Assessing supermarket patronage in Matola, Mozambique

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Abstract

As an indicator of a potential broader nutrition transition, the supermarketization of urban food systems in the Global South has become a growing area of research interest. While the rising dominance of supermarkets in urban food systems has been noted in several global cities in the Global South, there have been fewer investigations into the spatial and demographic characteristics that may govern the patronage of supermarkets in smaller secondary cities. This paper assesses this supermarketization trend via an investigation of supermarket patronage in a secondary city through a 2014 household survey of Matola, Mozambique ($n = 507$). Using a combination of descriptive statistics and decision tree learning algorithms, the findings suggest a strong geographic pattern to supermarket patronage among the surveyed households in Matola. Further analyses comparing frequent and infrequent supermarket patrons confirms the observation that spatial distance may be a more significant determinant of supermarket patronage than household wealth among the surveyed households in Matola. These findings suggest that the spatial availability of supermarkets may play a greater role in defining the supermarketization of Matola's food system than household entitlements. These findings also have implications for the evolving concept of urban food deserts in secondary cities, recognizing the role of spatial location in determining household access to supermarkets.

Keywords: Urban food security, Urban food system, Supermarketization, Matola

Science highlights

- Spatial availability of supermarkets may play a greater role in defining the supermarketization of Matola's food system than household poverty or food security.
- The demographic structure of households in Matola does not appear to be strongly associated with supermarket patronage.
- Supermarket patronage in Matola appears to be motivated by a combination of factors relating to food preferences and spatial accessibility.

Policy and practice recommendations

- Given the impact of spatial distance on supermarket access, zoning and public transportation may provide a means of supporting access to these food sources
- As cities continue to urbanize rapidly, the location of food sources in reference to residential areas may be a necessary policy consideration
- Further market research on food purchasing preferences and motivations may provide helpful guidance for municipal zoning policies.

Introduction

A brief introduction to urban food systems in the global south

The Global South, particularly Africa and Asia, is currently experiencing rapid urbanization (UNDESA, 2014). It has been projected that the urban population will increase by 2.5 billion people between 2018 to 2050 with about 90% of this growth occurring in Asia and Africa (UNDESA, 2018). Between 2007 and 2017, the population of the City of Matola increased from 671, 556 to 1, 032, 197 (INE, 2017). The form that this urbanization takes will determine the extent to which cities become sites of prosperity or sites of spatial inequalities, poverty, food insecurity and social exclusion for the urban poor (UN HABITAT, 2016). For many cities in the Global South, this rapid urbanization has led to a wider urbanization of poverty and food insecurity (Frayne et al., 2014).

Within Mozambique, the capital city Maputo, and the secondary city Matola, have experienced population increases within unplanned settlements, giving way to rising unemployment and poverty within the cities (Andersen et al.,2015). This rapid urbanization potentially influences food system transformation and food security. Previous studies within Maputo have illustrated that only about 33% were food secure whilst about 37% were severely food insecure (McCordic & Abrahamo, 2019). There are several interconnections between urbanization and food systems which support access to food. Food systems bring together all processes related to the production, distribution and consumption of food as well as infrastructure and institutions involved (HLPE, 2017).

With urbanization, there is a shift from rural, productionist and government-driven policies towards market driven food system governance, which integrates both corporate and consumer interests (Lang & Barling, 2012). In Global South cities, the traditional and informal food sector comprising of informal street vendors and open air markets are heavily relied upon for providing food access among the urban poor (Crush & Frayne, 2011; Skinner and Haysom, 2017). However, rising incomes, and economic activities associated with urbanization, have increased the demand for sourcing food conveniently and the purchasing of processed food (Reardon et al., 2021).

This trend has created opportunities for various forms of food retail and the influx of large multi-national food businesses including supermarkets which aim to maximize sales and influence how consumers behave and purchase food (HLPE, 2017; Das Nair, 2020). For instance, transnational food and beverage companies, like Heineken, Walmart, and Carrefour, have entered many Sub-Saharan African urban food systems (Baker & Friel, 2016; Raimundo et al., 2018; Nkhonjera & Das Nair, 2018). The spread

of supermarkets appears to be catalyzed by rapid urbanization, rising incomes, and the promotion of ultra-processed convenience food spurred by the globalized media and the enhanced use of advanced internet technology (Traill, 2006; Battersby & Watson, 2018).

Supermarketization in urban food systems of the global south

Within this context of urbanizing food systems, Africa has become a growing market for supermarkets, especially Southern Africa (Reardon et al., 2004) where Matola is located. The spread of supermarkets is often referred to as "supermarketization" or "supermarket revolution" which is defined by the increased sale of food products through supermarkets (Das Nair, 2020). Supermarkets have become prominent food sources in cities, drawing consumers from both wealthy and poorer neighborhoods (Traill, 2006). City-wide surveys in Maputo, Mozambique by the Hungry Cities project reveal that a third of households purchased food such as milk, sweets and chocolate from supermarkets (Raimundo et al., 2018). The proliferation of supermarkets in the developing world and their implications for urban food system transformations have become a growing research area (Crush & Frayne, 2011).

