PART 2

Toward Healthier Food Systems

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Improving health is one of the five key goals in transforming food systems. Part 2 of this book presents a discussion on diets and food safety in Kenya. What food systems produce, how they deliver food to consumers, and the food choices offered to consumers have profound impacts on health through dietary quality and food safety. As Kenya faces a dual nutrition problem—with undernutrition in many rural areas and incipient overnutrition in some urban areas—understanding the role of food availability, affordability, preferences, and safety is important to designing policy that leads to healthier lives for all Kenyans. These aspects of the food system are increasingly important against the backdrop of rapid food price inflation, supply chain disruptions, and sometimes low local food production levels.

Chapter 4 presents an analysis of Kenyan diets, food affordability, and food preferences in rural, peri-urban, and urban areas. Overall, there is underconsumption of nutritious foods (for example, vegetables) and overconsumption of calorie-rich foods (for example, staples). Most Kenyan households cannot afford a healthy, diverse diet, as the cost of healthier foods is much higher than the cost of staple foods and foods with added sugars. Further, food preferences are often preventing people from consuming affordable, healthy alternatives such as pulses and nuts. The combined issues of affordability and preferences point to a need for policy that targets poverty reduction and nutrition education together.

Foodborne diseases can undermine health even if diverse, nutritious foods are made affordable and available. Chapter 5 presents an overview of food safety in Kenya. Such hazards can take various forms (for example, microbiological or chemical) and appear in any value chain. The prevalence of foodborne diseases in Kenya is high, and there are a number of approaches that can be used to improve safety. For example, harmonizing the fragmented food safety regulatory landscape and improving the enforcement of food safety regulations can lead to an improved balance between food safety and food security. Further, policy must recognize the importance of informal markets and the need for regulatory frameworks to simultaneously address the needs of formal and informal

markets. Providing water, sanitation, and hygiene (WASH) infrastructure; conducting monitoring of water sources; building the capacity of value chain actors; and leveraging co-regulatory approaches with the private sector are all promising policy avenues to improve food safety.

In summary, Part 2 places health at the forefront of food system outcomes through its discussions of diets and food safety. Improving food security, nutrition, and safety for Kenyans is a primary concern in food system transformation. After all, food is ultimately produced for consumption, so any policy related to its production must keep in mind the health and well-being of the ultimate user of agricultural and livestock output—the consumer.

Chapter 4

KENYAN DIETS: QUALITY, AFFORDABILITY, AND PREFERENCES

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Dysfunctions in food systems in developing countries prevent many people from consuming a healthy diet (FAO et al. 2021), and Kenya is no exception. Globally, poor-quality diets are the leading cause of all forms of malnutrition (Afshin et al. 2019; Willet et al. 2019). In Kenya in 2020, an estimated 19 percent of children under five years of age were stunted (UNICEF, WHO, and World Bank 2021); in 2014, 33 percent of women aged 15–49 years were overweight or obese (KNBS et al. 2015), while recent regional trends in adults' body mass index suggest a rapid increase in the prevalence of overweight and obesity (Abarca-Gomez et al. 2017). The number of deaths resulting from noncommunicable diseases (NCDs), such as coronary disease, type 2 diabetes, and cancer, is projected to surpass malaria and tuberculosis by 2030 (Mkuu et al. 2021). Malnutrition and NCDs can have lifelong health consequences and high social and economic costs for individuals and societies alike, including from impaired human capital formation, reduced labor productivity, and high healthcare costs (Popkin et al. 2006; Shekar, Heaver, and Lee 2006; Victora et al. 2008; Black et al. 2013).

Public policies in developing countries have often failed to address malnutrition. The challenges have become more complex in recent decades because of the simultaneous occurrence of both under and overconsumption of food and nutrients, most notably among the poor, and often within the same population strata or even the same households (Popkin, Corvalan, and Grummer-Strawn 2020). While there is broad consensus that food system transformation is urgently needed to achieve healthier diets (HLPE 2017; Webb et al. 2020; FAO et al. 2021), there is less clarity on what are promising entry points for policy and technology and which policy levers would most effectively bring about change.

Policy considerations in this regard are mostly country- and context-specific, and thus require thorough analysis.

Analysis of current dietary patterns and the gaps between consumption levels and healthy reference intakes for nutritious food groups is an important starting point in understanding how to improve the nutritional quality of diets. The next step is to grasp the constraints that prevent consumers from obtaining high-quality diets. For poor populations, the relatively high cost of a diverse and nutritionally adequate basket of foods is a major constraint, as is consumer knowledge of the types and quantities of food required for healthy living given unique physiological needs. Finally, it is important to understand people's food consumption behavior, and specifically their food preferences and consumption responses when food prices and real incomes change. A range of policy instruments and technological innovations can target such economic variables. For example, investments in agricultural production and food value chains, consumer subsidies and food assistance, or cash transfer and employment programs can all affect relative prices of foods or household disposable incomes, which, subject to preferences, may result in dietary change.

This chapter examines the nutritional quality of Kenyan diets, the affordability of healthy diets in the country, and the food preferences of consumers. Because of rural–urban differences in food consumption patterns and rapid urbanization in Kenya, we separate our analysis into rural areas, peri-urban areas, and urban centers, with the latter two forming urban agglomerations. With more than 70 percent of the population living in rural areas, Kenya is still one of the least urbanized countries in sub-Saharan Africa, but its urbanization rate, like that of neighboring East African countries, is high (DESA 2019). The data for our empirical analysis are taken from the 2015/16 Kenya Integrated Household Budget Survey (KIHBS), a large representative survey of 12,318 rural households, 2,541 peri-urban households, and 5,353 urban households (after data cleaning).[1] Our analysis includes foods consumed at home, as

1 A detailed description of the 2015/16 KIHBS is available from the Kenya National Bureau of Statistics (KNBS 2018). We cleaned the released data for obvious reporting errors in the main variables of our analysis observation by observation. We dropped entire households from the sample if these did not complete the survey interview or did not report food consumption (at home). We also dropped households with implausible calorie consumption amounts that we derived from the survey's seven-day food consumption recall. Households were defined as having implausible calorie consumption amounts if their consumption per adult equivalent was below 600 kcal/day or above 6,000 kcal/day. Lastly, we dropped households if they reported implausibly large consumption quantities or expenditures for any of the 15 food groups used in the food demand system estimations (presented in the fourth section). Based on the two latter criteria, we dropped 7.1 percent of households that reported any food consumption.

information on their quantities and nutritional qualities can be assessed easily,[2] but excludes (prepared) foods consumed away from home, for which detailed information is unavailable.

