frontiers | Frontiers in Sustainable Food Systems

TYPE Original Research
PUBLISHED 18 October 2022
DOI 10.3389/fsufs.2022.718443

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Nutrition and Sustainable Diets, a section of the journal Frontiers in Sustainable Food Systems

RECEIVED 31 May 2021
ACCEPTED 22 September 2022
PUBLISHED 18 October 2022

CITATION
Chege CGK, Onyango K, Kabach J and Lundy M (2022) Effects of COVID-19 on dietary behavior of urban consumers in Nairobi, Kenya. *Front. Sustain. Food Syst.* 6:718443. doi: 10.3389/fsufs.2022.718443

Effects of COVID-19 on dietary behavior of urban consumers in Nairobi, Kenya

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The disruptions wrought by the COVID-19 pandemic on food systems worldwide have endangered food and nutrition security for many consumers. The resource-poor, especially those in urban areas, are more susceptible to pandemic-related disturbances. This study uses primary data collected from 2,465 households located in and outside of informal settlements (slums) in Nairobi, Kenya to assess how COVID-19 and related public-health measures have influenced diets of urban consumers, their purchasing patterns and overall food security. Questions about food security and consumption behavior, including household dietary diversity scores, were used to capture the pre- and mid-pandemic situation. The data show that low-income households in the informal settlements were more affected than middle-income households. About 90% of slum households reported dire food insecurity situations, including being unable to eat preferred kinds of food, eating a limited variety of foods, consuming smaller portions than they felt they needed, and eating fewer meals in a day. With a score of four food groups out of nine, household in the informal settlements have lower dietary diversity than middle-income households, whose score is five out of nine. The consumption of nutritious foods, including fruits, vegetables, and animal products, fell among people living in slums during the pandemic. In addition to assessing dietary changes, this study highlights the factors associated with quality food consumption during the pandemic period such as household income levels and male-vs-female headed households. Our research demonstrates the need to attend to slums and vulnerable, poor consumers when enacting mitigation measures or designing and implementing policy.

KEYWORDS

COVID-19, urban poor consumers, consumption, diets, nutrition, Africa, Kenya

Introduction

Food and nutrition security are ongoing concerns for global public health. The FAO's State of Food Security and Nutrition in the World 2019 report showed that an estimated 821 million people were undernourished between 2016 and 2018, most in low-income countries (FAO, 2019). In addition, undernourishment, micronutrient malnutrition, and rates of obesity are increasing rapidly in

Africa, especially in urban areas, driven by dependence on markets and increases in food prices (Ruel et al., 2010). In Kenya, a large portion of the population is undernourished, with 26% of children under five stunted, 11% underweight, and 4% wasted (KNBS, 2014). Among women of reproductive age (15–49 years old), 27% are anemic. In urban informal settlements (slums), the prevalence of stunting among children under five and among women can exceed 40% (Olack et al., 2011; Kimani, 2014; Kimani-Murage et al., 2015). Inadequate nutrition harms the development and health of children and women. A recent study of the informal settlements in Nairobi indicated that 87% were food-insecure, with 46% severely insecure (Wanyama et al., 2019).

Food and nutrition insecurity is expected to rise significantly because of the COVID-19 pandemic; those who are already vulnerable, such as the urban poor, are likely to face the worst consequences (HLPE, 2020; U. N. Habitat, 2020). Governments are putting various measures in place to mitigate the spread and the effect of the COVID-19 pandemic. In Kenya, the government has been adopting several measures (Center for Policy Impact in Global Health., 2020). During the first 6 months of the pandemic, government restrictions included social distancing; a nationwide dusk-to-dawn curfew; border closures; the closure of traditional markets, learning institutions, and places of worship; and mandatory quarantine for international travelers (Quaife et al., 2020). The government also identified "hot spots" where higher numbers of infections were reported and restricted movement into and out of those regions. Nairobi, Mombasa, Kilifi, and Kwale were all identified as hotspots.

While public health measures are critical to mitigate the spread of COVID-19, they can pose a significant threat to livelihoods and food and nutrition security, especially in low- and middle-income countries (Demeke et al., 2020; International Labour Organization, 2020; UN Habitat and World Food Programme, 2020). Likewise, they disproportionately affect the urban poor, who often rely on low-wage, casual employment and depend on frequent market purchases for food (Wanyama et al., 2019; Bundervoet and Arden, 2020; Hirvonen et al., 2020). Social distancing and stay-at-home orders significantly limit the informal employment sector and the restriction or closure of traditional markets reduces food access and security (FAO, 2019; Wanyama et al., 2019; Wertheim-Heck et al., 2019; IPES Food, 2020; Wertheim-Heck, 2020). Income and food access disruptions may cause households to change their consumption behavior, for instance, addressing their immediate hunger needs with cheaper but nutritionally poor, less diversified diets. These changes curtail on-going initiatives to promote nutritious foods. The COVID-19 crisis is expected to increase demand for nutrient-poor foods while reducing demand for high-value, nutritious foods like fruits, vegetables, and animal products (Headey and Marie, 2020). Restrictions on food supply chain logistics, increased transaction costs, and speculative hording could all exacerbate this trend (Reardon et al., 2020).

