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# Does Retail Food Diversity in Urban Food Environments Influence Consumer Diets?

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**Abstract:** The food environment influences consumer diets in significant yet underexplored ways. In this study, we assess the way in which the Nairobi urban food environment—availability, accessibility, affordability, desirability, convenience and marketing—influences the dietary choices and quality of poor urban consumers, by combining market-level diversity scores (MLDS) with household and individual data collected from resource-poor (slum) neighbourhoods in Nairobi, Kenya. We find that urban-poor settings are characterized by a variety of food retail venues, including informal markets such as kiosks, mom-and-pop shops and tabletop vendors, as well as modern retail outlets such as supermarkets. Most of these food outlets predominantly sell unhealthy, highly-processed and energy-dense foods rather than nutritious foods such as vegetables, fruits and animal products. Our analyses show that supermarkets have the highest MLDS, yet they do not significantly influence the diets of resource-poor households. However, a high MLDS among informal retail outlets has a positive association with diet quality; conversely, open-air markets have a negative association. The nutritional status of urban-poor consumers can be improved by promoting the diversification of healthy, nutritious foods across traditional retail outlets and improving accessibility of the outlets to consumers.

**Keywords:** food environment; market-level dietary diversity (MLDS); individual dietary diversity; household dietary diversity; urban-poor consumers; Kenya

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## 1. Introduction

Food and nutrition security are still a major concern in most developing economies. In 2019, about nine per cent of the global population—690 million people—was undernourished [1]. This figure is expected to be much higher as a result of the COVID-19 pandemic. Food and nutrition insecurity figures for 2019 were significantly higher in Africa, where more than 19 per cent of the population—250 million people—was undernourished; this represents a 1.5 per cent increase for Africa compared to 2014. Globally, just over 21 per cent of children under five years of age were stunted in 2019, of which 40 per cent were in Africa. In addition, 340 million children around the world were affected by micronutrient deficiencies in 2019, and 38.3 million (5.6 per cent) were overweight [1].

These nutrition and food insecurity challenges persist, while global population and urbanization are rapidly increasing. More than half of the global population currently live in urban areas, a share that is expected to increase to 70 per cent by 2050 [2]. Africa has the highest population growth and urbanization rates in the world; more than half of the projected global population growth between 2015 and 2050 will occur in Africa, and

projections indicate that 56 per cent of the African population will be living in urban areas by 2050 [3]. Given these trends, there is an urgent need to identify ways to provide the growing population, across the wealth spectrum, with sufficient food and healthy diets, especially the urban poor.

Income and food environment both influence household dietary choices. The food environment is the context in which consumers interact with food and what influences their choices; it encompasses key elements such as food availability, accessibility, affordability, desirability, convenience and marketing [4–8]. Given that most urbanites access food through markets, it would be important to ensure the affordability and accessibility of nutritious foods through these outlets [9]. While sufficient income is a key element to extending healthy diets among urban households, its role is somewhat contingent on the nature of the food environment. Rising incomes can influence food environments and have a positive effect on dietary diversity and quality, making healthy foods, such as vegetables, fruits, legumes and animal products, more widely available and affordable to consumers. Conversely, when inexpensive, low-quality, ultra-processed, highly-salted and sugary foods are primarily offered, negative dietary effects may be observed [4,10], particularly among resource-poor consumers whose limited budgets often influence their dietary choices.

The food environment plays a crucial role in shaping consumers' dietary preferences, food choices and nutritional outcomes [11,12]. It is the interface that mediates one's food acquisition and consumption within the wider food system [9]. In simpler terms, the food environment comprises the range of foods available in food retail outlets such as supermarkets, grocery stores, wet markets, street food stalls, coffee shops, teahouses, school canteens, restaurants and all other venues where people procure and eat food. The types of food available in these outlets, their pricing and their proximity to households all play a role in determining what consumers purchase and consume.

In developing economies, the food environment has undergone tremendous transformation in recent years, particularly the expansion of supermarkets [13]. The trend started in the early 1990s in Latin America and Asia, while in Africa the 'supermarket revolution' took off almost a decade later [14]. Since the late 1990s, the spread of supermarkets in Africa has been rapid, accounting for more than 10 per cent of all food retail outlets across this continent. In some countries, such as Kenya, this share rises to about 20 per cent in large cities [15,16]. The expansion of supermarkets generally implies the availability of diverse foods to urban consumers who traditionally rely on markets to procure food. However, while modern retail outlets, especially supermarkets and convenience stores, are mostly utilized by high-income consumers, traditional retail outlets such as wet markets, mom-and-pop shops, kiosks and informal tabletop vendors (*mama mboga*) remain the most important sources of food procurement for resource-poor consumers [17]. Therefore, studies assessing the role of the food environment on consumer behaviour must consider the co-existence of formal and informal markets [5].

From a policy-development perspective, it is important to consider how the food environment influences the food choices of resource-poor consumers. Information about the direct relationship between food environment and consumer choice is limited, especially for households located in urban informal settlements (slums), despite this category's higher vulnerability to all forms of malnutrition and poor health. Moreover, urban dwellers, including resource-poor consumers, depend on purchased food rather than on home-grown food. The urban food environment therefore needs to be clearly understood if it is to be leveraged to respond to the dietary needs of the urban poor.

Urban and rural consumers live within differing food environments. In rural areas, the food environment is influenced by what households produce, in addition to what is available from markets. Recent studies have shown how production diversity influences dietary diversity among farm households [18–21]. Production diversity is positively associated with individual and household dietary diversity in some but not all cases. Sibhatu and Qaim, for instance, showed that farms would need to produce, on average, 16 additional

crops or livestock species to increase their dietary diversity by one food group [18]. This indicates that the effect of production diversity on dietary diversity is relatively small. However, when coupled with improved market access, farm production diversity could boost access to diversified diets for rural farm households. While this may be an important development approach, it does not apply to urban households that rely almost entirely on market purchases for food.