Dietary patterns and quality

In its influential 2019 report on healthy diets from sustainable food systems, the EAT–*Lancet* Commission on Food, Planet, Health proposed a global reference diet that meets nutritional requirements, reduces the incidence of NCDs and mortality, and considers environmental sustainability of food production (Willet et al. 2019). This "healthy reference diet" provides quantitative dietary guidelines by food group. In addition to optimal food intakes in grams, it defines possible food intake ranges (except for added sugars) and specifies caloric intakes by food group that are derived from the optimal food intakes. In the absence of quantitative food-based dietary guidelines for Kenya, we use these optimal caloric intakes as the reference intakes for our dietary analysis. The global healthy reference diet of the EAT-*Lancet* Commission was complemented with four common, nutritionally balanced and predominantly plant-based, dietary patterns—namely, for flexitarian, pescatarian, vegetarian, and vegan consumers (Springmann et al. 2021).[3] Our analysis also uses the reference intakes for the flexitarian diet as an alternative set of dietary guidelines, because most diets in Kenya are mainly plant-based but often contain meat

2 The food consumption recall includes 196 food item categories (excluding bottled water and calorie-free stimulants such as coffee and tea) for at-home consumption. For converting reported food item consumption quantities to calorie consumption amounts, we used the National Nutrient Database of the United States Department of Agriculture (USDA 2016) and, for East Africa-specific food items, the most recent Tanzania Food Composition Tables (Lukmanji et al. 2008).

3 A modeling analysis was performed to construct the four common dietary patterns (Springmann et al. 2018, 2021). They are calorie-balanced variants of the healthy dietary guidelines as defined by the EAT–*Lancet* Commission (Willet et al. 2019), and hence their reference intakes are within the possible intake ranges of the healthy reference diet. On a calorie basis, the flexitarian diet has a larger amount of starchy staples than the optimal intake of the healthy reference diet (that accounts for about 47 percent of total caloric intake, compared with 34 percent); a small red meat amount that is still larger than the optimal healthy reference intake (equivalent to one serving per week); a modest amount of other animal-source foods (including poultry, fish, and dairy) that is smaller than the sum of the optimal healthy reference intakes (by about one-third); a generous amount of plant-based foods (including fruits, vegetables of different colors, and pulses and nuts) that is still somewhat lower than the sum of the optimal healthy reference intakes; a lower amount of oils and fats than the sum of the optimal healthy reference intakes (while the considered vegetable oils, however, are higher in saturated fat); and a lower maximum amount of added sugars compared with what is allowed under the healthy reference diet. The more specialized diets were constructed from the flexitarian diet by replacing meat with two-thirds fish and seafood and one-third fruits and vegetables—for the pescatarian diet; by replacing meat with two-thirds pulses and one-third fruits and vegetables—for the vegetarian diet; and by replacing all animal-source foods with two-thirds pulses and one-third fruits and vegetables—for the vegan diet (Springmann et al. 2018).

or other animal-sourced foods. (For simplicity, we refer to the healthy reference diet and flexitarian diet together as the "EAT–*Lancet* diets.")

While the reference intakes should not be interpreted as strict caloric thresholds that individual consumers must achieve, they provide useful benchmarks for an average diet that yields sufficient calories from a diverse set of food groups that are likely to also provide adequate amounts of essential macro and micronutrients for most people. The major food groups of the EAT–*Lancet* diets are starchy staples (separated into cereals and starchy roots and tubers), vegetables, fruits, protein sources, dairy foods, added fats and oils, and added sugars. In our analysis, we separate the protein sources into animal-source proteins (that is, meat, fish, and eggs) and plant-based proteins (that is, pulses and nuts); combine the starchy staples into one group (because starchy root and tuber consumption is very low across Kenya); and add a "discretionary foods" group. Discretionary foods include snacks, sweets, and beverages that all provide calories but that the EAT–*Lancet* Commission considers nutritionally non-essential and partly even unhealthy foods (Willet et al. 2019). All reference diets are scaled for a total daily caloric intake of 2,500 kcal—the healthy intake of a moderately active, average-size adult. Households' food consumption in our analysis is therefore expressed based on calories per adult equivalent (AE).[4]

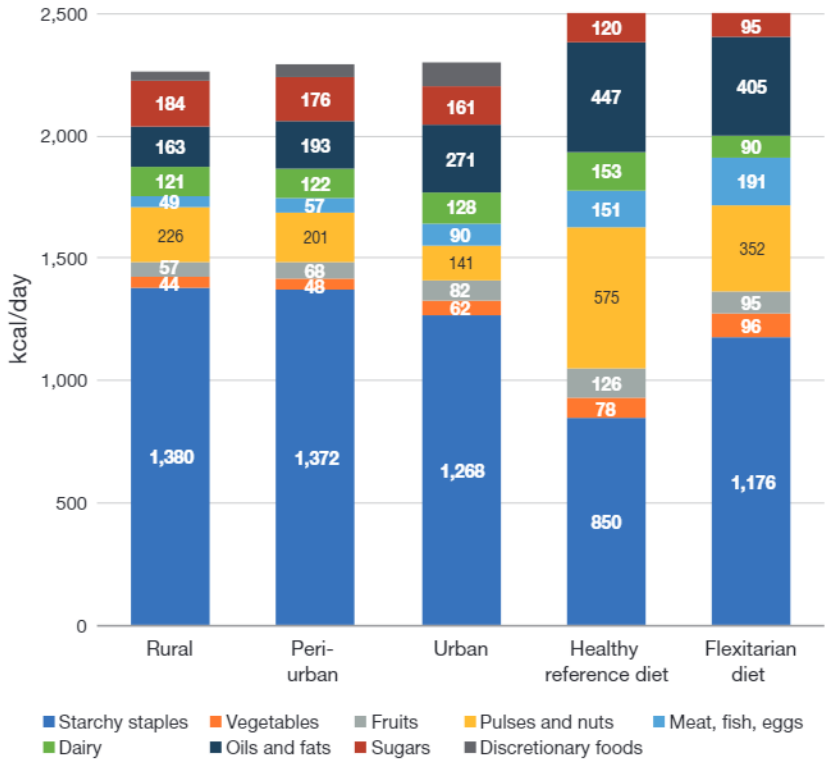
Figure 4.1 shows average calorie consumption amounts for rural, peri-urban, and urban areas in Kenya and relates them to the reference intakes of the healthy reference and flexitarian diets. Apart from the fact that the average person obtains less than the requisite quantity of daily calories, average dietary patterns differ significantly from dietary guidelines, which is suggestive of poor dietary quality overall. The average person overconsumes starchy staples and underconsumes nutritious foods such as vegetables, fruits, and both animal-source and plant-based protein foods. Around 60 percent of total calories consumed in rural and peri-urban areas and 55 percent in urban areas are obtained from starchy staples. According to the healthy reference diet, only one-third of total calories should come from staples, while the flexitarian diet allows for just less than half of total calories to come from staples. Over 90 percent of staple calories come from cereals. These are consumed primarily in refined form, predominantly as maize meal but also as wheat flour or polished rice. The high consumption of refined grains is concerning because removal of the bran during

