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EFESS: Development of External Food Environment Surveillance Systems Using a Tele-cohort of Informal and Formal Food Vendors in Two Secondary Cities in Kenya.

Abstract

This project aims to develop and implement an External Food Environment Surveillance System (EFESS) to monitor food environments in low- and middle-income countries (LMICs), with a specific focus on informal and formal food vendors in two secondary cities in Kenya. The research will create a sampling methodology for measuring food environments and establish a protocol for longitudinal monitoring. This surveillance system will capture spatial and temporal variations in food environments, accounting for differences due to urbanization and agroecological factors.

Here I will discuss the first of the two primary aims for the project which is to map food environments across rural-urban gradients in two Kenyan cities. This data collection will capture dynamic changes within and between days, as well as over longer periods, including seasonal variations.

Problem Statement

In low- and middle-income countries (LMICs), food environments are a critical determinant of diets and health outcomes. The external food environment (EFE)—which includes both formal and informal food vendors—shapes the availability, affordability, and accessibility of food for millions of people. Informal food vendors, often unlicensed and operating without regulatory oversight, play a vital role in LMIC food systems by providing access to affordable and nutritious foods such as fresh produce, prepared meals, and snacks. However, the contribution of these informal vendors remains under-researched, particularly in terms of their role in urban food security and their responses to market stressors and shocks (Young & Crush, 2020; (Ruben et al., 2021). Moreover, the gendered dimensions of informal food vending are

critical yet insufficiently explored despite the critical role they play in food vending in urban and periurban areas(Ambikapathi et al., 2020; (Tacoli & Vorley, 2016).

Informal vendors frequently face changes in food availability, consumer demand, regulatory pressures, and economic challenges, yet their resilience to these stressors remains largely unmeasured (Downs et al., 2022; Turner et al., 2020).The high degree of mobility, seasonality, and other sources of variability that characterize informal food vending and especially in secondary cities warrant study as they have been less researched (Ambikapathi et al., 2021; Kimenju et al., 2015)

Literature review

The external food environment (EFE) is increasingly recognized as a critical determinant of diet quality, nutrition, and health in low- and middle-income countries (LMICs). While formal food environments, such as supermarkets and regulated food markets, have been widely studied, informal food environments—those dominated by unlicensed, small-scale vendors—have received less attention. Informal vendors, who often operate without formal oversight, play a crucial role in making affordable, nutritious food available to vulnerable populations, particularly in rapidly urbanizing areas (Young & Crush, 2020). However, gaps remain in our understanding of the role these vendors play in food systems and how they respond to stressors and shocks (Downs et al., 2022).

Importance of Informal Vendors in LMIC Food Systems

Informal food vendors are a major source of food for low-income urban and peri-urban populations in LMICs.informal vendors, especially women, supply essential foodstuffs such as fresh fruits, vegetables, and prepared meals, which are often more affordable and more nutritious than those found in formal retail environments (Ambikapathi et al., 2020),(Rischke et al., 2015). These vendors,often the primary source of affordable,and nutritious food in secondary cities and other underserved areas (Tacoli & Vorley, 2016) face so many challenges despite their key role in food security (Battersby et al., 2016).

Gaps in Research on Temporal and Spatial Dynamics of Food Environments

Despite secondary cities experiencing rapid urbanization and demographic changes, little is known about how food environments in these settings fluctuate over time and across space (Reardon et al., 2021; Popkin, 2003). Informal food vendors, in particular, exhibit high levels of mobility and seasonal variation, creating food environments that are dynamic and temporally variable (Turner et al., 2020). Ambikapathi et al. (2020) and Kimenju et al. (2015) highlight the importance of longitudinal research in capturing the complex, ever-changing nature of food environments in LMICs amongst informal vendors (Downs et al., 2022).

Gender and Equity in Informal Food Systems

As women vendors dominate, gender plays a critical role in determining the types of food sold, the customer base, and the challenges faced by vendors (Ambikapathi et al., 2021). For example, female vendors are more likely to sell fresh produce and prepared foods, which are key to improving dietary diversity among low-income populations (Tacoli & Vorley, 2016). Battersby & Marshak (2016) emphasize the vulnerability of women to shifts in policy and economic disruptions threatening their livelihoods and customers they serve.

Methods section

Kirinyaga and Machakos were chosen for their differing agroecological and urbanization contexts. Both counties have high rates of noncommunicable diseases, with a notable burden of overweight and obesity among women (Kenya National Bureau of Statistics et al., 2015). The methodology is designed to capture both formal and informal food environments, with particular attention given to informal vendors, who play a critical role in urban food security. The study will be conducted in two major phases: data collection on food vendors and tool development for ongoing surveillance.