Existing evidence shows that while food remained generally available in most low- and middle-income countries, COVID-19 restrictions limited consumers' access (GAIN, 2020). Urban, lower-income, and migrant populations face greater affordability and access barriers (GAIN, 2020). In Ethiopia and India, preliminary findings demonstrated declining consumption of high-value, nutritionally rich foods like fruits, vegetables, and animal products (Harvard University, 2020; Hirvonen et al., 2020; Tamru et al., 2020). Income loss, which ties directly to consumption patterns, has also been reported in 70% of households across nine countries in Africa, Asia, and Latin America (Egger et al., 2021). A study on urban consumers in Ethiopia showed that income loss was more likely to be reported by less-wealthy households than wealthier households (Hirvonen et al., 2020). Results from a nationwide telephone survey conducted in Kenya showed that about 30% of the respondents were absent from work because of temporary layoffs or reductions for technical or economic reasons (KNBS, 2020).

While these broad findings provide important insights, there is still limited understanding of the ways in which COVID-19 and the measures put in place to reduce its spread influence household diets, purchasing patterns, and overall food security in Kenya. This paper provides early evidence of these changes, with a focus on households in urban informal settlements (slums), using primary data collected in April and May of 2020. The study surveyed 2,465 households in and outside of slums in Nairobi, Kenya. The data allow us to analyze consumption and purchasing behavior for nutritious foods—especially fresh fruits and vegetables—and to assess effects of the COVID-19 in the early months of the pandemic, on food security and nutrition. These findings identify potential entry points for food and nutrition interventions targeting vulnerable households and can help policy makers to prioritize the needs of poor urban consumers.

Materials and methods

This study was conducted in urban Nairobi, focusing on households living in urban informal settlements and those living in middle income areas of Nairobi. The goal of the study was to understand how COVID-19 has affected the two consumer groups and document evidence on the early effects of the pandemic on consumption behavior and diets of low-and-middle income urban consumers in Nairobi. We conduct comparative analysis with the two groups to gain a better understanding of the similarities and differences on the effects so that targeted solutions can be formulated to address dietary challenges by policy makers and programs.

Sample selection and data collection

The study uses primary data collected between 26 April and 13 May 2020 in Nairobi, Kenya. The survey period falls within the first national COVID-19 lockdown in Kenya which began on March 25th, 2020. Within this period, the government of Kenya put in place several measures to reduce the spread of the disease, such as social distancing, nationwide dusk-to-dawn curfew, border closures, closure of traditional markets, learning institutions and places of worship, and mandatory quarantine for travelers from foreign countries, among others.

Respondents of the study were resource-poor consumers in urban informal settlements and middle-income consumers from urban areas. More than 50% of the urban population in Nairobi city lives in slums (World Bank, 2016). A multi-stage sampling strategy was used to select respondents for this study. Based on official data (KNBS, 2014) and information from the government administration, a list of residential estates and slums in Nairobi was developed and ordered by average incomes as a proxy indicator for living standard. Next, the estates were grouped according to low, middle and upper income. From the low income category, the Kibera and Mathare slums were chosen because they have the highest poverty levels in Nairobi based on national statistics (KNBS, 2014). Then, six middle-income residential estates—Nairobi West, Embakasi, Kaloleni, Waiyaki Way, Langata, and Dagoretti Corner—were randomly selected from the middle income category. Due to resource constraints, not every household in the selected estates could be interviewed. The study sought to interview 2,600 households, 1,300 from each group category. However, about 5% of the respondents refused to be interviewed so we ended with a total sample of 2,465 households: 1,298 in slums and 1,167 in non-slum sites. Within each residential estate, households were selected for interviews using a systematic sampling procedure. Starting from the center of each slum, every fifth household in all directions (north, south, east and west) was selected.

Physical interviews were conducted using Swahili language, the country's national language that is spoken by the vast majority of the population and each interview took about 1 h. The government of Kenya's ministry of health COVID-19 recommendations to reduce spread of the virus such as wearing masks and use of sanitizers were observed. The target respondent at the household level was the main decision-maker on household food consumption; in most but not all cases, this was the main female in the household.