Many studies have focused on the role of modern retail outlets, especially supermarkets, in relation to consumer diets and nutrition [22–26]. They often look at whether or not consumers are using a specific kind of retail outlet, without providing deeper analysis of the food diversity offered in these outlets or how it is associated with consumer dietary diversity. In this study, we address these research gaps by analysing the way in which the food environment influences the food choice of resource-poor consumers in the urban slums of Nairobi, Kenya. Studies of dietary diversity in rural areas utilize a farm-level production diversity indicator, but we use the emerging market-level diversity score (MLDS) to show the association between diversity in the food environment and urban, resource-poor households and consumers [27,28]. To our knowledge, given that the MLDS indicator is a relatively new concept, no study to date has considered this relationship.

## 2. Materials and Methods

### 2.1. Sampling and Data

Data for this study were collected in 2017 from resource-poor consumers in two urban slums of Nairobi, Kenya. Household and retail outlet data were gathered through surveys, using structured questionnaires programmed into computer-aided personal interviewing technology. The questionnaires were well-tested prior to conducting the surveys. In addition, the data collection assistants were trained to ensure they understood the questionnaires, eliminating unnecessary data errors. Various types of data were collected, including household demographics, household and individual food consumption patterns and information about the commodities sold in the outlets. Location variables and Global Positioning System (GPS) coordinates for households and outlets were taken and used to calculate the distances between households and outlets.

Nairobi was selected because it is one of the largest cities in East Africa and the most urbanized in Kenya. In addition, more than half of its population is believed to live in informal settlements [29]. Two low-income study sites were selected based on census data from the Kenya National Bureau of Statistics (KNBS): Kibra and Imara Daima [30]. Within Kibra, four sub-locations were selected, namely Kibera, Lindi, Makina and Siranga; within Imara Daima, the focus was placed on the Mukuru Kwa Njenga slum. The KNBS national census for Kenya categorizes our study sites as low-income locations. Study households from each sub-location were selected using a systematic random sampling procedure. In total, 187 households were interviewed across the two study locations. The target respondent for each household was the main food consumption decision-maker; in most cases, but not all, this was the spouse of the household head or the main female figure in the household.

In defining the food environment, our study targeted formal outlets, represented by supermarkets, and informal outlets, represented by kiosks, mom-and-pop shops, tabletop vendors, cereal shops, open-air markets, street vendors and informal restaurants selling cooked foods. However, the representation of some retail outlets, particularly supermarkets, was low in some study sites. In total, 149 outlets were interviewed. The target respondent at the outlet level was the owner. The outlet operators were only interviewed if the owner was not available and if the operator had sufficient information about business operations. In our study, we expand upon earlier work conducted in the urban slums of Nairobi, which made an initial attempt at characterizing retail outlets, and reclassify some of these outlets to provide a better understanding of available outlets in the informal settlements of Nairobi (Table 1) [17].

**Table 1.** Categorization of food retail outlets in the informal settlements of Nairobi, Kenya.

| Type | Description |
|---|---|
| Supermarkets (formal) | Fixed structures. Offer a large selection of types and brands of processed and ultra-processed foods. Additionally offer packaged cereals and legumes, household goods and personal care products in small, less-diverse quantities. Rarely offer fresh fruits or vegetables. Independently owned; self-service; size: 300–500 $m^2$. No possibility of purchasing on credit. |
| Kiosks (informal) | Small, temporary or mobile stands. Offer quick-service food and non-food products mostly in small quantities; repackage food and non-food products into smaller quantities for resale. Do not stock fresh produce. Individually- or family-owned; over the counter service; size: as small as 4 $m^2$; can offer purchase on credit to known customers. |
| Mom-and-Pop Shops (informal) | Fixed structures. Offer a moderate variety of non-food items, processed and ultra-processed foods, especially cereals. Offer limited quantities of fruits and vegetables. Individually- or family-owned; service is by owner; smaller than supermarkets but larger than kiosks; can offer purchase on credit to known customers. |
| Tabletop Vendors or *Mama Mboga* (informal) | Small mobile and temporary roadside stands. Offer fresh fruits, vegetables, and roots and tubers. Shred vegetables for customers on request. Individually-owned, mainly by women and youth; can offer credit, especially to well-known customers. |
| Cereal Shops (informal) | Small fixed structures. Offer cereals and legumes as grains and flour in 25, 50 or 90 kg bags, or packed in quantities according to demand. Individually- or family-owned; service is by operator; can offer credit to well-known customers. |
| Open-Air or Wet Markets (Informal) | A cluster of semi-permanent structures operated by various retailers. Open on specific market days, weekly. Stock fresh fruit and vegetables, cereals, legumes, roots and tubers and spices. Some have a section with non-food items. Stalls are individually-owned; service is by operator; no credit offered. |
| Cooked Food Street Vendors (Informal) | Small mobile and temporary roadside stands. Offer cooked foods. Most are set up daily, operating from late afternoon to late evenings. Individually-owned; no seating space for customers; no credit offered. |
| Informal Restaurants (Informal) | Small permanent or semi-permanent structures. Offer a diversity of cooked foods, including dishes prepared from cereals, legumes, vegetables and meat. Individually-owned; service by operator to customers who enter the structure and sit to eat; can offer credit to well-known customers. |

Source: Adapted from Wanyama et al. [17], and updated based on field observations.