Quantifying Spatial and Temporal Variations

Objective 1.1: Spatial Variations

Data was collected using a food vendor typology tool, gathering vendor's gender, location (via GPS coordinates), typology (formal, semi-formal, or informal), and the types of food sold. The tool also documented key food categories, including fresh produce, prepared foods, processed foods, and beverages

(Ambikapathi et al., 2021). The census took place during daylight hours to map the spatial distribution of food vendors within the transects, capturing variations in vendor type, gender, and food availability.

Objective 1.2: Temporal Variations

Accessed using temporal transects, where data was collected at different times of the day (morning, afternoon, and evening) on both weekdays and weekends capturing within-day and between-day variations in food vending activity. Temporal transects will be repeated at intervals of four and eight months to observe seasonal changes in the food environment. We hypothesize that informal vendors, particularly women, will exhibit greater temporal variability due to mobility, seasonality, and economic stressors (Turner et al., 2020) using capture recapture to highlight vendor mobility, migration patterns, and vendor longevity in the food system (Tilling, 2001).

Results

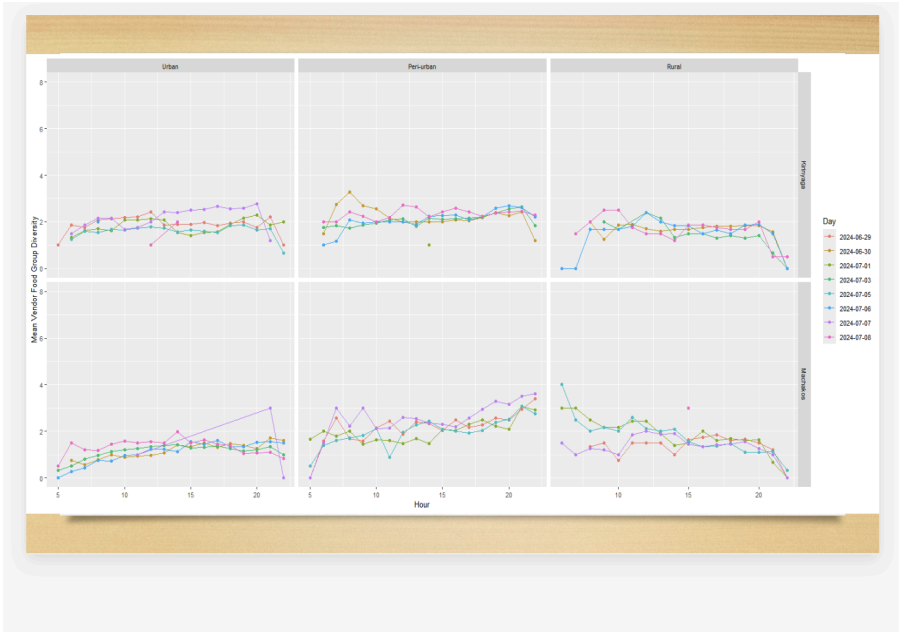
I present findings on the different variables that were tested during the randomly sampled interviews conducted in Machakos and Kirinyaga. The study sheds light on the different market dynamics across these settings and the potential health implications related to food choices in both Kirinyaga and Machakos in a bid to show time variations in food environments. The spots of study were urban, peri urban and rural areas. Data was collected on weekdays, weekends and a market day in the rural areas which is a specific day set aside for vendors to operate from a traditional market.

Vendor Count Trends

Vendor count in urban areas peaks around midday (between 10 AM and 2 PM), with counts reaching up to 40-50 vendors on some days with fewer vendors in the early morning and late evening. In peri urban areas the curve looks steadier with 15-25 vendors throughout the day while rural markets had the smallest count of 10-20 vendors a day. Of the three study regions urban areas tend to have the highest fluctuations of the three.

Food Group Diversity

Urban areas show greater diversity with a steady supply of 3-5 food groups offered throughout the day with peaks in late morning and early afternoon. Peri Urban areas had a lower diversity between 2-4 food groups peaking in the evenings while rural areas had the lowest at 1-3 food groups.



NCD Risk Analysis

The Non-Communicable Disease (NCD) risk in urban areas is moderately high, ranging from 1.5 to 3.0 with a slight increase in the evening. While in periurban it shows a gradual rise in the evening with a greater fluctuation than urban areas. Rural areas have the lowest NCD risk consistent between 1.5 and 2.0.

Female Vendor Participation

Female vendor participation is robust in urban areas averaging at around 50-75% , starting high in the morning and remaining consistent throughout the day with occasional peaks above 90% in the early morning. In peri-urban areas it shows more variability, fluctuating between 50-75% and drops during certain hours, while in rural regions, some parts show less than 25% female participation, suggesting that rural vendor markets are more male-dominated, especially during peak hours.