The study tool captured household demographics and asked questions about food security; consumption behavior, including the diversity of foods like fresh fruits and vegetables eaten; and the impact of the COVID-19 pandemic on household consumption behavior. The study has a special focus on fruits and vegetable owing to their importance in improving diet quality of consumers. FAO (2020b) affirms that consumption of fresh fruits and vegetables is essential for healthy lives, better mental health, and lower obesity risks among other benefits. Data on food consumption during COVID-19 period were collected with a reference period of the past 4 weeks to capture the COVID-19 lockdown period by the government of Kenya. Household Food Insecurity Access Score (HFIAS) questions were modified, adapted and used to measure the effects of the pandemic on household food security. Due to the pandemic and recommendations by the Kenyan ministry of health to reduce human interactions to avoid the spread of COVID-19, the study questionnaire was shortened to give a quick understanding of the consumption behavior during the pandemic using selected HFIAS questions. As such, the study does not compute the HFIAS index because not all HFIAS questions were asked. Ethical clearance for this study (#2020-IRB02) was obtained from the International Center for Tropical Agriculture (CIAT) Institutional Review Board.

Dietary diversity score

Using a 7-day recall period, food consumption data were collected to generate dietary diversity scores. A seven day recall period was used instead of the 24 h recall to ensure that certain food groups that are consumed once or twice a week by poor households, such as animal products, are captured. Dietary diversity scores from 7-day recall data are likely to be systematically higher than those from 24 h recall because more of the day-to-day variation in food consumption is captured. Therefore, results from studies using 7-day recall may not be directly comparable with those using 24 h recall.

Dietary diversity scores offer a simple count of the number of food groups consumed by an individual or household within a specified recall period (Gina et al., 2010). A household dietary diversity score indicates the economic ability of a household to access a variety of foods; individual dietary diversity scores can also be collected (Gina et al., 2010). Previous analyses have shown that the correlation between household and individual dietary diversity scores is significant (Sibhatu and Qaim, 2018; Wanyama et al., 2019). Since households typically try to satisfy food energy needs before diversifying their diets, these scores are used as a food security proxy (Headey and Ecker, 2013; Vhurumuku, 2014).

The household dietary diversity score was originally developed by the Food and Nutrition Technical Assistance II project as a measure of household food access and it has been widely used since then (Swindale and Bilinksy, 2006; Headey and Ecker, 2013; Chege et al., 2015; Fongar et al., 2019). Scores can be generated using nine, 12, or 16 food groups; the higher the number of indicators, the higher the demands are for the data collection process (Gina et al., 2010; Martin-Prevel et al., 2015). Studies using only nine food groups have nevertheless been robust, as they exclude food groups with low micronutrient density: oils and fats; sweets; and spices,

condiments, and beverages (Sibhatu et al., 2015). For this study, we generated scores based on nine food groups: cereals; white roots and tubers; vegetables; fruits; meat; eggs; fish and other seafood; legumes, nuts, and seeds; and milk and its products. While a higher score indicates higher dietary diversity, there is no consensus on a household dietary diversity score threshold that would mark households as food secure (Gina et al., 2010). These scores do not take into account the quantities of foods consumed, but it is easy to collect the data required to generate them and they are easy to measure.

Statistical analyses

We conducted descriptive and econometric analyses to understand the socioeconomic, demographic, and food security and dietary situation in households located in slums and non-slum areas. Descriptive analyses present the diet characteristics and consumption behavior of sampled households. We computed mean values, percentages, and *t*-tests to describe the consumption levels of different food groups; the effects of COVID-19 on the diversity, frequency, and quantity of foods consumed; and the frequency with which preferred foods were eaten. Further analyses explore the effect of COVID-19 on the consumption of nutritious foods, especially fresh fruits and vegetables by slum and non-slum consumers using the Difference-in-Difference model.

To show the influence of various factors on household diets, we estimated a simple regression model of

$$HDDS = \alpha + \beta X + \varepsilon \quad (1)$$

where HDDS is the household dietary diversity indicator based on nine food groups, α and β are estimated parameters, and ε is the random error term. X is a vector of controlled variables including the head-of-household's gender, education, and occupation; household size; consumption of fresh fruits and vegetables; and the location of the household in a slum or non-slum area.

Results

Descriptive results

Households in the slums constituted slightly more than half of the sample size, at 52% (Table 1). Overall, 62% of the study households were headed by a male. In the aggregate, household heads had an average of 12.7 years of formal education; with 14.9 years of education, non-slum heads outperformed the 10.7 years of their peers living in the slums. At the time of the survey, most household heads were working as casual laborers, salaried workers, or were self-employed. Employment varied by group: nearly 48% of household heads living in the slum areas were employed as casual workers, while 34% of those in non-slum areas were salaried, and 34% were self-employed. Although most heads of household were working, at the time of the survey 16% of those in the slums were not, compared to only just over 5% from the non-slum areas.

Households in the slum areas were larger than those in the non-slum locations. In addition, the average monthly income of a household in the slums, USD 78, was significantly lower than in the non-slum households, where the average was USD 382. The wide difference between the two income groups is expected given that the low income residents mainly obtain their incomes from casual employment, which is informal employment on a short-term basis and have lower wages (Wanyama et al., 2019). Residents in the non-slum locations have relatively higher incomes, mainly from formal employment and businesses, and are more likely to offset their income risks from the pandemic (Kansiime et al., 2021). At four out of nine groups, the mean household dietary diversity score in the slums was significantly lower than for middle-income households, which averaged five of nine groups.