Regarding the prevalence of the food retail outlets in the areas covered by this study, of the eight defined types (Table 1), only street vendors and informal restaurants sell cooked foods. In addition, only supermarkets can be broadly classified as modern retail establishments, given the variety of products they sell, their use of advertising and branding, procurement procedures and location. Supermarkets generally sell a wider range of food products than other outlets; this includes cereals, meat, dairy, sugar, fats and oils, and—to some extent—fruits and vegetables [17,23,31]. The rest of the studied outlets are regarded as traditional or informal outlets and are often characterized by the limited number of products they sell, although kiosks and mom-and-pop shops tend to be more diversified than the rest. The traditional/informal food retail outlets surveyed in this study were selected using a systematic random sampling approach, while for supermarkets, since there were very few in the study sites, we included all those present across the sites. The total number of outlets interviewed in the different categories is presented in Table 2.

Figure 1 presents the study outlets in the two study locations (Imara Daima and Kibra). The different types of outlets are presented in different colours and positioned on the map using their Global Positioning System (GPS) coordinates.

### 2.2. Household and Individual Dietary Diversity Scores

Individual-level and household dietary diversity scores (HDDS) are a simple count of the number of food groups consumed by an individual or household within a specific recall period [32–34]. We used seven-day dietary recall data to compute the study participants' HDDS. Following Kennedy et al., we calculated HDDS based on a 12-group classification, counting: cereals and grains; eggs; fish; fruits; legumes and nuts; meat; milk and dairy

products; oils and fats; roots and tubers; spices, condiments and beverages; sugar and sweets; and vegetables [32]. We also computed HDDS using a smaller, nine-group classification that excluded oils and fats; sugar and sweets; and spices, condiments and beverages, as these groups offer minimal contributions to micronutrient density. A full list of food groups by category is provided in Appendix A (Table A1). While a higher HDDS reflects a household's economic capacity to access food and consume a diverse diet, there is no agreed-upon threshold for HDDS as an indicator of a healthy diet [32].

**Table 2.** Prevalence by type of retail outlets sampled.

| Type | Frequency |
|---|---|
| Cereal Shops | 20 |
| Informal Restaurants | 22 |
| Kiosks | 18 |
| Mom-and-Pop Shops | 25 |
| Open-Air Markets | 20 |
| Street Vendors | 20 |
| Supermarkets | 7 |
| Tabletop Vendors | 17 |
| Total | 149 |

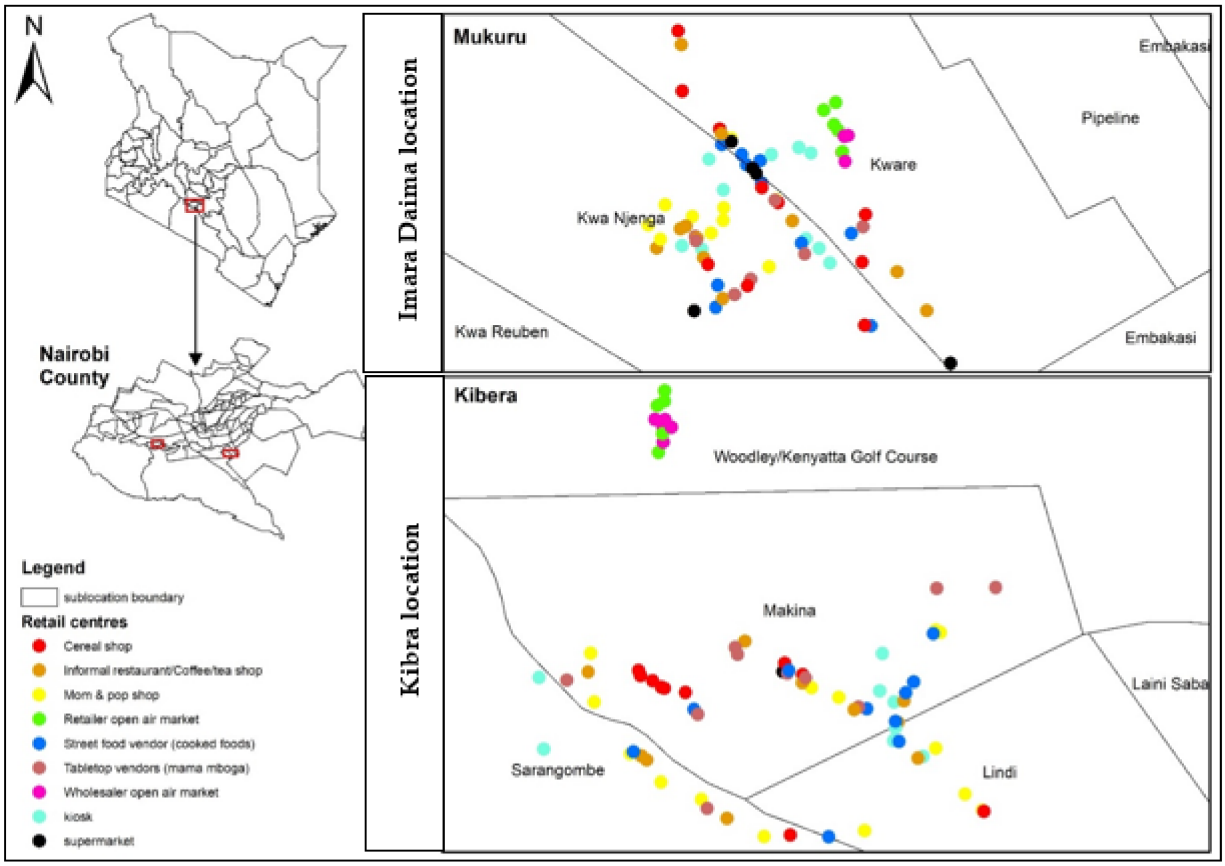


**Figure 1.** Distribution of sampled food retail outlets in the study areas by type. Source: Developed by authors.

At an individual level, we computed two scores: minimum dietary diversity for women (MDD-W) and minimum dietary diversity for children (IDD). The food groups included in each score are detailed in Appendix A (Table A1). MDD-W reflects the diversity and micronutrient adequacy of diets among women of reproductive age—15–49 years [35]. MDD-W is computed by comparing the target individual female's food consumption

over the previous 24 h to a list of 10 food groups. A score of five or more food groups is considered to represent the minimum dietary diversity that is associated with adequate intake of 11 key micronutrients [35]; anything less than five indicates that an individual has not achieved the minimum dietary diversity. IDD considers the dietary diversity of children between six months and five years of age as a proxy for the micronutrient adequacy of their diets [32]. IDD counts seven food groups (Table A1); micronutrient adequacy is thought to be achieved if a child has consumed four of them during the recall period. Consuming at least four of the seven food groups is associated with better quality diets for children.