Reardon et al. (2019) offer a conceptual framework for understanding food system transformations from traditional to modern food systems. The traditional food system, defined by small food supply chain actors and rural food producers dealing in low processed food, undergoes a transition to a modern food system defined by urban food enterprises selling increasingly processed food (Reardon et al., 2019). Food systems in the modern stage are characterized by widely accessible supermarkets and processed foods (Reardon et al., 2019). Most countries are experiencing these transformations simultaneously with product-specific and location-based variations as consumer behavior changes from the traditional stage to the modern stage via increasingly frequent food purchases from supermarkets (Reardon et al., 2021).

The spread of supermarkets implicated in food system transformations have also been linked to ongoing nutritional and epidemiological transitions (Popkin, 1999, 2001; Baker & Friel, 2016). The nutrition transition describes cultural shifts in dietary preferences towards processed, fatty and sugary foods and shifts in activity levels towards sedentary lifestyles (Popkin, 2001). These marked shifts have influenced non-communicable disease patterns and the intertwined occurrences of undernutrition, stunting and obesity in the last few decades (Popkin, 2001; Popkin, 2004). This phenomenon, termed "the double burden of malnutrition," or 'DBM', has been observed across Sub-Saharan Africa and South Asia (Popkin, 1999, 2001; Reardon et al., 2021). That said, the implications of the supermarket revolution for this nutrition transition appear to be mixed in the research literature (Popkin, 2021). For instance, recent meta-analyses indicate that the results from investigations into the association between supermarket accessibility and rates of childhood obesity are mixed and further research is needed (Zhou et al., 2021).

These trends have significant implications for local food markets in cities. Studies from the early 2000s predicted that the spread of supermarkets in the Global South would accelerate and overtake local retailers (Reardon et al., 2003; Reardon & Hopkins, 2006). Indeed, some authors have identified growing tensions in price, convenience, quality and safety between traditional retailers and supermarkets (Reardon & Hopkins, 2006; Machado et al., 2017; Makhitha & Khumalo, 2019). However, recent

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studies indicate that traditional, transitional and local food retailers still dominate sub-Saharan food consumption and purchases (Crush et al., 2018), whilst supermarkets cater for only about 10–20% of total processed food retail (Reardon et al., 2021). Notably, local or traditional food systems have begun to incorporate the sale of ultra-processed foods that were previously only found in supermarkets (Global Panel, 2017).

The diversity of household food sources is displayed in Maputo, Mozambique where common household food sources include supermarkets, traditional markets, small shops, informal street and backyard vendors. According to Raimundo et al., (2018), 91% of households in their survey of households in Maputo purchased food from traditional markets and small shops at least twice weekly whilst only 37% purchased food from supermarkets at least once a week or less. Within the Mozambican context, supermarket products are more often accessed via smaller kiosks and shops rather than at supermarkets themselves (Gómez, & Ricketts, 2013). In other words, patrons may be able to access supermarket products at a variety of sources (each with varying pricing and convenience) and supermarkets are integrated in the value chain for other food sources, like small to medium sized kiosks.

Local and informal food systems therefore play an important role in providing food access among residents in deprived areas who cannot access supermarkets (McCordic & Raimundo, 2019) as well as providing jobs and income for the urban population (Raimundo et al., 2020). Within this context, poor urban households can increase the stability of their food access by accessing food from a range of food sources (Battersby & Haysom, 2018). This observation supports the phenomenon of 'selective' adoption, which has been documented in other cities, where consumers who purchase food at supermarkets still frequently purchased food from traditional markets as well (Goldman, 2000; Ratnayake, 2015; Si, Scott, and McCordic, 2019).

These transformations also reflect evolving consumer food purchase behaviors, which can differ based on demographic and socioeconomic characteristics. Studies in Nanjing China identified frequent supermarket shoppers as mostly younger males earning high incomes who frequently purchased convenience foods like canned and pre-cooked food (Veeck & Veeck, 2000). Conversely, traditional food market patrons were mostly older married females, earning lesser incomes who purchased frequently from local markets near their homes (Veeck & Veeck, 2000). More recent studies from Nanjing have indicated the important role that accessibility plays in shaping food purchasing decisions (Si, Scott, & McCordic, 2019).

Consumer purchasing behavior is driven by both consumer motivations and by the characteristics of the food environment in which that consumer resides (Reardon et al., 2021). However, the influence of such factors on food sourcing from supermarkets or local food retailers has not been extensively researched in a Global South context.

Drivers of Supermarketization

The interrelated factors of urbanization, employment shifts, income growth and liberalization policies have influenced the demand and supply of ultra-processed foods, primarily via supermarkets, in Sub-Saharan Africa (Reardon et al., 2021). An assessment of

demand side factors indicates that supermarkets are positioned in areas where consumers can afford supermarket products (close to high-income residential areas). According to Tschirley et al., (2015), more than 66% of urban household food expenditure in sub-Saharan Africa went to processed foods. Battersby (2017), demonstrated that a similar supermarket diffusion process can also happen within cities based on socioeconomic indicators of wealth. Via a case study of Cape Town, Battersby tracked the proliferation of supermarkets from wealthy to poor neighborhoods over an approximate 20-year period. Her findings indicated that wealthy neighbourhoods were often targeted first by supermarkets before lower income neighbourhoods.