To understand how the food security situation of households has been affected by the current pandemic, we used a range of questions adopted from the Household Food Insecurity Access Scale to elicit respondents' perceptions of their food security or insecurity over a four-week recall period (Coates et al., 2007). More than 65% of all respondents reported reduced food security, with households located in the slums reporting at a much higher rate than those in non-slum locations (Table 2). In total, 90% of households in the slums were not able to eat their preferred foods during the recall period, compared to 56% in non-slum households. Moreover, 92% of households in the slums reported having to eat a limited variety of foods, compared to just 53% for households in the non-slum locations; 89% of households in the slums and 42% of non-slum households had to eat smaller quantities at meals; and 88% of households in the slums ate fewer meals, compared to 46% of non-slum households.

In terms of the types of foods consumed, consumption behavior varied depending on the location of households (Table 3). Almost all the study households consumed cereals and fresh vegetables. However, 89% of non-slum households consumed fresh fruits, compared to 52% within slum areas. Likewise, only 23% of households in slum areas consumed meat, compared to 46% of non-slum households. Patterns for eggs and dairy products replicate these trends: in middle-income areas, 57% reported eating eggs and 82% consumed dairy products, compared to 37 and 51%, respectively, in slum areas. Conversely, fish consumption was higher, at 57%, among households in the slums, compared to 43% in non-slum areas. The most consumed fish was silver fish, locally known as *omena*; it is relatively cheap and frequently consumed in low-income areas.

TABLE 1 Demographic characteristics of the study sample.

Variables	Overall ($n = 2,465$)	Slum ($n = 1,298$)	Non-slum ($n = 1,167$)
Male household head (dummy)	62.2 (48.5)	61.5 (48.7)	63.1 (48.3)
Household head education (years)	12.8 (8.1)	10.8 (9.4)	15.0 (5.5)***
Occupation of the head			
None	11.5 (31.9)	16.8 (37.4)***	5.7 (23.1)
Salaried employment	23.3 (42.3)	13.4 (34.1)	34.3 (47.5)***
Casual laborer	37.2 (48.4)	47.9 (50.0)***	25.4 (43.5)
Self-employment	28.0 (44.9)	21.8 (41.4)	34.7 (47.6)***
Household size	3.8 (2.0)	4.3 (1.9)***	3.3 (1.9)
Average Monthly income (USD)	222.4 (2,267.1)	78.8 (145.4)	382.2 (3,284.7)***
Mean household dietary diversity score during COVID-19 (out of 9 scores)	5.3 (1.7)	4.9 (1.8)	5.8 (1.6)***
Study sites			
Kibera	32.3 (46.8)	61.3 (48.7)	0 (0.0)
Mathare	20.4 (40.9)	38.67 (48.7)	0 (0.0)
Nairobi West	0.1 (2.9)	0 (0.0)	0.8 (4.1)
Embakasi	11.3 (31.7)	0 (0.0)	23.9 (42.7)
Kaloleni	12.6 (33.2)	0 (0.0)	26.6 (44.2)
Wayiaki Way	11.2 (31.6)	0 (0.0)	23.7 (42.6)
Langata	2.6 (14.5)	0 (0.0)	4.5 (20.8)
Dagoretti Corner	9.98 (30.0)	0 (0.0)	21.1 (40.8)

Means are presented with the standard deviation in parentheses; the USD–KES exchange rate used was the rate at the time of the survey of KES 107.11 = 1USD; HDDS stands for household dietary diversity score; mean differences between slum and non-slum locations were tested for statistical significance; *** $P < 0.01$.

TABLE 2 Percentage of households facing various food insecurity challenges.

Variables	Overall	Slum	Non-slum
In the past 4 weeks, household members were not able to eat the kinds of foods they preferred because of the COVID-19 pandemic	74.3 (43.7)	90.6*** (29.2)	56.1 (46.6)
In the past 4 weeks, household members had to eat a limited variety of foods due to a lack of resources occasioned by the COVID-19 pandemic	74.0 (43.9)	92.4*** (26.6)	53.6 (49.9)
In the past 4 weeks, household members had to eat a smaller meal than they felt they needed because there was not enough food due to the COVID-19 pandemic	67.4 (46.9)	89.8*** (30.2)	42.5 (49.5)
In the past 4 weeks, household members had to eat fewer meals in a day because there was not enough food due to the COVID-19 pandemic	68.7 (43.4)	89.0*** (31.3)	46.2 (49.9)
Number of observations	2,465	1,298	1,167

Means are presented with the standard deviation in parentheses; mean differences between slum and non-slum locations were tested for statistical significance; *** $P < 0.01$.