### *2.3. Market-Level Diversity Scores*

Market-level diversity score (MLDS) is an indicator that shows the number of distinct foods or food groups available in a local market at a given point in time [27,28]. As with HDDS, it is computed using a 12-group classification (Table A1) in the Appendix [27,33]. Although still considered an 'emerging indicator', MLDS can provide an accurate understanding of local market supply, allowing for differentiated interventions to improve target consumers' dietary diversity [27,28]. A lower MLDS means that the market in question does not have a variety of food groups available for purchase; lack of supply reduces household and individual dietary diversity.

### *2.4. Statistical Methods*

We applied descriptive statistical and econometric analyses to the collected data. GPS data allowed us to compute the mean distance from households to nearby food retail outlets. We also calculated the market level diversity score (MLDS) and dietary diversity indicators at the household level and the individual level for women and children, both for the whole sample and disaggregated by study location. To show the influence of food environment on diets, we estimated a simple regression model using the following formula:

$$DD = \alpha + \beta MLDS + \varepsilon \quad (1)$$

where *DD* is the household or individual dietary diversity (DD) score, *MLDS* is the market-level diversity indicator for the food retail outlet in question, $\alpha$ and $\beta$ are estimated parameters, and $\varepsilon$ is the random error term. We estimated four separate models for each of the eight food retail outlet types to understand the association between retail outlet food diversity and consumption diversity. Positive values for $\beta$ imply that a higher *MLDS* for the retail outlet has a positive influence on individual or household dietary diversity, while negative values imply a negative influence.

## 3. Results and Discussion

### *3.1. Sample Characteristics*

Overall, 83 per cent of the sampled households were male-headed (Table 3). The average age of the household head was 34 years, and most had about 10 years of schooling, the equivalent of having completed primary education. The average annual household income across the two study sites was quite low (USD 3598), but those in Kibra had much lower average annual incomes (USD 1905) compared to households in Imara Daima (USD 5462).

Slightly more than half of the household heads were dependent on salaried employment as their primary source of income. At 46 per cent, the next largest share of the households' incomes came from casual employment, which is typical of the livelihoods of the urban poor [36].

**Table 3.** Summary statistics of household sample characteristics.

| Variable (Household) | Description | Mean | SD[+] |
|---|---|---|---|
| Gender of Head | =1 if household head is male (%) | 83.40 | 37.28 |
| Age of Head | Age of the household head (years) | 34.12 | 9.19 |
| Education of Head | Education level of the household head (years) | 9.79 | 4.10 |
| Income | Average annual household income (USD) | 3598.07 | 4381.73 |
| | Kibra site | 1905.22 | 1596.27 |
| | Kibra | 1988.35 | 1157.01 |
| | Lindi | 2044.08 | 2085.61 |
| | Makina | 1824.73 | 1364.75 |
| | Siranga | 1715.23 | 1169.80 |
| | Imara daima site | 5462.11 | 5573.76 |
| Occupation of head (%) | None | 1.60 | 12.60 |
| | Farming | 0.53 | 7.31 |
| | Salaried employment | 51.87 | 50.1 |
| | Casual laborer | 45.99 | 49.97 |
| Study location | Kibra | 52.41 | 50.06 |
| | Imara Daima | 47.59 | 50.08 |
| Number of Households | | 187 | |

[+]SD = Standard deviation.

### 3.2. Dietary Indicators

At the pooled sample level, household dietary diversity scores were high with 9 out of 12 food groups consumed (Table 4). When sweets and sugars, oils and fats, and spices, condiments and beverages were excluded, scores were 6.94 out of nine. Of the two location, households in Kibra have significantly lower IDD (3.23 out of 7) and MDD-W (6.79 out of 10) compared to those in Imara Daima location, whose averages were 3.91 and 8.01 respectively. When considering individual indicators, the results show that children's diets were characterized by low micronutrient adequacy. The overall IDD was 3.56 and all study locations also had a mean IDD of fewer than four food groups, which is below the minimum diet diversity threshold for children. Overall, 46 per cent of sampled children did not achieve the recommended minimum dietary diversity of four out of the seven food groups, and this number was significantly higher in Kibra (54 per cent) than in Imara Daima (37 per cent).