This research implies that low-income communities will be the least considered for the siting of supermarkets. Ongoing trends, however, indicate that there is little difference in the demand for supermarket items across low to high income terciles in Africa and Asia with regards to the consumption of non-staple and processed food (Reardon et al., 2019). Despite this shared demand for supermarket products across income groups, the neglect of low-income communities as sites for supermarket locations may mean that the food security of such communities will be undermined by urban planning (Pothukuchi & Kaufman, 2000). This trend may result in the creation of urban food deserts. Food deserts have been described as communities in economically disadvantaged areas who are food insecure because of structural inequalities such as the absence of supermarkets. However there is the need for caution when applying the concept to African urban food systems, where a diversity of formal and informal food retailers may comprise a given food system (Battersby, 2012; Crush et al., 2018).

The food desert phenomenon is primarily grounded in a Global North context and has often been measured according to the presence or absence of supermarkets in a given spatial area (Battersby & Crush, 2014). This association between supermarket location and food security may not be appropriate in the Global South, where the emergence of supermarkets in the region has been more recent compared to the Global North (Battersby & Crush, 2014). In line with this discussion, Battersby and Watson (2018) recommend that the siting of supermarkets in low-income communities should not displace existing informal markets which are suited to consumer demands (which may include a demand for smaller food purchases, payments on credit and earlier/later hours of operation when compared to supermarkets). This diversity in food sourcing is already seen in Maputo where urban residents purchase groceries from both informal vendors and supermarkets. Conceptualizing food deserts in the Global South should include complexities regarding mobility, accessibility, transportation, time and education as well as structural drivers of food insecurity existing outside the scope of households (Battersby & Crush, 2014; Wagner et al., 2019; Shannon, 2014).

From a supply perspective, supermarket diffusion can be described at a regional scale, where supermarket diffusion begins in larger cities before spreading to rural towns (Reardon & Hopkins, 2006). Battersby (2017), indicated that changes in zoning restrictions following the end of apartheid in South Africa allowed large supermarkets to establish themselves in population centers of Cape Town that was previously prevented. This trend highlights the role of urban planning, zoning and spatial distribution in facilitating supermarket access.

Reducing spatial unavailability by localizing food systems creates more options and provides access to nutritious food whilst reducing the incidence of diet related diseases (Seyfang, 2009). The spatial availability of supermarkets and their proximity to living areas (accessible within minutes by biking or walking) have been key for increased patronage of supermarkets (Goldman, 2000; Zhong et al.,2018). In some communities without supermarkets, large supermarket chains may own smaller convenience stores to be able to cater for the needs of such consumers in urban, peri-urban as well as rural areas (Das Nair, 2020). Given the evolving role of supermarkets in urban food systems, the literature on the drivers of supermarket patronage in cities offers heterogeneous insights into the social and spatial drivers of the phenomenon.

The studies that have investigated the drivers of supermarket patronage are often contextually bound to the large global cities within which these investigations were carried out. Given the focus on global cities in the supermarketization literature, further research on the drivers of supermarket patronage within the context of secondary cities of the Global South is needed. This gap and research impetus is especially true given the projected rapid growth of these cities in Africa and Asia (UN DESA, 2019). Consequently, Matola provides a fertile ground for empirical studies on the spread of supermarketization and food insecurity in secondary cities. This investigation will rely on household survey data to investigate the respective social and spatial drivers of supermarket patronage within the secondary city of Matola, Mozambique.

Methods
Research objectives

- Objective One: Subset the sampled household market base for supermarkets in Matola using key spatial and demographic indicators
- Objective Two: Compare supermarket attitudes among frequent and infrequent supermarket patrons in Matola

Sample

The sample for this investigation was drawn from a household survey of Matola conducted in 2014 by the Hungry Cities Partnership ($n = 507$). The survey was administered by trained enumerators from Eduardo Mondlane University in Maputo. The survey was administered in 10 randomly selected wards in the city of Matola (Table 1). The total survey sample was then distributed across the 10 selected wards using approximate proportional allocation based on the most recently available census data for Matola. Within the 10 selected wards, enumerators followed a systematic sampling pattern to select households for the survey. The survey was then administered to adult household members who were able to respond on behalf of their household. This survey received research clearance from the Research Ethics Board at Queen's University in Kingston, Ontario.

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Table 1 Distribution of sampled households in Matola

Ward	n	%
Accordo de Lusaka	22	4.3
Fomento	50	9.9
Infulene	24	4.7
Liberdade	66	13
Matola A	94	18.5
Matola Gare	18	3.6
Ndlavela	99	19.5
Nkobe	16	3.2
São damaso	47	9.3
Zona verde	71	14
Total	*507*	*100*

Table 2 Demographic indicators used to subset the market base for supermarkets

Dependent Variable	Categories				
Supermarket Access	No	Yes			
Independent Variables	**Categories**				
Ward	Sampled Wards				
Household Structure	Female centered	Male centered	Nuclear	Extended	Other
Lived Poverty Index	<=1.00	1.01–2.00	2.01–3.00	>=3.01	
Household Food Security (HFIAP)	Food Secure	Mildly Food Insecure	Moderately Food Insecure	Severely Food Insecure	

Variables

The survey instrument administered in this household survey of Matola collected data on household food security, consumption, demographic and poverty indicators. In order to assess the market base for supermarkets in Matola, this investigation relied upon the following variables (Table 2).