To further understand changes in diet quality, indicated by changes in fresh fruit and vegetable use in the study areas, we asked households how their behavior differed relative to the four weeks prior to the study (Table 4). Almost all the households in the slums reported reduced consumption of fruits and vegetables; at 92%, their reduction was almost double the 55% in non-slum households. Additionally, while 42% of the non-slum households reported no change in the frequency and quantity of their fruit and vegetable consumption, only 7% of households in the slum areas reported the same. The respondents who reported reduced consumption were further asked about the reasons for this change. Among middle-income households, 89% indicated that fruits and vegetables had become more expensive; 95% of households in the slums attributed the shift to reduced incomes. Very few households indicated low supply or non-availability as a reason.

TABLE 3 Consumption of various foods groups in seven days prior to interview.

Food groups	Overall	Slum	Non-slum
Cereals	97.7 (14.9)	97.6 (15.3)	97.8 (14.5)
Roots and tubers	32.0 (46.7)	32.7 (46.9)	31.3 (46.4)
Nuts and pulses	33.1 (47.1)	35.2 (47.8)*	30.7 (46.1)
Fresh vegetables	99.4 (7.2)	99.7 (5.5)	99.1 (8.8)
Fresh fruits	69.6 (46.0)	52.2 (50.0)	89.0 (31.2)***
Meats	34.4 (47.5)	23.9 (42.7)	46.2 (49.9)***
Eggs	46.7 (49.9)	37.4 (48.4)	57.1 (49.5)***
Milk and dairy products	66.3 (47.3)	51.4 (50.0)	82.9 (37.6)***
Fish (including omena)	50.99 (50.00)	57.9 (49.4)***	43.4 (49.6)
Sample size	2465	1298	1167

Means are presented with the standard deviation in parentheses; mean differences between slum and non-slum locations were tested for statistical significance; * $P < 0.1$, *** $P < 0.01$.

Econometric model results

In addition to the descriptive analysis, we conducted two econometric analysis; (1) to understand consumption of fruits and vegetables by the slums and non-slum households using Difference-in-Difference analysis (Tables 5, 6), and (2) to understand the factors that may be associated with higher or lower household dietary diversity during the COVID-19 pandemic using simple econometric regressions (Table 7).

To understand the changes in consumption of fruits and vegetables by all households, an indicator of diet quality, respondents were asked to indicate the three fresh fruits and vegetables they primarily consumed before and during the pandemic period. The results were analyzed using Difference-in-Difference approach comparing consumption of fruits and vegetables by the slum and non-slum households before and during the pandemic, Results are presented in Tables 5, 6. Table 5 shows that relative to non-slum households, there was a significant increase in the proportion of slum households that did not consume any fruits as part of their diet during the pandemic period compared to the period before. Results also show a significant decline in the proportions of slum households consuming other fruits such as mangoes, bananas, citrus fruits, watermelon, pineapple, pawpaw, guava, avocado, and apple relative to non-slum households. For example, relative to non-slum households, there was a 0.55 decline in the proportion of slum households who consumed mangoes during the COVID-19 period compared to the period before. The decline was 0.75 for ripe bananas, 0.66 for citrus fruits, 0.37 for watermelon and 0.35 for pineapples.

The story is similar for the consumption of vegetables. Overall we observe a decline in the proportion of slum households that consumed various vegetables relative to the non-slum households, before and during the pandemic (Table 6). There was a significant decline in the proportions of slum households consuming Tomatoes, Amaranthus leaves, Black night shade, Spider plant, Spinach and Carrots. On the other hand, results show a significant increase in the proportions of slum households consuming Kales and Onions during the pandemic relative to non-slum households. Kales are the most available and affordable leafy vegetables in Nairobi.

Table 7 shows results of the simple econometric regressions used to analyze factors that may be associated with higher or lower household dietary diversity during the COVID-19 pandemic. Households headed by males tended to have higher dietary diversity scores than those headed by females. The education level of the household head was only significant among the non-slum households, where increased educational levels corresponded to higher dietary diversity. Likewise, where the head was either salaried or self-employed, the household was likely to have a higher dietary diversity score; stable employment corresponds to higher diversity.

Decreased consumption of fruits and vegetables is positively associated with lower diet diversity scores in the overall model and in households in the slums. Increased food prices are also associated with reduced dietary diversity for these households. In sum, the overall model indicates that households in the slums have a lower and more precarious dietary diversity than those in the non-slum locations.

Discussion and policy recommendations

In this paper we have analyzed effects of COVID-19 on diets in slum and non-slum areas in Nairobi, Kenya. Our descriptive analysis illustrates the pandemic's effects on households in terms of socioeconomic factors, food security, and nutrition. We also assessed the factors with the greatest influence over diets during the pandemic period using household dietary diversity scores.