**Table 4.** Summary of dietary diversity indicators.

| Indicator | Pooled | Kibra | Imara Daima | Difference † |
|---|---|---|---|---|
| Household Dietary Diversity Score—HDDS12—(12 food groups) | 9.91 | 9.74 | 10.09 | −0.34 |
| | (1.46) | (1.50) | (1.40) | (0.21) |
| Household Dietary Diversity Score—HDDS9—(9 food groups) | 6.94 | 6.80 | 7.10 | −0.31 |
| | (1.41) | (1.42) | (1.39) | (0.21) |
| Dietary Diversity Score for Children—IDD—(7 food groups) | 3.56 | 3.23 | 3.91 | −0.68 *** |
| | (1.34) | (1.31) | (1.29) | (0.19) |
| Children not Achieving Minimum Dietary Diversity (proportion) | 0.46 | 0.54 | 0.37 | 0.17 ** |
| | (0.50) | (0.50) | (0.49) | (0.07) |
| Minimum Dietary Diversity for Women—MDD-W—(10 food groups) | 7.37 | 6.79 | 8.01 | −1.23 *** |
| | (1.87) | (1.92) | (1.60) | (0.26) |
| Women not Achieving Minimum Dietary Diversity (proportion) | 0.08 | 0.14 | 0.01 | 0.13*** |
| | (0.27) | (0.35) | (0.11) | (0.04) |
| Observations | 187 | 98 | 89 | 187 |

Mean values with standard deviation in parenthesis; †, Difference in mean between Kibra and Imara Daima tested using *t*-test; Significant difference denoted by: ** $p < 0.05$, *** $p < 0.01$.

Surprisingly, women's diets were better than the children's. Only 8 per cent of women in the study sample consumed fewer food groups than the recommended minimum dietary diversity of 5. Kibra had the highest share of women with inadequate diet diversity

(14 per cent), while Imara Daima only had 1 per cent, and the difference was statistically significant. The disparities between locations could be attributed to differences in poverty levels. Wanyama et al. reported that income is one of the drivers of dietary patterns in slums [17,36]. Our study shows that residents of Imara Daima location on average had a slightly better economic situation than those in the Kibra slum (Table 3).

Regarding the diversity of products sold in the food retail outlets surveyed, organized according to the 12-food group categories, our results indicate that cereals were the most purchased food item (23 percent) followed by sugars and sweets (14 per cent), and spices, condiments and beverages (13 per cent) (Table 5). The least purchased foods were fish and meats, both with less than 1 per cent, roots and tubers (3 per cent) and eggs (5 per cent). Analysis of the foods sold in the various outlets showed that kiosks, mom-and-pop shops, street vendors and informal restaurants offered a larger diversity of food than other outlets (Table 5). Kiosks, for instance, sold almost all food groups, except fish. However, cereals, sugars and sweets, and spices, condiments and beverages comprised a significant share of kiosk food offered, indicating that retail diversity does not necessarily equate to good nutritional quality for consumers. A similar pattern was observed in the selection offered in mom-and-pop shops and supermarkets, where about 30 per cent of the foods sold were cereals and 20 per cent were sugars and sweets. The spices, condiments and beverages category accounted for 18 per cent of food commodities in mom-and-pop shops and 15 per cent in supermarkets. The sample size (*n* value) shows the number of times an outlet was mentioned as a point of purchase for items across food groups (Table 5). Overall, for uncooked foods, mom-and-pop shops were the most-utilized outlets, followed by kiosks; while open-air markets and supermarkets were the least exploited. Informal restaurants were the most common point of purchase for cooked foods.

**Table 5.** Point of sale for raw food items belonging to different food groups by percentage.

| Food Group | Kiosks | Mom-and-Pop Shops | Super markets | Cereal Shops | Open-Air Markets | Informal Restau-rants | Tabletop Ven-dors | Street Vendors | Total |
|---|---|---|---|---|---|---|---|---|---|
| Cereals | 25.78 | 29.92 | 32.14 | 34.11 | 1.2 | 12.43 | - | 15.58 | 23.11 |
| Roots and Tubers | 2.48 | 0.99 | 1.02 | 0.47 | 10.84 | 4.14 | 5.94 | 11.00 | 2.96 |
| Legumes, Nuts, Seeds | 1.55 | 3.47 | 8.16 | 59.35 | 1.2 | 12.43 | 0.5 | 13.00 | 10.84 |
| Vegetables | 1.24 | 1.65 | - | - | 40.96 | - | 67.82 | - | 9.78 |
| Fruits | 2.17 | 0.66 | - | - | 33.73 | 9.47 | 21.29 | 5.00 | 5.45 |
| Meat | 0.62 | - | - | - | - | 1.78 | - | 3.00 | 0.42 |
| Eggs | 5.90 | 4.13 | 3.57 | 0.93 | - | 12.43 | 0.99 | 13.00 | 4.71 |
| Fish | - | - | 0.51 | | - | 0.59 | - | 0.93 | 0.21 |
| Milk and Milk Products | 9.01 | 10.91 | 9.18 | 2.34 | - | 11.24 | - | 3.00 | 7.4 |
| Oils and Fats | 10.25 | 9.59 | 10.2 | 1.4 | - | 12.43 | - | 17.00 | 8.04 |
| Sugars and Sweets | 22.05 | 20.33 | 19.9 | 0.47 | - | 10.65 | - | 5.00 | 13.59 |
| Spices, Condiments, and Beverages | 18.94 | 18.35 | 15.31 | 0.93 | 12.05 | 12.43 | 3.47 | 13.00 | 13.48 |
| Number of observations | 322 | 605 | 196 | 214 | 83 | 169 | 202 | 100 | 1891 |

Notes: The *n* values in this table indicate the number of times the outlet was mentioned as a source of food items, not the number of outlets surveyed.

While supermarkets generally offer fruits, vegetables and meats, our study showed that households in the poor urban settings did not purchase those food items from supermarkets. This could be due to the small size of these supermarkets and lack of refrigerated facilities needed to stock fresh foods. It could also be explained by price differences between products in supermarkets and similar products in informal outlets [36]. In such a case, poor households may prefer to purchase from the informal outlets where products are offered at lower prices. As expected, cereal shops offered legumes, nuts and cereals. Open-air markets and tabletop vendors were the least-diversified outlets, primarily selling vegetables and fruits. Overall, the most diverse retail outlets were dominated by unhealthy,

highly-processed, sugar-laden and energy-dense foods rather than nutritious foods such as fruits, vegetables and meat.