4 An AE expresses an individual household member as a fraction of an adult person—here, in terms of daily calorie requirements. We calculated household-specific AE values from detailed dietary energy requirements for individuals (provided by FAO, WHO, and UNU 2004). These calculations account for household compositions by sex and age and the dietary energy needs of breastfeeding mothers. In our sample, the average household member corresponds to about 0.95 AE.

the milling process results in loss of fiber and much-needed micronutrients. Moreover, the EAT–*Lancet* Commission emphasizes the importance of whole grain consumption as this is associated with reduced risk of coronary disease, type 2 diabetes, and mortality (Willet et al. 2019).

Figure 4.1 also shows that the average diets in Kenya are lacking vegetables, fruits, pulses or nuts, and meat, fish, or eggs, in both relative and absolute quantities. For meat, fish, and eggs, the average shares of consumed calories in the reference intake of the flexitarian diet range from 26 percent in rural areas to 47 percent in urban areas. The respective average calorie consumption shares

FIGURE 4.1 Mean calorie consumption amounts per AE and reference intakes of the EAT–*Lancet* diets by major food group



Source: Authors' estimates using 2015/16 KIHBS data.

Note: Consumption estimates refer only to foods consumed at home. Starchy staples include cereals, starchy roots/tubers, and plantains. Discretionary foods include snacks, sweets, and beverages and are considered as non-required foods according to the EAT–*Lancet* Commission. AE = adult equivalent.

account for 46–65 percent for vegetables and 60–87 percent for fruits. For pulses and nuts, the average calorie consumption shares are larger in rural aeras than in peri-urban and urban areas, accounting for 64 percent and 40 percent of the flexitarian diet's reference intake in rural and urban areas, respectively. When relating the average calorie consumption amounts to the intakes of the healthy reference diet, these shares are somewhat higher for meat, fish, and eggs and for vegetables, and lower for fruits and for pulses and nuts. The average calorie consumption amounts obtained from dairy foods, an essential source of key micronutrients for children in particular, meet the reference intake of the flexitarian diet and equate to around 80 percent of the reference intake of the healthy reference diet. This highlights the importance of dairy in the diet of many Kenyans.

For added sugars, the EAT–*Lancet* Commission defined acceptable maximum intakes, because, unlike the other major food groups, added sugars are nutritionally not essential. The average dietary patterns in Figure 4.1 reveal an alarming overconsumption of added sugars. The average calorie consumption of added sugars exceeds the allowed maximum intake level of the healthy reference diet by about one-third and is nearly double that of the flexitarian diet, with higher consumption amounts in rural areas than in peri-urban and urban areas. In fact, observed consumption amounts likely underestimate total sugar consumption, especially in urban areas. First, discretionary foods, which includes snacks, sweets, and sugar-sweetened beverages, are often rich in sugar. However, detailed information on the sugar content of the consumed foods is unavailable from the survey data used. Second, our calorie consumption estimates exclude food consumed away from home, which is another significant source of sugar consumption. (Consumption of oils and fats is likely underestimated for similar reasons.) Food-away-from-home consumption is probably another considerable source of calorie consumption, especially in urban areas. Food consumed away from home amounts to 10 percent of households' total food expenditure in urban areas, on average, and 5 percent and 3 percent in peri-urban and rural areas, respectively. Thus, the true average total calorie consumption is likely to be somewhat higher than the estimates presented in Figure 4.1, especially in urban areas.[5]

Overall, the average dietary patterns shown in Figure 4.1 are very consistent with the "nutrition transition" that is observed across the developing world and