The dependent variable in this analysis was supermarket access. This variable measured whether or not the respondent household sourced their food from supermarkets. This variable was administered as part of a broader list of food sources in which the respondent was asked to select their household food sources. If the respondent selected supermarkets as a food source, then they were categorized into the "yes" category for this variable. If the respondent did not select supermarkets as a food source, then they were categorized into the "no" category for this variable.

The ward location of each sampled household was collected in the survey administration process. In addition to this spatial variable, the survey instrument also measured the household structure. This variable describes the demographic structure of the household based on the characteristics of the household members. The variable categorized each sampled household into one of the following household structure categories: Female centered (No husband/male partner in the household, may include relatives, children, friends), Male centered (No wife/female partner in household, may include relatives, children, friends), Nuclear (Husband/male partner and wife/female

partner with or without children), Extended (Husband/male partner and wife/female partner and children and relatives) and Other (encompassing any other household structure).

Household food security was measured in this investigation by the Household Food Insecure Access Scale (HFIAS) (Coates et al., 2007). This scale measures food security according to the frequency with which households have experienced food access challenges in the previous month. The dimensions of food access challenges covered by the HFIAS questions include physical, economic, and social challenges to food access. In response to these questions, household respondents were provided with the following ranked answers (on a scale from 0 to 3): No, Rarely (once or twice), Sometimes (3 to 10 times), Often (more than 10 times). In order to calculate the final categorical score for the scale (The Household Food Insecure Access Prevalence or HFIAP), a scoring algorithm was applied to the numeric scores for each of these answers. The HFIAP categorizes a household as either: Food Secure, Mildly Food Insecure, Moderately Food Insecure, or Severely Food Insecure.

Household poverty characteristics were measured using the Lived Poverty Index (LPI). This index measures the frequency with which households have gone without basic resources and services in the previous year. The scale includes questions regarding the frequency with which households have gone without the following resources in the previous year: food, clean water for home use, medicine or medical treatment, electricity, cooking fuel and a cash income. In response to these questions, respondents were provided with the following ranked answers (on a scale from 0 to 4): Never, Just Once or Twice, Several Times, Many Times, Always. The numeric responses to each of these answers were then averaged across the six questions. The average score was then categorized as: <= 1.00, 1.01–2.00, 2.01–3.00, > 3.01 (where higher scores represent greater degrees of poverty as measured by frequency of access to the resources included in the scale questions).

In addition to these spatial and demographic characteristics, this investigation also included a series of attitudinal measures meant to assess opinions about supermarkets among frequent and infrequent supermarket patrons. For the purposes of this investigation, a frequent supermarket patron was a household that accessed supermarkets on a monthly basis. An infrequent supermarket patron was a household that accessed supermarkets less than once a month. Depending on the category that a household was allocated to (a frequent or infrequent supermarket patron), the household respondent was asked to respond to a unique series of attitudinal questions about supermarkets. The frequent supermarket patrons were provided with a series of statements about reasons for shopping at a supermarket. The infrequent supermarket patrons were provided with a series of statements about reasons for not shopping at a supermarket. The respondents were given the option of agreeing, neither agreeing or disagreeing, or disagreeing with the statement (Table 3).

Analysis

All analyses in this investigation were carried out using IBM SPSS version 27. This investigation achieved the first research objective (subset the sampled household market base for supermarkets in Matola using key spatial and demographic indicators) using

Table 3 Attitude questions posed to frequent and infrequent supermarket patrons

Frequent Supermarket Patron Attitudes	Categories		
Food is cheaper at supermarkets	Agree	Neither	Disagree
Food is better quality at supermarkets	Agree	Neither	Disagree
Supermarkets have a greater variety of foods	Agree	Neither	Disagree
We can buy in bulk at supermarkets	Agree	Neither	Disagree
Supermarkets are where we get social pay-outs so we shop there	Agree	Neither	Disagree
Infrequent Supermarket Patron Attitudes	**Categories**		
Supermarkets are too expensive	Agree	Neither	Disagree
Supermarkets do not provide credit	Agree	Neither	Disagree
Supermarkets are only for the wealthy	Agree	Neither	Disagree
Supermarkets do not sell the food that we need	Agree	Neither	Disagree

Chi-Square Analyses and a CHAID decision tree. The Chi-Square Analyses was carried out to determine whether supermarket access (the dependent variable) was independent from a household's HFIAP score (food security status), LPI score (poverty status), household structure or ward of residence. Due to the small sample size and number of categories subsumed by the variables included in this analyses, the Chi-Square Analyses provided in this investigation were supported by monte carlo simulations based on 10,000 sampled tables with a starting seed of 2,000,000. While none of the analyses violated the assumption that no more than 20% of the cross-tabulated expected counts were less than five in any given cell (Yates et al. 1999, p. 734), some of the cross tabulated analyses did indicate this issue for less than 20% of the cells in the cross-tabulated tables (these analyses have been noted in the results section). As a result, the *p*-values derived from the monte carlo simulations provide convergent validity for the observed Chi-Square findings.