### *3.3. Distance Between Households and Food Retail Outlets*

The degree to which a household can access a food retail outlet could significantly influence individual and household dietary diversity. Using GPS coordinates for households and retail operations, we calculated the average distances between the two (Figure 2). Generally, most households were located within 1 km of all food retail outlet types, with the exception of open-air markets and supermarkets. On average, the two were located between 1.1 and 1.3 km, respectively, from the study households. Generally, tabletop vendors were closest at a mere 378 m. Mom-and-pop shops and cereals shops were 450–489 m from study households. Disaggregated by locations, households in Kibra location were furthest from food retail outlets, while those in Imara Daima were the closest, except for supermarkets. Nevertheless, households in Imara Daima had higher indicators for dietary diversity. This could be an indication that the proximity of retail outlets can influence dietary diversity, but it is not the only factor; it is likely that other food environment factors, such as availability and affordability, are also at play.

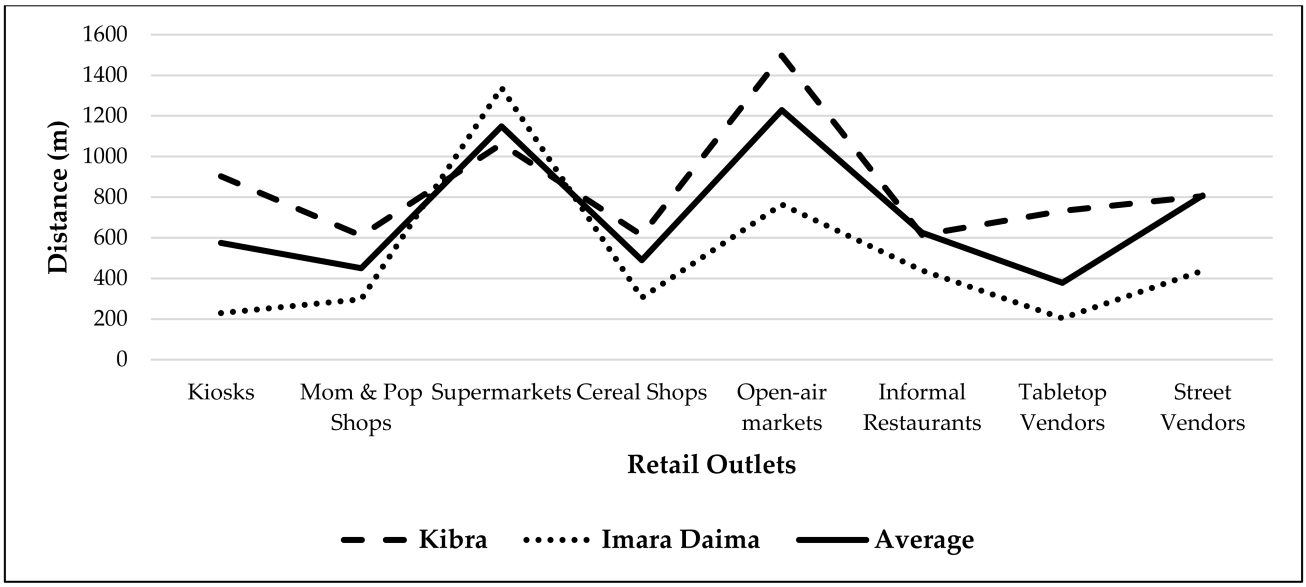


**Figure 2.** Global Positioning System (GPS)-generated mean distance in metres between households and retail outlets by type.

### *3.4. Market-Level Diversity Scores*

To understand the availability of food in the sampled outlets, we computed the MLDS, which shows dietary options for consumers. In computing the MLDS we used both 9 and 12 food groups to assess market situation when all food groups (12 FG) and only the more nutritious foods are considered (9 FG). MLDS utilizes a food-group categorization similar to the HDDS. As expected, supermarkets had the highest MLDS (Figure 3), a finding that is consistent with literature on the expansion of supermarkets in low- and middle-income countries [13,14]. Cereal shops, open-air markets, and tabletop vendors offered the least diversity, with MLDS scores of less than three food groups. Mom-and-pop shops and kiosks offered almost equal levels of food diversity. These trends were unchanged even when excluding the less nutritious food groups: sweets and sugars; oils and fats; and spices, condiments and beverages. However, while cereal shops, open-air markets and tabletop vendors generally stocked low diversity (Figure 3), they also had few offerings from the sweets and sugars, oils and fats, and spices, condiments and beverages groups, all of which make minimal contributions to micronutrient density. Despite the high MLDS

in supermarkets, evidence shows that the use of supermarkets is positively associated with income; the urban poor do not regularly patronize them [15,17,23,36]. Kiosks and mom-and-pop shops, second only to supermarkets in terms of MLDS, are more common in poor urban neighbourhoods, and could therefore be used to deliver healthy dietary options among the urban poor.