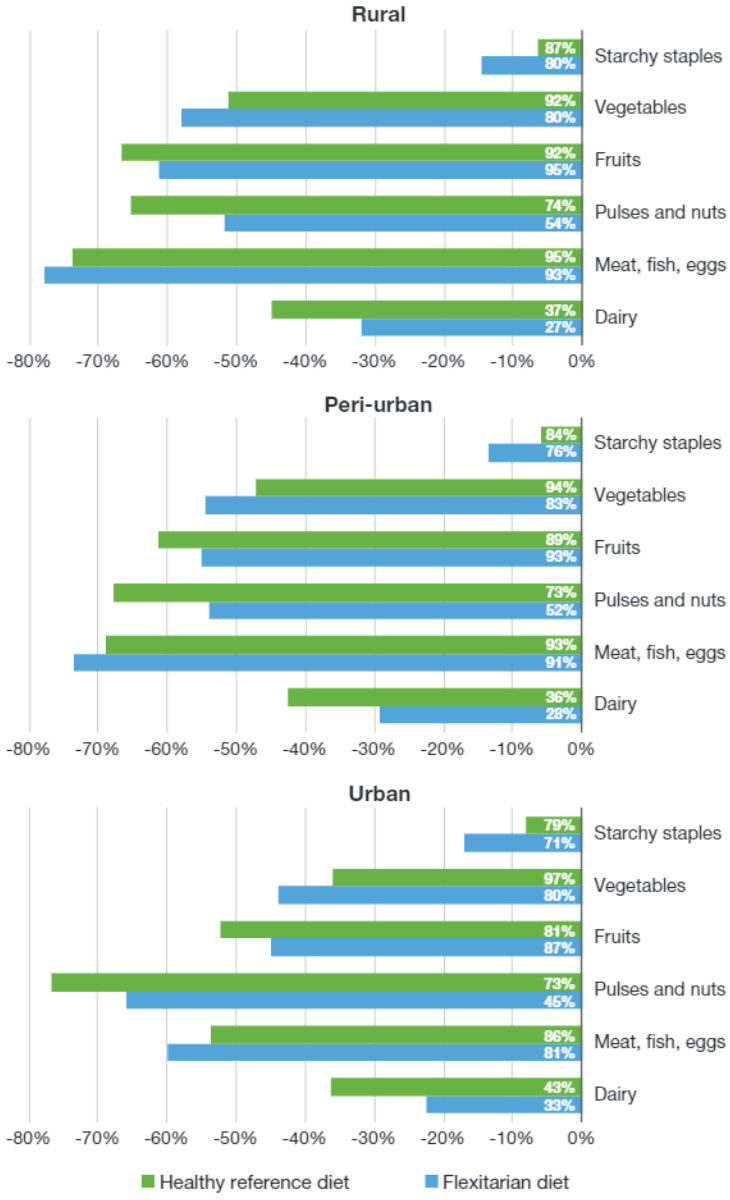
5 It should also be noted that people's calorie expenditures tend to be higher in rural areas than in peri-urban and urban areas because of higher physical activity levels in common economic activities such as farming.

that is closely associated with urbanization and other food systems dynamics (Popkin 1999, 2006, 2017).

Our examination of the distribution of food consumption provides first evidence of large inequalities in household access to healthy diets across the Kenyan population (which will be further explored in the next subsection). While large proportions of the population overconsume starchy staples and calorie-rich non-required foods, underconsumption of nutritious food groups is even more prevalent. According to our estimates, 28 percent of all households obtain more than two-thirds of their total calories from starchy staple food consumption. This proportion is considerably larger in rural areas (34 percent) and peri-urban areas (29 percent) than in urban areas (18 percent). In contrast, Figure 4.2 shows that at least an estimated 80 percent of rural households, 75 percent of peri-urban households, and 70 percent of urban households have calorie consumption amounts from vegetables, fruits, or animal-source or plant-based protein foods that are lower than the reference intakes of the healthy reference and flexitarian diets, and the consumption by most of these households falls short in multiple nutritious food groups. Dairy consumption is insufficient in more than 50 percent of all households relative to the reference intake of the flexitarian diet, and more than 70 percent relative to that of the healthy reference diet. Yet even the consumption of starchy staples is below the flexitarian diet's reference intake among more than 20 percent of all households, and nearly twice that percentage have calorie consumption amounts for starchy staples below the staple reference intake of the healthy reference diet. In each residential area, almost all households have consumption amounts that are lower than the reference intakes of both the healthy reference diet and the flexitarian diet for at least one of the six major nutritious food groups of the EAT–*Lancet* diets, suggesting widespread overall poor diet quality.

Figure 4.2 also shows the average gaps in calorie consumption amounts by major nutritious food group. The calorie consumption gaps are calculated as the differences between the reference intakes and households' food consumption amounts that are averaged across all households, while households that have consumption amounts above the reference intakes enter the calculation with a zero deficit. The gaps in rural, peri-urban, and urban areas are largest for the two protein food groups, varying between 50 percent and 80 percent. Thus, closing the gaps for protein foods requires more than doubling the current average consumption. The next largest consumption gaps are found for fruits, vegetables, and dairy foods, in that order. The average consumption gaps for starchy staples are relatively small in all three residential areas, accounting for less than 10 percent of the reference intake of the healthy reference diet and less

FIGURE 4.2 Proportions of population with calorie consumption amounts below the reference intakes and mean calorie consumption gaps by major nutritious food group of the EAT–*Lancet* diets



Source: Authors' estimates using 2015/16 KIHBS data.

Note: The bars indicate the average size of the calorie gap for each food group. The white percentages at the inside base of the bars indicate the proportions of the population with calorie consumption amounts below the reference intakes of the EAT–*Lancet* diets. Households with calorie consumption amounts above the reference intakes enter the calculation of the mean calorie consumption gaps with a zero deficit. Consumption estimates refer only to foods consumed at home. Starchy staples include cereals, starchy roots/tubers, and plantains.

than 20 percent of the flexitarian diet's reference intake. The consumption gaps for all major nutritious food groups are considerably smaller in urban areas than in peri-urban and rural areas, with the important exception of pulses and nuts.

Diet costs and affordability

Large consumption gaps for nutritious foods observed in Kenya reflect, at least in part, the high costs of a healthy diet relative to household incomes. Figure 4.3 shows the median prices per 100 kcal for the major food groups of the EAT–*Lancet* diets in Kenya's rural, peri-urban, and urban areas. Prices are derived from the food expenditures reported in the 2015/16 KIHBS.[6] The meat, fish, and egg group is by far the most expensive food group in all three residential areas, as Figure 4.3 demonstrates. On a calorie basis, the median price of meat, fish, and eggs is about 14–16 times the price of oils and fats; 12–15 times the price of starchy staples; and 10–11 times the price of sugars and the price of pulses and nuts. While the nutritional value of meat, fish, and eggs is certainly more than as a source of calories, this comparison demonstrates that the problem of food affordability when satisfying dietary energy needs is a primary motivation in food consumption decisions. The comparison of the prices of meat, fish, and eggs and of pulses and nuts clearly suggests that plant-based protein foods are the much cheaper source of high-quality protein and essential micronutrients, beyond the provision of calories. This prompts the question why plant-based proteins are vastly underconsumed in Kenya—a question that this chapter will address later. Meat, fish, and eggs are also two to three times more expensive than dairy products, which is another animal-source food group rich in essential amino acids and key micronutrients, as well as calories.