The initial descriptive results show that around 5% of households in non-slum areas experienced unemployment during the study period, compared to 16% in slum areas. Other studies conducted in developing countries in 2020 also found a decline in employment during the COVID-19 period compared to the period before. Egger et al. (2021) in their study conducted in 2020 found that in Kenya, there was a 37% decline in employment at the national level, and 17% for low income groups in the rural areas. Kansiime et al. (2021) through their online survey with both rural and urban respondents also reported job losses and reduction in incomes in Kenya and Uganda. Similar findings have been reported by other studies (ILO (2020);U. N. Habitat, 2020; World Bank, 2020). Unemployment and a divergence of working situations, with casual labor more common in the slums than in the non-slum areas, could explain the low monthly incomes reported. Furthermore, pandemic-related movement

TABLE 4 Changes to consumption of fresh fruits and vegetables (FFV).

Variables	Category	Overall	Slum	Non-slum
Over the past 4 weeks, how has the frequency or quantity of household fresh fruits and vegetables consumption changed?	No change	24.9 (43.2)	7.7 (26.7)	44.0*** (49.7)
	Increased	0.5 (7.0)	0.0 (0.0)	1.0*** (10.1)
	Reduced	74.7 (43.5)	92.3*** (26.7)	55.0 (49.8)
Reasons for reduced frequency or quantity of fresh fruit and vegetable consumption	FFV not available	0.4 (6.2)	0.0 (0.0)	1.1*** (10.4)
	FFV became expensive	34.1 (47.4)	4.3 (20.2)	89.7*** (30.4)
	Reduced incomes	64.8 (47.8)	95.7*** (20.2)	7.0 (25.6)
	Low supply	0.8 (8.7)	0.0 (0.0)	2.2*** (14.6)
Reasons for increased frequency or quantity of fresh fruit and vegetable consumption	More household members	91.7 (28.9)	0.0 (0.0)	91.7 (28.9)
	Own supply from rural home	8.3 (28.9)	0.0 (0.0)	8.3 (28.9)
Number of observations		2,465	1,298	1,167

Means are presented with the standard deviation in parentheses; mean differences between slum and non-slum locations were tested for statistical significance; *** $P < 0.01$.

TABLE 5 Difference-in-difference model results on household fruit consumption before and during COVID-19 in slum and non-slum areas.

Commodities	Residence * time Coef	SE	Constant	SE	Observations	Model Prob > chi2
None	0.474***	0.131	−2.214***	0.099	4,930	0.000
Mango	−0.551***	0.081	0.048***	0.037	4,930	0.000
Ripe bananas	−0.75***	0.074	0.366***	0.038	4,930	0.000
Citrus - Lemon, Orange, Tangerine	−0.664***	0.073	0.242***	0.037	4,930	0.000
Plums	−0.244	0.381	−2.384***	0.116	4,930	0.020
Watermelon	−0.366***	0.086	−0.169***	0.037	4,930	0.000
Pineapple	−0.351***	0.104	−0.825***	0.042	4,930	0.000
Pawpaw	−0.364***	0.130	−1.461***	0.055	4,930	0.000
Guava	−0.870**	0.374	−2.566***	0.141	4,930	0.000
Avocado	−0.478***	0.083	−0.732***	0.040	4,930	0.000
Wild fruits (wild berries, zambarau)	−0.160	0.281	−2.422***	0.121	4,930	0.041
Apple	−0.363**	0.153	−1.237***	0.049	4,930	0.000
Passion fruit	0.192	0.261	−2.512	0.133	4,930	0.211

** $P < 0.5$, *** $P < 0.01$; reference group is non-slum households and reference time is before COVID-19.

restrictions and curfews enacted by the government could have further endangered the economic situation of households that derive their income from casual labor. Generally low dietary diversity scores were attributed by study participants to reduced income and increased food prices.

Using self-reported information about food insecurity during the pandemic period, we found that about 90% of households in the slums were not able to eat the kinds of foods they preferred; most also reported eating a limited variety of foods, smaller meals, and fewer daily meals due to the pandemic. Food insecurity measures were considerably lower in non-slum locations, ranging between 42 and 56%. While all households in the study indicated food insecurity, households in the slums were more vulnerable, exacerbating their general levels of precarity. These findings are in line with other studies conducted with both urban and rural households in Kenya where food insecurity of 88% of the population during COVID-19 period was reported compared to 50% before COVID-19 (Kansiime et al., 2021). Previous studies conducted in the slums of Nairobi before COVID-19 showed that only 13% of the sampled households were food secure, 46% were severely food insecure, and 41% were moderately or mildly food insecure (Wanyama et al., 2019). The high rates of food insecurity may be due to reduction in incomes and food supply disruptions due to government restrictions during the lockdown period FAO, 2020a; Reardon et al., 2020). In addition, increased food prices due to disruptions in the supply chains could also lead higher food insecurity.

TABLE 6 Difference-in-difference model results on household vegetable consumption before and during COVID-19 in slum and non-slum areas.