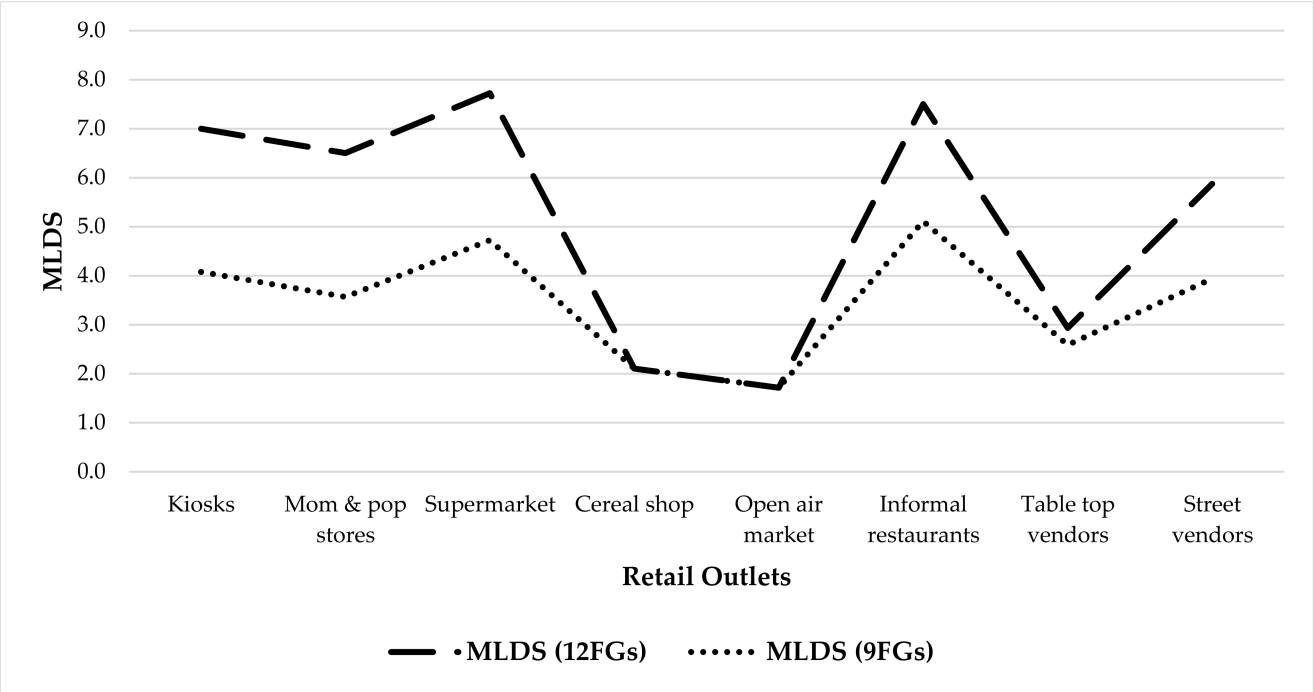


**Figure 3.** Market-level diversity scores (MLDS) using 9 and 12 food groups (FG) by type of retail outlet.

### *3.5. The Association of Market-Level and Consumption Diversity*

In our final analysis, we combined data from retail outlets with consumer data to assess the association between MLDS and individual (MDD-W and IDD) or household (HDDS) diversity scores. Four models were estimated: HDDS with 12 food groups, HDDS with 9 food groups, MDD-W and IDD (Table 6).

Our analysis in Table 6 show that a higher MLDS for kiosks was positively and significantly associated children's dietary quality. More than 70 per cent of the foods sold in kiosks are energy-dense products falling into the cereals; oils and fats; sugar and sweets; or spices, condiments and beverages categories (Table 5). A positive and significant association was also observed between children's dietary diversity and diversity of products offered at cereal shops. About 90 per cent of cereal shop products fell within the cereal and legumes, nuts and seeds categories (Table 5). The correlation of kiosk and cereal shop diversity with children's nutrition status is in line with earlier studies [23,24,37].

Higher MLDS scores for mom-and-pop shops had a positive and significant association with HDD generally and dietary quality for women. Higher MLDS at informal restaurants also had a positive and significant association with HDD. Although supermarkets are often much more diversified than traditional outlets, we did not observe any significant association between supermarket MLDS and either household or individual dietary diversity. In fact, they had a negative influence on HDD and the dietary quality of women and children. The urban poor rarely purchase their food from supermarkets [36]. As a result, the diversity of products offered in these outlets is not reflected in resource-poor households' dietary diversity. Furthermore, supermarkets were located farther away from households than other outlets (Figure 2).

**Table 6.** Association between consumption dietary diversity and market-level diversity.

| Variables | Kiosks | Mom-and-Pop Shops | Super markets | Cereal Shops | Open-Air Markets | Informal Restaurants | Tabletop Vendors | Street Vendors |
|---|---|---|---|---|---|---|---|---|
| HDDS 12 | | | | | | | | |
| MLDS | 0.000 | 0.804 *** | −0.219 | 0.715 | −1.329 ** | 0.738 *** | 0.188 | −0.084 |
| | (0.000) | (0.280) | (0.251) | (1.072) | (0.580) | (0.275) | (0.314) | (0.136) |
| HDDS 9 | | | | | | | | |
| MLDS | 0.000 | 0.623 ** | −0.218 | 0.706 | −1.315 ** | 0.729 *** | 0.139 | −0.084 |
| | (0.408) | (0.250) | (0.249) | (1.047) | (0.568) | (0.268) | (0.278) | (0.135) |
| MDD-W | | | | | | | | |
| MLDS | 0.625 | 1.127 * | −0.540 | −0.545 | −2.537 *** | 0.509 | −0.200 | −0.187 |
| | (0.646) | (0.598) | (0.352) | (1.603) | (0.394) | (0.410) | (0.250) | (0.160) |
| IDD | | | | | | | | |
| MLDS | 1.249 *** | 0.496 | −0.346 | 0.704 ** | −1.577 *** | 0.140 | −0.144 | −0.044 |
| | (0.412) | (0.336) | (0.299) | (0.315) | (0.356) | (0.319) | (0.186) | (0.148) |
| Observations (*n*) | 25 | 30 | 29 | 19 | 21 | 18 | 29 | 16 |

Notes: Values shown are marginal effects from Poisson estimator with standard errors in parentheses. Abbreviations include household dietary diversity score (HDDS), minimum dietary diversity for women (MDD-W), dietary diversity for children (IDD), market-level diversity score (MLDS). The *n* value indicates the number of households that sourced foods from the specific outlets; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Strikingly, the diversity of foods at the open-air markets has a negative and significant influence on both individual and household dietary diversity. Although open-air markets in the study areas had the highest share (73 per cent) of fruit and vegetable sales, overall consumption of these foods among resource-poor households was very low (Table 5). This may be due to the average distance of these markets from households, which represents a potential accessibility constraint (Figure 2). In fact, open-air markets were only mentioned 2.5 per cent of the time by study households as a point of purchase.