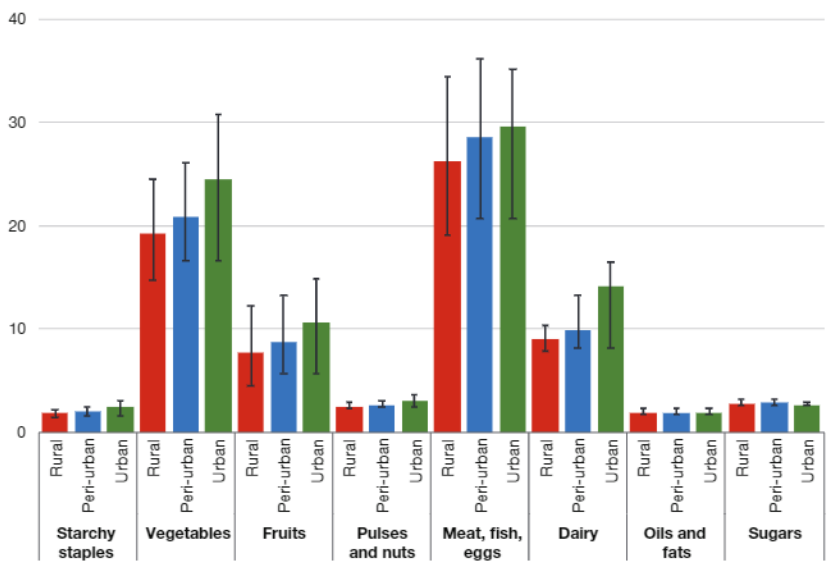
The second most expensive food group per calorie in all three residential areas is vegetables. Observed vegetable prices per weight may not be high but many vegetables (and especially green leafy vegetables) are low in calories, which yields high per calorie prices. Again, the nutritional properties of vegetables

6 In the absence of local market prices for the variety of foods consumed in Kenya, we estimated the median food group prices from reported food item-specific unit values. We calculated the food item unit values from 2015/16 KIHBS data on households' expenditures on purchased foods. As we obtained the food item unit values through a stepwise average calculation procedure starting with sub-counties as the lowest level of aggregation, the median food group prices shown in Figure 4.3 captures consumer market price differences. They also account for differences between households' food group compositions, consisting of combinations of food items yielding a total of 100 kcal. Our food group price approximation procedure uses medians for averaging across households (instead of means) to select food group compositions whose estimated item prices are not inflated by non-nutrition quality aspects of foods and outlier observations owing to reporting errors. Thus, the interquartile ranges presented in Figure 4.3 and Figure 4.4, which include household-level estimates from the 25th to the 75th percentile, have interpretational value.

are other than a source of calories but this is a main reason why food-insecure households find it difficult to choose such micronutrient-dense foods. Compared with vegetables and meat, fish, and eggs, fruits were found to be surprisingly cheap per calorie. However, the median price of this food group is driven primarily by the high share of bananas in fruits, which, compared with other fruits, are rich in calories but lack important vitamins such as vitamins A and C. In all three residential areas, the interquartile range, proportional to the median price level, is also largest for fruits, indicating large heterogeneity in this food group. In contrast, the interquartile ranges, in relative terms, are smallest for sugars; oils and fats; and pulses and nuts. Differences between the median prices in rural and urban areas are largest for dairy products, followed by fruits and starchy staples. There are virtually no rural–urban differences between the median prices of sugars and of oils and fats. Moreover, Figure 4.3 illustrates the inexpensiveness of added sugars and added oils and fats as calorie sources—roughly equivalent to starchy staples.

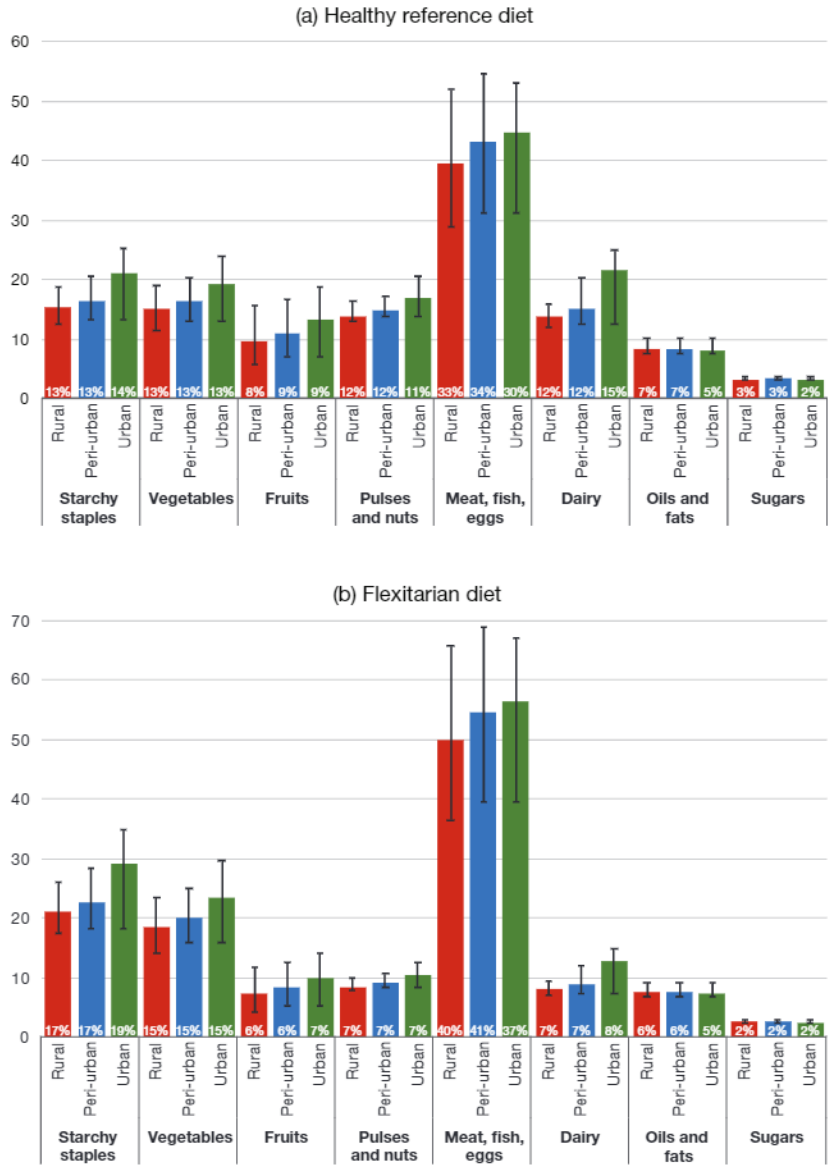
Figure 4.4 presents the cost structures of the healthy reference diet and the flexitarian diet in Kenya's rural, peri-urban, and urban areas. Depending on the place of residence, the median costs for consuming the reference intake