One of the limitations of this Chi-Square analysis is that it only assesses the association between supermarket patronage independent variables according to the categories in these variables. When identifying subsets of supermarket patrons in the sample, it is possible that significant groupings or splits in the categories of the independent variables may strongly differentiate supermarket patronage. In order to address this limitation, this investigation has used CHAID (Chi-Square Automatic Interaction Detection) analysis to build a decision tree for classifying supermarket patronage based on the independent variables in this investigation. The CHAID decision tree was built using a learning algorithm that iteratively divides the sample through a Chi-Square analysis of the independent variables included in the investigation (ward of residence, household structure, LPI, and HFIAP) against the dependent variable (supermarket access). The Chi Square analysis is applied to the splits in the independent variable categories associated with the highest Chi-Square value (by merging and splitting categories within each variable). The variable with the highest Chi-Square value is then used to segment the sample (according to the splits identified for that variable). The process is then repeated within the sample sub-segments defined by the categories of the split variable (identifying the variable, and variable splits, associated with the highest Chi-Square value). As a result, the learning algorithm can very efficiently segment a sample based on responses to a dependent variable (in this case, supermarket access). In order to avoid over-fitting, the

model was pruned so that each parent node had a minimum of 50 households and each child node had a minimum of 25 households. This method of analysis can also be used to identify the variables that can most efficiently categorize the sample (based on the independent variable that is used in the first split of the decision tree). This investigation also relied upon descriptive statistics and cross-tabulations in order to better understand the attitudinal factors involved in supermarket food sourcing among frequent and infrequent supermarket patrons.

Limitations

Given the sampling methods used in this investigation, and the limited availability of list frames or area frames (highly detailed lists or maps of the target population) to inform the random selection of respondents, the household sample used in this investigation may not be representative. Instead, the analyses provided in this investigation give insight into some of the potential factors driving supermarket patronage among the sampled households. Furthermore, as is common to all surveys, the results of this analysis are reliant upon the accuracy of recall among survey respondents. None of the analyses presented in this investigation should be interpreted as causal inferences, instead, this investigation relied upon measures of association between variables to investigate broader trends in supermarket patronage. Finally, this analysis is based on a cross-sectional case study design. The findings are specific to the sampled households in Matola at the time of data collection. Further research will be needed to assess these trends in other areas or time-periods and to further assess the contribution of ward-level data to the inference of supermarket access among households in Matola.

Results

Objective one: subset the sampled household market base for supermarkets in Matola using key spatial and demographic indicators

The cross-tabulations of the independent variables (the household structure, HFIAP, LPI, and ward of residence) against the dependent variable in this investigation (supermarket patronage) revealed some interesting trends. The majority of the independent variables were not independent of supermarket patronage according to the Chi-Square analysis with the support of monte carlo simulations. That said, the *p*-value for household structure does not conclusively indicate that the variable is not independent of supermarket patronage. In other words, the distribution of household supermarket patrons according to household structure did not appear to significantly deviate from what would have been expected. The HFIAP and LPI cross-tabulations indicated that food insecure and poorer households in the sample were less frequently identified as supermarket patrons. The Chi-Square analysis indicated that, among the independent variables, the ward of residence demonstrated the highest Chi-Square value when the variable was cross tabulated with supermarket patronage. In other words, the ward of residence variable was the least likely to be independent of supermarket patronage as indicated by the wide degree of variation in supermarket patronage amongst the wards represented in this variable (Table 4).

The CHAID decision tree identified some very interesting trends among the sampled households (Fig. 1). These trends can be understood according to the variables that were

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Table 4 Chi-Square analysis of cross-tabulated spatial and demographic indicators by supermarket patronage