Total Food Groups and Vendor Behavior

The total number of food group offered by vendors in urban areas ranges from 4 to 6 throughout the day, with a slight dip around midday and a peak in the late afternoon. In peri-urban areas, total food groups range from 3 to 5, with the highest number of food groups offered in the evening. The rural vendors consistently offer between 2 and 3.5 total food groups with minimal variability throughout the day.

Key Insights on Market Dynamics

Time of Day Patterns

Urban areas see more dynamic changes in vendor count, food group diversity, and gender distribution throughout the day, with peaks and valleys corresponding to demand surges during market hours. Peri-urban and rural regions, on the other hand, exhibit more stable but lower vendor counts and food group diversity.

Health Implications

The NCD risk associated with vendor foods is higher in urban and peri-urban areas, particularly during the evening when processed food availability increases. Rural areas, with their limited diversity and lower vendor counts, show the lowest NCD risks, emphasizing the contrast between urban and rural food environments.

Gender Disparities

Urban markets are more inclusive of female vendors, with a consistently high percentage of women participating in food sales throughout the day. In contrast, rural and peri-urban markets show more significant fluctuations and lower female representation, especially during peak hours.

Discussion

The aim of this step of the project was to show temporal variations (variations within time) in food environments.

Food Group Availability and Diversity

The data shows variations within time in the different study sites studied in food group availability and diversity with urban and peri urban areas having a more steady food availability throughout the day both on weekdays and weekends. Rural areas in contrast show a lot of disparity which could be due to heavy

reliance on market days. This could be attributed to the infrastructural development in towns and the urban life which sees more employed people live in the cities and thus increase demand for purchasing from vendors. Majority of the employed people in urban areas do not have enough time to cook their own foods increasing demand for the food vending (Berkhout et al., 2023),(Chagomoka et al., 2018).

Furthermore, the data highlights that peri-urban areas display the highest food group diversity, particularly during peak times such as midday and the late afternoon. This suggests that peri-urban regions serve as a transition zone between urban stability and rural variability, providing a mix of permanent and temporary food sources. These areas may offer the best of both worlds—higher diversity like urban areas but at a lower cost or greater flexibility, as seen in rural settings(Petrikova et al., 2024). This could imply that improved infrastructure in the rural areas could regularize food supply. Policies that promote permanent vendor setups in these areas could mitigate fluctuations in food diversity and reduce reliance on transient markets.

Vendor Activity

Similarly , vendors were more consistent in urban areas throughout the day followed by peri urban and last rural areas. Urban and periurban have a strong presence regardless of whether market day or not which indicates the heavy reliance of rural areas on market days. Consequently female vendors followed a similar trend with rural areas spiking during markt days. All this beehive of activities in urban and peri urban can all be attributed to the more development in towns and high demand for food besides the majority of women joining the trade as a source of income due to high levels of unemployment in urban areas and the ease of entry into food vending(Berkhout et al., 2023),(Chagomoka et al., 2018).

NCD Risk

The analysis of NCD risk highlights a significant site-based variation, with peri-urban areas showing the highest average NCD risk, particularly during weekends and late in the day.

This elevated risk is likely due to increased consumption of energy-dense, processed foods, which are more readily available in these areas compared to rural regions. Urban areas also exhibit elevated NCD risk, but the trend is more stable across the week, suggesting that urban consumers have a more consistent access to processed foods that pose a health risk. This can be attributed to the consistent food vending in the region (Berkhout et al., 2023), (Chagomoka et al., 2018), (Osei-Kwasi et al., 2020). The spike in rural areas during market days implied rural seemed safer due to lack of consistent supply. Nutritional interventions especially in periurban areas should be held to create awareness on healthy diets.

Market Day Dependence and Temporal Patterns

Rural areas heavily depend on market days for food diversity and vendor activity, with non-market days showing reduced food availability and fewer economic opportunities, particularly for female vendors. This intermittency increases the risk of food insecurity on non-market days. In contrast, urban and peri-urban areas enjoy more consistent food availability, with less reliance on specific market days.

Additionally, food diversity and vendor activity in peri-urban and rural areas peak around midday and late afternoon, aligning with meal times, while urban areas have a stable supply throughout the day. This suggests urban areas benefit from more formalized, continuous food supply chains.

Conclusion

This analysis of the first aim in the project provides crucial insights into the disparities in food access, vendor activity, and health risks between urban, peri-urban, and rural areas. While urban areas benefit from consistent access to diverse food groups and vendor activity, peri-urban and rural areas, particularly the latter, rely heavily on market days to meet their food needs. This market-based dependency, combined with the higher NCD risks seen in peri-urban areas, suggests a need for targeted interventions that improve food supply chains, promote healthier eating habits, and support continuous vendor activity, especially in rural settings.

Addressing these disparities will require a multi-faceted approach, combining infrastructural investments, gender-sensitive economic policies, and health-focused interventions to reduce food insecurity and improve health outcomes across all regions.