Commodities	Residence * time Coef	SE	Constant	SE	Observations	Model Prob > chi2
Kales/Sukuma wiki	0.225***	0.073	−0.048	0.037	4,930	0.0000
Onions	0.165**	0.072	−0.035	0.037	4,930	0.0000
Cabbage	−0.055	0.077	−0.687***	0.040	4,930	0.3428
Tomato	−0.182**	0.073	0.089**	0.037	4,930	0.0000
Amaranth leaves	−0.248**	0.096	−0.701***	0.040	4,930	0.0000
Cowpea leaves	−0.146	0.090	−0.840***	0.042	4,930	0.0000
Black night shade	−0.178**	0.078	−0.313***	0.037	4,930	0.0000
Spider plant	−0.316***	0.084	−0.704***	0.040	4,930	0.0000
Egg plant	−0.222	0.183	−2.009***	0.081	4,930	0.0207
Pumpkin	−0.222	0.341	−2.348***	0.112	4,930	0.0000
Pumpkin leaves	−0.200	0.171	−1.963***	0.078	4,930	0.0000
Spinach	−0.509***	0.082	−0.696***	0.040	4,930	0.0000
Carrot	−0.616***	0.201	−1.607***	0.060	4,930	0.0000

** $P < 0.5$, *** $P < 0.01$; reference group is non-slum households and reference time is before COVID-19.

TABLE 7 Poisson regression for determinants of household dietary diversity.

	Model 1 (Overall)		Model 2 (Slum)		Model 2 (Non–slum)	
Variables	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Male household head (dummy)	0.058***	0.019	0.127***	0.027	0.000	0.026
Household head education (years)	0.002	0.001	0.001	0.001	0.005**	0.002
Occupation of the head (base = none)						
Salaried employment	0.166***	0.034	0.092*	0.047	0.150**	0.058
Casual laborer	0.032	0.032	0.024	0.038	0.000	0.060
Self-employment	0.138***	0.033	0.120***	0.042	0.097*	0.058
Household size	0.001	0.005	−0.006	0.007	0.009	0.007
Decrease in consumption of fruits (dummy)	−0.055**	0.024	−0.120***	0.034	−0.021	0.033
Decrease in consumption of vegetable (dummy)	−0.042*	0.022	−0.077**	0.030	−0.012	0.033
Increase in food prices (dummy)	−0.015	0.023	−0.083**	0.039	0.008	0.028
Slum dweller (dummy)	−0.089***	0.020				
Constant	1.632***	0.042	1.687***	0.062	1.575***	0.071
LR chi2(9)	184.970		93.220		38.300	
Prob > chi2	0.000		0.000		0.000	
Log likelihood	−4,922.062		−2,574.092		−2,327.8804	
Number of observations	2,465		1,298		1,167	

* $P < 0.1$, ** $P < 0.5$, *** $P < 0.01$.

Analyzing the consumption of various food groups, constituting the household consumer behavior, we found that 98% of all study households consumed cereals in the 7 days prior to interview. However, 89% of non-slum households consumed fresh fruits in the same period, compared to 52% in the slums, a significant difference. Further, we found that animal products, which usually offer higher-quality nutrition but are also more expensive, were consumed more by non-slum households than households in the slums. The small share of animal products eaten by households in the slums could be attributed to high prices and low incomes. Fish was an exception, as it was more commonly consumed within the slums than outside of them, but the wide availability and low cost of omena, or sliver fish, explains this finding (Cornelsen et al., 2016).

Our findings also show that 99% of study households consumed fresh vegetables, although the specific varieties

changed due to the pandemic. While kales and onions were widely eaten prior to the pandemic, their share rose considerably during the study period. Conversely, the consumption of nutritious indigenous vegetables fell significantly during the pandemic period across all study locations. Other vegetables, such as tomatoes, spinach, eggplants, cucumbers, and carrots, were also eaten significantly less frequently during COVID-19 in all study households. These trends could be attributed to the availability and costs of various kinds of vegetables.

An analysis of changes in fresh fruit and vegetable consumption patterns during the study period found that 92% of households in slums and 55% of those outside ate fresh fruits and vegetables less frequently and in smaller amounts under pandemic conditions. Most households in slum areas noted reduced incomes as the main reason for this shift, as reported in other studies (World Bank, 2020; Kansiime et al., 2021). Government measures to control COVID-19, including market closures, stay-at-home orders, and social distancing, have more drastic effects on the types of casual income-generating opportunities on which these households rely. Insufficient day labor opportunities cut incomes and purchasing power. However, 90% of the non-slum households also cited financial considerations, noting increased prices as the reason for eating fewer fresh fruits and vegetables.

In addition to changes in quantity, the variety of fruits consumed also narrowed. Households reported consuming almost all fruits less frequently during the pandemic period, with greater changes in the slum-based households compared to those in non-slum areas. The Difference-in-Difference models show a decrease in the proportion of slum households consuming fruits and vegetables during COVID-19 relative to the non-slum households. This included the nutrient-dense fruits, such as mangoes and paw paws—both rich in vitamin A. However, it is important to note that mangoes were out of season locally, which may have rendered them less available and more expensive. The decreased consumption could be attributed to increase in prices and decreased household incomes FAO (2022).