		Supermarket Patron			
		No		Yes	
		n	%	n	%
Household Structure[a]	Female centered	98	28%	32	21%
	Male centered	37	11%	19	12%
	Nuclear	108	31%	64	42%
	Extended	96	27%	37	24%
	Other	11	3%	1	1%
	Total	*350*	*100%*	*153*	*100%*
			Monte Carlo Simulation Findings		
	Pearson Chi-Square	*2-Sided*	*2-Sided*	*99% Confidence Interval*	
	Value	*P-Value*	*P-Value*	*Lower*	*Upper*
	9.332	*.053*	*.052*	*.046*	*.058*
Household Food Insecure Access Prevalence	Food Secure	78	22%	88	58%
	Mildly Food Insecure	39	11%	14	9%
	Moderately Food Insecure	80	23%	18	12%
	Severely Food Insecure	155	44%	32	21%
	Total	*352*	*100%*	*152*	*100%*
			Monte Carlo Simulation Findings		
	Pearson Chi-Square	*2-Sided*	*2-Sided*	*99% Confidence Interval*	
	Value	*P-Value*	*P-Value*	*Lower*	*Upper*
	63.093	*<.001*	*.000*	*.000*	*<.001*
Lived Poverty Index Categories[b]	<= 1.00	277	81%	142	96%
	1.01–2.00	57	17%	5	3%
	2.01–3.00	8	2%	1	1%
	Total	*342*	*100%*	*148*	*100%*
			Monte Carlo Simulation Findings		
	Pearson Chi-Square	*2-Sided*	*2-Sided*	*99% Confidence Interval*	
	Value	*P-Value*	*P-Value*	*Lower*	*Upper*
	18.673	*<.001*	*<.001*	*.000*	*<.001*
Ward of Residence[a]	Accordo de Lusaka	14	4%	8	5%
	Fomento	15	4%	35	23%
	Infulene	17	5%	7	5%
	Liberdade	57	16%	9	6%
	Matola A	43	12%	51	33%
	Matola Gare	11	3%	7	5%
	Ndlavela	85	24%	14	9%
	Nkobe	13	4%	3	2%
	São damaso	44	13%	3	2%
	Zona verde	54	15%	17	11%
	Total	*353*	*100%*	*154*	*100%*
			Monte Carlo Simulation Findings		
	Pearson Chi-Square	*2-Sided*	*2-Sided*	*99% Confidence Interval*	
	Value	*P-Value*	*P-Value*	*Lower*	*Upper*
	99.759	*<.001*	*.000*	*.000*	*<.001*

a ≤ 10% of the cells have an expected count less than 5

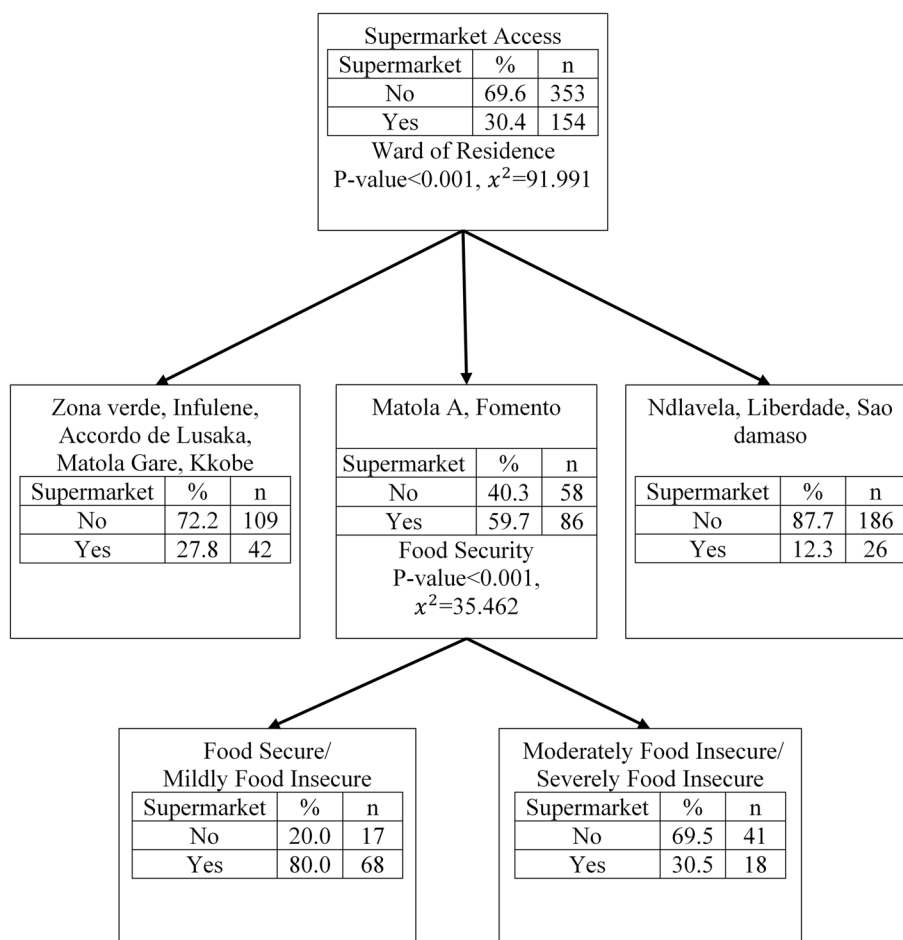*b 11–20% of the cells have an expected count less than 5*

Fig. 1 CHAID Decision Tree Model of Household Supermarket Patron Segmentation ($n = 507$)

included and excluded in the model based on the analyses performed by the CHAID learning algorithm. The model indicated that the best initial split for predicting household supermarket access would be the ward of residence. As demonstrated in the earlier Chi-Square analysis, this finding indicated that the spatial characteristics of the sampled households were more important than the demographic characteristics of the sampled households in predicting supermarket access. Within the Matola A and Fomento wards, the household sample was further segmented by food security status before the learning algorithm stopped due to insufficient sample sizes in either the parent or child nodes.