FIGURE 4.3 Median food group prices per 100 kcal (in 2015 KSh)



Source: Authors' estimates using 2015/16 KIHBS data.
Note: The error bars indicate the interquartile ranges.

Figure 4.4 Median daily costs of the EAT–*Lancet* reference intakes per AE (in 2015 KSh)



Source: Authors' estimates using 2015/16 KIHBS data.

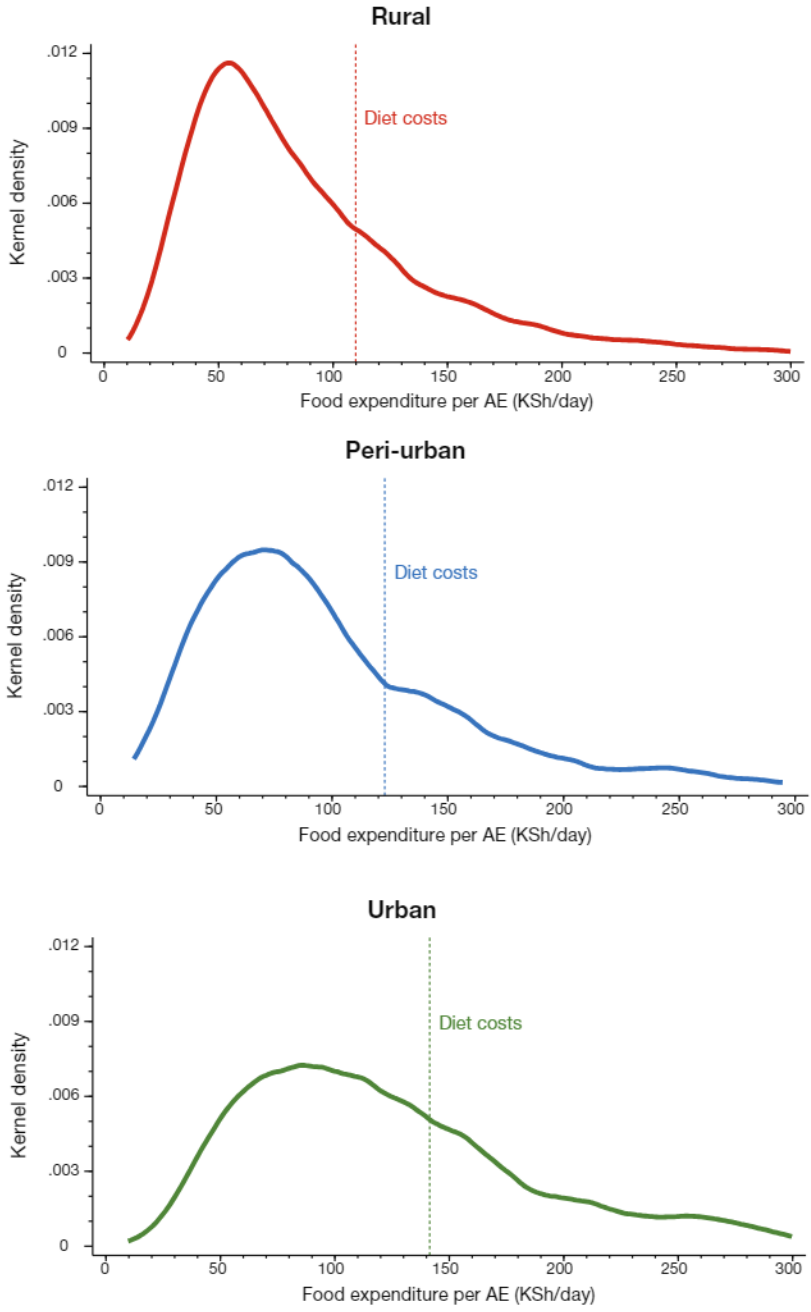
Note: The error bars indicate the interquartile ranges. The percentages are the shares of the median food group costs in the totals of all food groups' median costs.

of meat, fish, and eggs amount to between 30–34 percent and 37–41 percent of the median cost totals for consuming the reference intakes of the healthy reference diet and the flexitarian diet, respectively. The respective median cost shares of pulses and nuts are only 11–12 percent for the healthy reference diet and 7 percent for the flexitarian diet. Obtaining the reference intakes for meat, fish, and eggs for both EAT–*Lancet* diets is also more than twice as expensive as obtaining the reference intakes for dairy products, vegetables, and starchy staples (except for the starchy staple reference intake of the flexitarian diet in urban areas).

The median daily costs of the healthy reference diet are about KSh 110 in rural areas, KSh 123 in peri-urban areas, KSh 141 in urban areas, and KSh 120 nationally (all at 2015/16 price levels). The median daily costs of the flexitarian diet are higher by 4–5 percent (or KSh 4–6). The cost differences between the healthy reference diet and the flexitarian diet are driven mainly by the higher reference intakes of meat, fish, and eggs and of vegetables in the flexitarian diet and the high per calorie prices of these food groups. The median costs of both EAT–*Lancet* diets are considerably higher than the official food poverty lines in rural areas (KSh 69 per AE per day) and peri-urban and urban areas (KSh 84 per AE per day). This in part reflects the fact that Kenya's poverty lines are calculated for a total calorie consumption amount of 2,250 kcal/day per AE as opposed to 2,500 kcal/day but mostly reflect the lower cost of the basic food basket used for poverty analysis, which is nutritionally less balanced than the EAT–*Lancet* diets. Our diet cost estimates are also consistent with results from previous EAT–*Lancet* diet cost analysis. Using retail prices from the World Bank's International Comparison Program, Hirvonen and colleagues (2020) estimate that the minimum daily cost of the healthy reference diet across Kenya is $2.17 in 2011 purchasing power parity (PPP). Our national estimate of the median daily cost of this EAT–*Lancet* diet converted to 2011 PPP levels is $2.26, which is similar to the median daily cost estimates for adjacent East African countries (Headey et al. 2023).

