaboratively, and with the urban poor in mind. Key steps could include establishing city-level institutions, such as a municipal department of food or food policy councils, which has been done recently in Lusaka, and integrating food system concerns into the work of existing urban planning departments (Pothukuchi & Kaufman, 1999).

For smaller secondary cities, coordinating with city officials will be key, especially for cities that are not yet large enough to justify the establishment of a municipal department of food or food policy councils. For instance, at the time of fieldwork, key urban food systems governance decisions and oversight in our Kenyan cities were made at the county-level. At the same time, each city also had their own county-level representatives, including a market master that oversees the implementation of county-level policies, suggesting some limitations to policy autonomy that secondary cities wield in the governance of urban food systems.

At present, however, policy decisions related to food systems governance globally are largely made at higher levels, despite decentralization policies that purportedly afford power to local authorities for city management and service delivery. Yet cities are mobilizing across the globe to take greater responsibility to provide access to urban food governance decision making to citizens (Moragues-Faus, 2021). In this process, urban governance and planning processes should engage directly with the dynamics of each city's unique urban food system, which is inclusive of the social, spatial and economic dimensions of access to food from different sources (Moragues-Faus & Battersby, 2021).

6. Conclusion

Our study directly addresses the challenges associated with the lack of data availability and methodologies in articulating urban food systems planning opportunities in secondary cities across the globe. We present the first multi-city analysis of SSA urban food systems that uses a standardized survey with a large-N sample of households in diverse secondary cities in Kenya and Zambia. We also address a knowledge gap regarding how household-level food acquisition varies across cities by examining the nature of urban food systems from the perspective of household food acquisition across diverse types of secondary cities in Kenya and Zambia.

Our study further illustrates some underlying reasons for why low- to

middle-income households across 18 cities in Kenya and Zambia predominantly purchase food at open air markets. We conducted quantitative analyses that identified household- and city-level factors related to household food purchasing patterns. We also considered the qualitative perceptions of household respondents that further explain household food purchasing behaviors. Based on these findings, we expect that low- to middle-income households will continue to mainly purchase food from open-air markets, regardless of the purported rise in supermarkets across Africa. Implications of these findings for future research point to the need for further systematic study of the dynamics of urban food systems planning, development, and governance in smaller secondary cities across the globe. A key policy and research question for the future remains. How can urban food systems planning across diverse urban retailers proceed in a way that best supports the diversity of cities and demographic groups within cities to access and afford sufficient, safe, and nutritious food to meet basic dietary needs and preferences?

Moving forward, national policy approaches to the persistent role of open-air markets in SSA's secondary cities should account for the nuance and heterogeneity associated with different city types. In doing so, local city officials and departments should be trusted and supported to implement plans that are most appropriate and beneficial to their own urban food system contexts and socioeconomic populations. Municipal governments have a salient role to play in policy development and change, as they operate at the local level and therefore have a better understanding of key grassroots issues, as well as greater opportunities to engage directly with local stakeholders (Gore, 2018). Thus, proactively pursuing an integrated food system planning agenda that can appropriately meet the food systems needs of these secondary cities will require policymakers and planners to work together across governance scales, from the local to the regional and national levels.

CRediT authorship contribution statement

Corrie Hannah: Conceptualization, Methodology, Formal Analysis, Investigation, Data Curation, Writing – Original Draft, Review & Editing, Visualization, Project Administration, Supervision. **Julia Davies:** Conceptualization, Methodology, Investigation, Writing – Original Draft, Review & Editing. **Rachel Green:** Conceptualization, Methodology, Investigation, Writing – Original Draft, Review & Editing. **Andrew Zimmer:** Visualization (map), Methodology, Investigation, Writing – Original Draft, Review & Editing. **Patrese Anderson:** Validation, Formal Analysis, Writing – Original Draft, Review & Editing. **Jane Battersby:** Writing – Original Draft, Review & Editing. **Kathy Baylis:** Validation, Methodology, Funding Acquisition, Writing – Review & Editing. **Nupur Joshi:** Writing – Original Draft, Review & Editing. **Tom Evans:** Conceptualization, Methodology, Investigation, Writing – Review & Editing, Funding Acquisition, Project Administration, Supervision.

Declaration of competing interest

None.

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Appendix A. Supplementary data

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