The findings indicate that the highest levels of supermarket access were among the sampled households in Matola A and Fomento, where about 60% of the sampled households had accessed supermarkets as a food source. The supermarket patronage in these wards was divided according to the food security status of the sampled households, where 80% of food secure or mildly food insecure households accessed supermarkets while only about 30% of moderately or severely food insecure households accessed supermarkets as a food source. The lowest levels of supermarket access were observed among the sampled households in Ndlavela, Liberdade, and Sao Damaso where only about 12% of the sampled households had accessed supermarkets as a food source.

The distribution of the demographic characteristics of the sampled households in each of the sampled wards provides further clarity to the supermarket access trends observed in the CHAID Decision Tree (Table 5). For example, Matola A and Fomento both had some of the highest rates of household food security (according to the HFIAP) when compared to the other sampled wards in Matola. That said, while poverty rates (as measured by the LPI) appeared to be relatively low in these wards, they were not exclusively low compared to the other sampled wards. Furthermore, there was no clearly discernable difference in the household structure of the households in these wards when compared to the other sampled wards. It is also worth noting that if these demographic variables better explained the association between ward of residence and supermarket access, then those demographic variables would likely have been selected over the ward of residence as the first split in the decision tree by the CHAID learning algorithm.

Objective two: compare supermarket attitudes among frequent and infrequent supermarket patrons in Matola

In order to investigate the potential motivations for frequently accessing supermarkets as a food source, the survey respondents were asked for their opinion on a number of attitudinal statements about shopping at supermarkets. Among these sampled household respondents, over 80% agreed that supermarkets provided a greater variety of food and over 75% agreed that supermarkets provided better quality food. That said, only a minority of the sampled household respondents claimed that they accessed supermarkets because they receive social grant pay-outs there and only around half the sampled households thought that food was cheaper at supermarkets.

The sampled household respondents that did not frequently access supermarkets (accessed less than once per month) were asked for their opinion on a number of attitudinal statements on reasons for not accessing supermarkets. Among the sampled households that did not frequently access supermarkets, over 65% agreed that supermarkets were too far away while only 40% thought that they were too expensive. Furthermore, only about 20% of these household respondents thought that supermarkets were only for the wealthy. Finally, less than 20% of the household respondents agreed that supermarkets did not sell the food that the household wanted. In summary, Tables 6 and 7 indicate that, among the sampled households, frequent supermarket patronage was associated with a desire for greater food variety and quality, while infrequent supermarket patronage seemed to primarily be associated with the challenge of spatial inaccessibility. Interestingly, while the majority of frequent supermarket patrons indicated that food was cheaper at supermarkets, about 38% of infrequent supermarket patrons indicated that supermarket prices were too expensive (but only 20% of these infrequent patrons thought that supermarkets were only for the wealthy).

Discussion

This investigation assessed the contribution of spatial and demographic factors in segmenting the supermarket market base in the secondary city of Matola, Mozambique. The findings indicated a potential spatial pattern to supermarket patronage in Matola. Further analysis of attitudinal statements from frequent and infrequent supermarket patrons appeared to indicate that spatial distance, more than wealth, was a common motivating factor for limited supermarket patronage. Taken together, these findings

Table 5 Cross-Tabulation of market segregation variables by sampled ward

Variable	Category	Accordo de Lusaka (n=22)	Fomento (n=50)	Infulene (n=24)	Liberdade (n=66)	Matola A (n=94)	Matola Gare (n=18)	Ndlavela (n=99)	Nkobe (n=16)	São damaso (n=47)	Zona verde (n=71)
Supermarket patron	No	63.6%	30.0%	70.8%	86.4%	45.7%	61.1%	85.9%	81.3%	93.6%	76.1%
	Yes	36.4%	70.0%	29.2%	13.6%	54.3%	38.9%	14.1%	18.8%	6.4%	23.9%
Household Structure	Female centered	22.7%	20.0%	37.5%	21.2%	24.7%	16.7%	23.5%	33.3%	17.4%	42.3%
	Male centered	9.1%	16.0%	8.3%	10.6%	14.0%	0.0%	6.1%	6.7%	30.4%	4.2%
	Nuclear	18.2%	50.0%	16.7%	24.2%	31.2%	77.8%	38.8%	46.7%	30.4%	29.6%
	Extended	50.0%	8.0%	37.5%	40.9%	28.0%	5.6%	29.6%	13.3%	17.4%	22.5%
	Other	0.0%	6.0%	0.0%	3.0%	2.2%	0.0%	2.0%	0.0%	4.3%	1.4%
Household Food Insecure Access Prevalence	Food Secure	4.5%	74.0%	25.0%	38.5%	40.4%	11.1%	32.0%	18.8%	25.5%	15.5%
	Mild F.I.	4.5%	4.0%	12.5%	7.7%	8.5%	0.0%	7.2%	12.5%	6.4%	31.0%
	Moderate F.I.	9.1%	8.0%	0.0%	21.5%	10.6%	44.4%	21.6%	18.8%	21.3%	36.6%
	Severe F.I.	81.8%	14.0%	62.5%	32.3%	40.4%	44.4%	39.2%	50.0%	46.8%	16.9%
Lived Poverty Index Categories	<= 1.00	94.7%	94.0%	100%	92.2%	85.9%	76.5%	76.5%	57.1%	89.1%	84.3%
	1.01–2.00	0.0%	4.0%	0.0%	7.8%	12.0%	23.5%	21.4%	42.9%	8.7%	12.9%
	2.01–3.00	5.3%	2.0%	0.0%	0.0%	2.2%	0.0%	2.0%	0.0%	2.2%	2.9%
	3.01+	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