We did not find any significant association between tabletop vendors and the dietary indicators for either households or individuals (Table 6). About 90 per cent of foods sold by tabletop vendors are fruits and vegetables. The low diversity in these outlets could be the reason we did not observe any significant association between their MLDS and dietary diversity indicators.

## 4. Conclusions

We used market-, household- and individual-level data collected from poor neighbourhoods (slums) in Nairobi, Kenya to examine how food environments influence the diets of urban resource-poor consumers. Our findings contribute to the existing literature on the role played by food environments in the diets of consumers by using market level diversity score (MLDS) to describe the diversity of foods at sampled food retail outlets and by assessing the association between market-level diversity and diet diversity at the individual and household levels. MLDS shows the diversity of foods in the market at a particular time, providing insights into local market supply for different types of food items. This type of information can assist in designing interventions targeted at improving the supply of quality foods to positively influence consumer diets. Our retail outlet and household datasets were collected within the same areas and combined using GPS coordinates. We found that the food environments of the urban poor are characterized by a mix of modern and traditional food retail outlets, with the latter more common than the former.

When describing the diversity of foods available in retail outlets, we find that the most diverse are dominated by unhealthy or energy-dense foods rather than nutritious foods such as vegetables, fruits and meat. Supermarkets have the highest MLDS, yet they have no significant influence on diets of resource-poor consumers. Earlier studies in Kenya have shown that supermarket patronage is influenced by income and this is still an important constraint on the urban poor, given their limited livelihood opportunities [36]. For instance, supermarkets account for less than 4 per cent of the food expenditures among slum households in Nairobi, Kenya and Kampala, Uganda [36]. Although diversity in

supermarkets presents an opportunity to improve the diets of the urban poor, until they are more commonly utilized, their influence may continue to be minimal. Furthermore, our study shows that supermarkets were, on average, the second-furthest outlets from study households, which could be an indicator of inaccessibility. We find that supermarkets were the second least-common outlet for household food purchases, having been mentioned by only 15 per cent of the households surveyed.

Mom-and-pop shops and kiosks are the two outlets most commonly used by the study households to purchase food items. They were also the most diverse of the traditional outlets, at least in terms of non-cooked food items. Furthermore, they were generally located closer to the study households. Informal outlets, specifically mom-and-pop shops are positively and significantly associated with household dietary diversity and dietary quality for women, while kiosks are positively and significantly associated with improved dietary quality for children. Diversity of foods at the open-air markets has a negative and significant association with both diet quality for women and children, and household dietary diversity. Although open-air markets in the study areas had the highest share of fruit and vegetable sales (73 per cent), their overall use by the resource-poor households was very low. This may be due to their long average distance from households, which represents a potential accessibility constraint.

Our findings have various implications for policy makers and other food system actors. First, there is need to promote food diversity in informal retail outlets because this could facilitate accessibility of diverse foods among the urban resource-poor consumers—which could have positive implications on their health and nutrition status. Second, addressing diversity at the retail market alone may not lead to improved dietary intake, especially for the low-income consumers who rely on markets for their food purchases. It is also important to ensure access and affordability of commodities offered to the resource-poor consumers. In our study, we do not find a significant association between retail diversity at the supermarkets and dietary diversity at both household and individual levels, irrespective of the high retail diversity at the supermarkets. Commodities sold in supermarkets are often much more expensive compared to similar products on sale in informal outlets. In addition, the open-air markets—which are the outlets located furthest away from our study households—have a negative and significant association with both household and individual dietary diversities. These two findings emphasize the need for affordability and accessibility of commodities, respectively. Finally, as we promote the purchase of foods from traditional outlets, it is necessary to attend to food safety concerns, especially for vendors selling fresh produce and cooked foods. Previous studies in the urban slums of Nairobi have highlighted food safety risks among informal retailers due to the sources from which they obtain their commodities and the environments in which they sell their goods [38,39]. Further studies are necessary to examine food safety challenges and possible solutions for the informal food retailers in urban slums.

As a final thought, the authors acknowledge the limitation of this study in terms of sample size. Follow-up studies using larger sample sizes are needed to validate the association between market level diversity and consumer dietary diversity especially in urban areas.

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**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** Data used for this analysis will be made available whenever requested.

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## Appendix A

**Table A1.** Classification of food groups for calculating dietary diversity scores.

| No. | Household and Market-Level Dietary Diversity | Dietary Diversity for Children | Minimum Dietary Diversity for Women |
|---|---|---|---|
| 1 | Cereals | Grains, roots, and tubers | Grains, roots, and tubers |
| 2 | White Roots, Tubers, and Plantains | Legumes, nuts, and seeds | Pulses (beans, peas, and lentils) |
| 3 | Vegetables | Dairy products | Nuts and seeds |
| 4 | Fruits | Flesh foods (meat, poultry etc.) | Dairy products |
| 5 | Meat | Eggs | Meat, poultry, and fish |
| 6 | Eggs | Vitamin A-rich fruits and vegetables | Eggs |
| 7 | Fish and Other Sea Food | Other fruits and vegetables | Dark green leafy vegetables |
| 8 | Legumes, Nuts, and Seeds | - | Other vitamin A-rich fruits and vegetables |
| 9 | Milk and Milk Products | - | Other vegetables |
| 10 | Oils and Fats | - | Other fruits |
| 11 | Sugars and Sweets | - | - |
| 12 | Spices, Condiments, and Beverages | - | - |

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