Notes concerning the article

The research is a two- year project funded by IMMANA which is still continuing. During the summer when I was involved with the project we did the first data collection which was on the first aim of the project - temporal transects and so in this article I have analyzed methods and discussions on the temporal transects.

The official team has not yet written a report on the findings yet so the findings and discussion I present on this report are based on data analysis and verbal discussions we had as a team during our weekly meetings.

References

<https://doi.org/10.1007/s12571-024-01475-8>

Battersby, J., Marshak, M., & Mngqibisa, N. (2016). No. 24: Mapping the Invisible: The Informal Food Economy of Cape Town, South Africa. *African Food Security Urban Network*.
<https://scholars.wlu.ca/afsun/8>

Berkhout, E., Sovová, L., & Sonneveld, A. (2023). The Role of Urban–Rural Connections in Building Food System Resilience. *Sustainability*, 15(3), Article 3.
<https://doi.org/10.3390/su15031818>

Chagomoka, T., Drescher, A., Glaser, R., Marschner, B., Schlesinger, J., Abizari, A.-R., Karg, H., & Nyandoro, G. (2018). Urban and peri-urban agriculture and its implication on food and nutrition insecurity in northern Ghana: A socio-spatial analysis along the urban–rural continuum. *Population and Environment*, 40(1), 27–46.

<https://doi.org/10.1007/s11111-018-0301-y>

Downs, S. M., Fox, E. L., Zivkovic, A., Mavros, T., Sabbahi, M., Merchant, E. V., Mutuku, V., Okumu-Camera, K., & Kimenju, S. (2022). Drivers of food choice among women living in informal settlements in Nairobi, Kenya. *Appetite*, *168*, 105748.

<https://doi.org/10.1016/j.appet.2021.105748>

Kimenju, S. C., Rischke, R., Klasen, S., & Qaim, M. (2015). Do supermarkets contribute to the obesity pandemic in developing countries? *Public Health Nutrition*, *18*(17), 3224–3233.

<https://doi.org/10.1017/S1368980015000919>

Osei-Kwasi, H., Mohindra, A., Booth, A., Laar, A., Wanjohi, M., Graham, F., Pradeilles, R., Cohen, E., & Holdsworth, M. (2020). Factors influencing dietary behaviours in urban food environments in Africa: A systematic mapping review. *Public Health Nutrition*, *23*(14), 2584–2601. <https://doi.org/10.1017/S1368980019005305>

Petrikova, I., Otieno, M. A., Were, G., Eltholth, M., Mateos, A. R., Harding, S., Moran, V., Osano, O., & Cole, J. (2024). Peri-urban agriculture and household food and nutrition security around Eldoret, Kenya. *Food Security*. <https://doi.org/10.1007/s12571-024-01475-8>

Reardon, T., Tschirley, D., Liverpool-Tasie, L. S. O., Awokuse, T., Fanzo, J., Minten, B., Vos, R., Dolislager, M., Sauer, C., Dhar, R., Vargas, C., Larrey, A., Raza, A., & Popkin, B. M. (2021). The Processed food revolution in African food systems and the Double Burden of Malnutrition. *Global Food Security*, *28*, 100466.

<https://doi.org/10.1016/j.gfs.2020.100466>

Rischke, R., Kimenju, S. C., Klasen, S., & Qaim, M. (2015). Supermarkets and food consumption patterns: The case of small towns in Kenya. *Food Policy*, *52*(C), 9–21.

Ruben, R., Cavatassi, R., Lipper, L., Smaling, E., & Winters, P. (2021). Towards food systems transformation-five paradigm shifts for healthy, inclusive and sustainable food systems. *Food Security*, *13*(6), 1423–1430. <https://doi.org/10.1007/s12571-021-01221-4>

Tilling, K. (2001). Capture-recapture methods—Useful or misleading? *International Journal of*

Epidemiology, 30(1), 12–14. <https://doi.org/10.1093/ije/30.1.12>

Turner, C., Kalamatianou, S., Drewnowski, A., Kulkarni, B., Kinra, S., & Kadiyala, S. (2020).

Food Environment Research in Low- and Middle-Income Countries: A Systematic Scoping Review. *Advances in Nutrition*, 11(2), 387–397.

<https://doi.org/10.1093/advances/nmz031>

Young, G., & Crush, J. (2020). *Chapter 10: The urban informal food sector in the Global South*.

<https://www.elgaronline.com/edcollchap/edcoll/9781786431509/9781786431509.00015.xml>

Tacoli, C., & Vorley, B. (2016). Informal food systems and food security in rural and urban East Africa.

IIED Briefing Paper-International Institute for Environment and Development, (17336)

Popkin, B. M. (2003). The nutrition transition in the developing world. *Development policy review*, 21(5-6), 581-597