(F.I. = Food Insecure)

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Table 6 Supermarket attitudes among frequent (monthly) supermarket patrons

Attitudes	Agree		Neither agree nor disagree		Disagree	
	n	%	n	%	n	%
Food is cheaper at supermarkets	78	56.1	34	24.5	27	19.4
Food is better quality at supermarkets	105	75.5	21	15.1	13	9.4
Supermarkets have a greater variety of foods	113	81.9	17	12.3	8	5.8
We can buy in bulk at supermarkets	86	62.8	25	18.2	26	19.0
Supermarkets are where we get social grant pay-outs so we shop there	31	23.8	30	23.1	69	53.1

Table 7 Supermarket attitudes among infrequent (Less than Monthly) supermarket patrons

Attitudes	Agree		Neither agree nor disagree		Disagree	
	n	%	n	%	n	%
Supermarkets are too far away	233	64.9	37	10.3	89	24.8
Supermarkets are too expensive	127	38.0	103	30.8	104	31.1
Supermarkets do not provide credit	93	31.3	123	41.4	81	27.3
Supermarkets are only for the wealthy	72	20.9	93	27.0	179	52.0
Supermarkets do not sell the food that we need	58	17.5	62	18.7	211	63.7

seem to indicate a spatial pattern to supermarket patronage in Matola that may not be better explained by wealth, food security status, or the demographic structure of households. The proximate location of a supermarket near communities seems to play an important role in household motivation to source food from supermarkets. This finding also supports findings in Shanghai and Nanjing where supermarket purchases were influenced by geographical diffusion and accessibility to supermarkets because they were within minutes of walking or bicycling from residences (Goldman, 2000; Zhong et al., 2018). While this investigation does not contribute towards broader discussions around the association between spatial distances to food sources and food security (Battersby, 2014), the findings do contribute towards an understanding of the drivers behind supermarket patronage and the motivations that seem to guide frequent and infrequent supermarket patronage (all within a secondary city context in Matola, Mozambique). That said, if supermarkets continue to proliferate within Matola and become more spatially accessible, it is difficult to predict whether supermarket patronage preferences would change. Other case studies have indicated a continued preference for informal food sources, even when supermarkets are spatially accessible (Peyton, Mosely, & Battersby, 2015).

This discussion emphasizes the important role of traditional and informal food systems and suggest that 'hybridized' forms of patronage may exist where households are able to purchase needed supermarket products from smaller convenience stores than supermarkets far away. This discussion may support findings by Das Nair, 2020 who identified that large supermarket chains may own smaller convenience stores in poor urban neighborhoods. These findings highlight the need for further research on the

relationships between large supermarket chains and smaller traditional food vendors or convenience stores in providing food access in the Global South. Knowledge of the limitations encountered by supermarkets in establishing their presence and spread in Mozambique and possibly the Global South may provide insights into their spatial location and patronage by consumers. Future research should also focus on determining other, spatially disaggregated, reasons that may explain the spatial pattern observed in this investigation. Further GIS analysis may provide a more precise analysis of the spatial distribution of supermarkets in relation to households in order to verify the impact of distance on supermarket patronage. It is also possible that the distribution of housing and infrastructure in the city may attract households of different socio-economic strata to different areas of the city (which may shape the spatial spread of supermarket patrons). It will also be interesting to note whether these findings are replicated in other secondary cities of the Global South, given the implications of these findings for the supermarketization of urban food systems.

Conclusions

The current findings indicate the importance of spatial location in driving consumer food preferences, indicating a possible leverage point for municipal zoning laws as part of urban food policies. If further research is able to validate these findings, municipalities should consider spatial distances between residential areas and food outlets when designing policies for zoning and transportation in secondary cities. The proliferation of public transportation systems in these secondary cities will also likely change the opportunity costs in time associated with food source preferences. In other words, the policy implications of this discussion may extend beyond zoning to include transportation planning within cities and increased access to safe and nutritious foods in both supermarkets and traditional food systems. At the same time, further market research on food sourcing preferences may provide helpful guidance for these municipal zoning policies by ensuring a diversity of food sourcing options to match heterogeneous food source patronage preferences.

Authors' contributions
Conceptualization, C.M. and B.F.; methodology, C.M.; validation, C.M..; formal analysis, C.M.; investigation, C.M., B.F., and N.S..; data curation, C.M.; writing—original draft preparation, C.M., B.F., and N.S.; writing—review and editing, C.M., B.F., and N.S.; visualization, C.M.; supervision, C.M. and B.F.; project administration, C.M. and B.F.; All authors have read and agreed to the published version of the manuscript.

Availability of data and materials
Due to the phrasing used in the informed consent process during the household survey, the data cannot be made available for public viewing.

Declarations

Competing interests
The authors of this manuscript declare that they have no financial or non-financial competing interests related to the research carried out in this manuscript.

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