The econometric regression analysis, which assesses determinants of household dietary diversity, confirms the descriptive results. We found that in the slum model, male-headed households had higher dietary diversity than female-headed households, perhaps because men tend to have more diverse income portfolios, and if one of them is affected by a shock, others may remain unaffected (Kansiime et al., 2021). At the same time, because women do considerable work in the informal sector (and are less likely to be employed formally as wage workers), they are quite exposed to COVID-19 health controls. Furthermore, during the pandemic male heads of household could generate income from casual jobs, while female heads may be kept from such employment by the need to care for children. Government-mandated school closures meant that all children were at home during the study period; households with young children were likely to have assumed greater child-care responsibilities and increased cost of food with more mouths to feed. For the low income neighborhoods, school also provides an opportunity for students to eat healthily through the school feeding programs (Van Lancker and Parolin, 2020). Our analysis also shows that that the education level of the head of household was associated with improved diet diversity, but only in non-slum households. This result could be due to greater opportunities outside of slum areas for salaried or self-employed work that requires higher levels of education. Further, we found that decreased consumption of fruits and vegetables was associated with lower diet diversity scores for the households in the slums. While the non-slum households may have replaced fresh fruits and vegetables with other foods, it is possible that households in the slums did not, instead lessening the diversity of their diets. Increased food prices were also associated with reduced dietary diversity for the slum households, perhaps due to meager household incomes. Overall, our analysis showed that households in the slums had a lower household dietary diversity score than non-slum households. Ongoing income shocks from COVID-19 control measures mean that the dietary quality of households in slums will likely continue to be suboptimal; the implications for health and wellbeing, especially among children and women, are troubling.

Several conclusions can be drawn from our findings. First, in terms of food security, nutrition, and economic factors, the COVID-19 pandemic has affected resource-poor consumers in the urban slums more than middle-income consumers in non-slum locations. Employment opportunities in the slums tend to be in casual labor; the pandemic disrupted these jobs, and household incomes shrunk. Second, households in slum areas significantly lessened their consumption of nutritious foods—especially fruits, vegetables, and animal products—during the pandemic compared to those in the non-slum areas. These changes indicate a reduction in diet quality which increases their risk of chronic and non-communicable diseases and other nutrition related challenges. Third, increased prices for fresh fruits and vegetables are at the root of dietary pattern changes among all households in the study, with diminished incomes in the slums presenting an additional constraint.

These findings can inform policy development. First, food and nutrition security policies need to be responsive to the needs of different income segments of the population. We find that slum and non-slum households were affected differently by the COVID-19 pandemic. Differentiated policies and solutions could address the food and nutrition security challenges of poor and middle-income groups simultaneously. For example, given that higher prices during the pandemic were a limiting factor on the consumption of fresh fruits and vegetables in both middle- and low-income households, interventions aimed at reducing food prices such as production cost reducing strategies at farm level, strategies for improved post-production value chain efficiencies to ensure unconstrained supply of commodities to consumer markets, and price subsidies to cushion consumers

from shocks, will help to improve their food security and nutrition. However, such interventions would not necessarily guarantee improved food security and nutrition for resource-poor households, who first need economic empowerment solutions to access nutritious foods. A generalized approach to policy formulation and implementation my not be effective.

A second insight generated by the study is the stark gender differences in experience of the impacts of the pandemic. We find that male- and female-headed households were affected differently by COVID-19. Women, who have lower formal employment opportunities and are also generally assigned more productive and reproductive roles in the household, may find it harder to achieve food and nutrition security when they head their households. This general situation was exacerbated by the pandemic and concurrent movement restrictions, which together reduced casual labor opportunities, and market and school closures that limited physical access to food and increased their workload. Further analysis of the gender impacts of COVID-19 is however required for a clear understanding of how different genders are affected by the pandemic.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by CIAT Institutional Review Board (IRB). The participants provided their written informed consent to participate in this study.

Author contributions

Conceptualization and writing—review and editing: CC, KO, ML, and JK. Methodology: CC, KO, and ML. Formal analysis and writing—original draft preparation: KO and CC. Investigation: CC and ML. Resources and funding acquisition: ML, CC, and JK. Investigation: CC. All authors have read and agreed to the published version of the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This research was funded by the CGIAR Platform for Big Data in Agriculture through the project Hungry cities: inclusive food markets in Africa. The project was implemented by the International Center for Tropical Agriculture in partnership with Twiga Foods Ltd. Twiga Foods Limited was not involved in the study design, collection, analysis, interpretation of data, the writing of this article, or the decision to submit it for publication.

Acknowledgments

The authors of this manuscript thank the consumers who participated in this study and the research assistants who supported the data collection. This manuscript has been released as a report at the CGSpace: the International Center for Tropical Agriculture (CIAT), (Chege et al., 2020).

Conflict of interest

Author JK was employed by the company Twiga Foods Ltd.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2022.718443/full#supplementary-material

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