Figure 4.5 relates the distributions of household food budgets, measured by estimated food expenditures (for at-home consumption), to the median daily costs of the healthy reference diet in rural, peri-urban, and urban areas. The graphs suggest that, in all three residential areas, most households cannot afford the healthy reference diet. According to our data, 75 percent of rural households, 74 percent of peri-urban households, and 65 percent of urban households have food expenditures below the median costs of the healthy reference diet. These percentages are more than twice the official proportions of food-poor

Figure 4.5 Distributions of household food expenditures and median costs of the healthy reference diet



Source: Authors' estimates using 2015/16 KIHBS data.

Note: Food expenditure distributions are truncated at 300 KSh/day. AE = adult equivalent.

households, estimated at 28 percent in rural areas, 22 percent in peri-urban areas, and 18 percent in urban areas (KNBS, World Bank, and UNICEF 2018).

Food preferences and consumption responses

The previous sections have shown that many Kenyans simply cannot afford a nutritionally well-balanced diet, much less the EAT–*Lancet* diets, because of the high costs associated with obtaining optimal intake levels for nutritious foods—especially for meat, fish, and eggs. High prices for nutritious foods are a main constraint to achieving dietary improvement among poor households, particularly when their calorie requirements are not, or barely, met. However, there are also many households that likely overconsume total calories and "empty calories," such as those from added sugars and sugary products. Pulses and nuts are relatively cheap sources of important proteins and micronutrients, as well as calories. Yet these plant-based protein foods are vastly underconsumed, especially in urban areas. A possible explanation for this finding is weak consumer preferences for these foods—a hypothesis that we explore in this section.

While consumer preferences cannot be observed directly, they can be inferred from analysis of how consumers respond to changes in incomes or prices. Behavioral responses can be estimated in a theoretically consistent manner from food demand systems, which allow the derivation of income and price elasticities. An income elasticity of food demand measures the responsiveness of consumption of a food (or food group) to a change in real income (higher income tends to be associated with increased consumption). An own-price elasticity of food demand, in turn, measures the responsiveness of consumption of a food to a change in the price of that food (higher prices tend to be associated with lower consumption).

Figure 4.6 shows estimated income and own-price elasticities for 15 distinct food groups that are a disaggregation of the major food groups of the EAT–*Lancet* diets, implemented to reflect potentially diverse consumer preferences for foods within these major food groups. We derived these elasticities from econometrically estimated parameters of complete food demand system models that include two modeling stages. In the first stage, we estimated a Working-Leser model to obtain the income elasticities of total food demand vis-à-vis the

aggregate demand for nonfood consumption (Working 1943; Leser 1963).[7] We then, in the second stage, modeled within-food budget allocations, allowing for full substitutability between all food groups, conditional on the available food budget. To estimate the demand for different food groups, we used a Quadratic Almost Ideal Demand System that accounts for censoring of food consumption observations (Banks, Blundell, and Lewbel 1997; Shonkwiler and Yen 1999). The estimation methodology is documented elsewhere in detail (see Ecker and Comstock 2021). We separately estimated the models for rural areas and for urban areas (combining urban centers and peri-urban areas) to allow for structurally different food demand curves between these areas, which may exist because of a greater share of farm households, and a larger dependence on subsistence-oriented agriculture, in rural areas. Figure 4.6 presents mean elasticity estimates for the lowest-, middle-, and highest-income quintiles within each residential area, which together span a range in which the individual elasticity estimates of most households fall.

The income elasticities of demand for most food groups are smaller in urban areas than in rural areas, as Figure 4.6 shows. This reflects higher incomes among urban households. Engel's Law states that, as household incomes rise, the percentage of income spent on food declines (Engel 1857). This translates into lower income elasticities for food among wealthier households. According to our estimates, the mean income elasticities of total food across all households are 0.707 in rural areas and 0.565 in urban areas. The income elasticities are largest for the two animal-source protein food groups (meat and fish; and eggs) in rural areas, with elasticity estimates for the middle-income quintile of around 1.5. The differences between the income elasticities of the lowest and highest income quintiles in rural areas are also very large. These results suggest that income growth in rural areas, and particularly among the poor, is likely to substantially increase people's consumption of animal-source foods and thus contribute to narrowing the large consumption gap found for this food group. In rural areas, the income elasticities for pulses and nuts, vegetables other than green leafy vegetables, and cereals other than maize (which includes mostly wheat-based products and rice) are also above the income elasticity of total food demand,

7 Food-away-from-home consumption is here considered as part of nonfood consumption, and related consumption behavior is therefore captured in the first modeling stage. This allocation is carried out to account for the fact that most of the costs of meals and drinks consumed in restaurants and bars are likely payments for food preparation and services (rather than for the market value of the raw meal ingredients and beverages) and to accommodate model requirements. Food demand system estimations require price information for each considered food category, which, however, are unavailable in the used household survey data for food-away-from-home consumption.

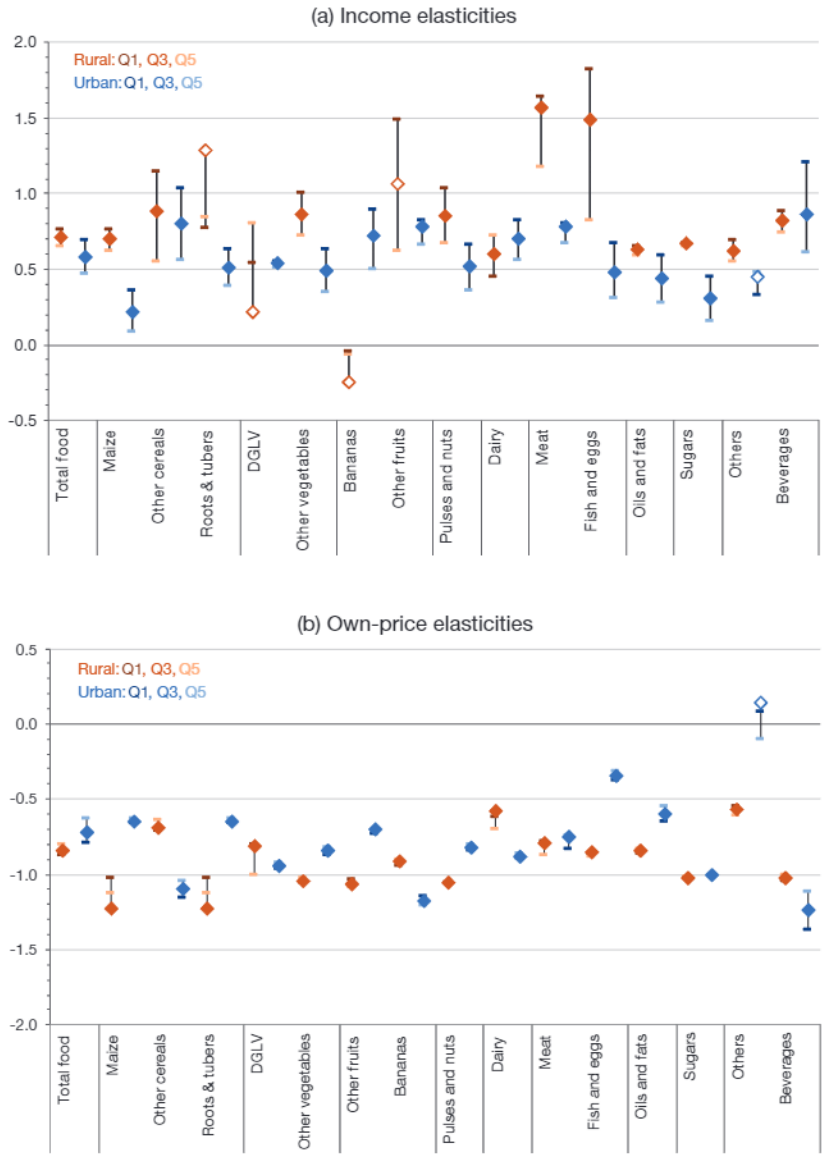
while the elasticities of the lowest income quintile for these food groups exceed unity. With growing household incomes, the consumption of these food groups can hence be expected to increase faster than the consumption of other food groups.

This holds true in urban areas for other cereals and beverages, which both include high proportions of highly processed foods, as well as sugary foods in the case of the latter. The observed tendencies for rapidly increasing consumption of highly processed foods are consistent with findings from previous studies on the positive association between the growing spread of modern food retailers (most notably supermarkets) and increasing prevalence of overweight, obesity, and related NCDs in Kenya's urban areas (for example, Rischke et al. 2015; Demmler, Ecker, and Qaim 2018; Khonje, Ecker, and Qaim 2020). Moreover, our income elasticity estimates suggest that, in urban areas, income growth likely leads to faster increases in the consumption of meat, dairy, and fruits (both bananas and other fruits) than for total food consumption, and slower increases in the consumption of pulses and nuts, dark green leafy vegetables, other vegetables, and fish and eggs. This provides support for our hypothesis of weak preferences among urban consumers for plant-based protein foods.

In addition to high prices per calorie, weak preferences for vegetables in general may explain the large consumption gaps found for vegetables in urban centers and peri-urban areas. Dairy is the only nutritious food group that shows lower (and statistically significant) income elasticity estimates for rural areas than for urban areas, which may be largely explained by better access to dairy products as a result of widespread livestock husbandry in rural areas. Maize consumption in urban areas is least elastic to income changes. As maize is the primary staple food, this result reflects Bennett's Law. This states that, as economies grow and per capita incomes rise, the share of calories from staple foods declines (Bennett 1941). In rural areas, and particularly for lower income quintiles, the income elasticities for maize are similar to the income elasticities of total food demand. The sensitivity of maize consumption to income changes within this population stratum confirms that food insecurity is a key factor of rural consumers' food choices.

Figure 4.6 shows that, compared with the estimated income elasticities, the estimated own-price elasticities of demand show much less differentiation between the estimates for the lowest income quintiles and the highest income quintiles in both rural and urban areas, suggesting similar consumption responses to relative price changes. Also, the elasticity patterns for prices across the food groups are less clear, as the price elasticity estimates for most food

FIGURE 4.6 Income and price elasticities of total food demand and the demand for 15 main food groups



Source: Authors' estimates using 2015/16 KIHBS data.

Note: Q1 = lowest income quintile, Q3 = middle income quintile, Q5 = highest income quintile. DGLV = dark green leafy vegetables. Other cereals are mostly wheat, wheat products, and rice. The food group of bananas includes plantains. Other foods include sweets, snacks, and condiments. Beverages include sugar-sweetened beverages. Hollow diamond-shaped markers indicate that the elasticities are statistically insignificant at the 5 percent level as per bootstrapped standard errors.

groups vary relatively closely around the elasticity estimates for the total food average. Nevertheless, there are some notable tendencies.

The consumption of beverages and sugars in both rural and urban areas is sensitive to price changes. Hence, taxation of the consumption of these non-required foods may be a way to curb overconsumption of these food groups. However, because the prices per calorie for sugars are low, marginal increases in the consumer prices are unlikely to have a notable effect on household consumption. Price-sensitive nutritious food groups include dark green leafy vegetables in urban areas and other vegetables and pulses and nuts in rural areas. Public investments to support price stability throughout the year for these foods (which are often produced and consumed locally) may be an important policy to reduce the large consumption gaps found for these food groups.

The own-price elasticities of starchy roots and tubers in rural areas and non-maize cereals in urban areas also have magnitudes greater than unity. An explanation for this result is the availability of alternative staple foods and substitution effects in staple consumption in response to relative price changes.[8] Dairy consumption in rural areas and fish and egg consumption in urban areas seem to be less responsive to own-price changes than the consumption of all other nutritious food groups. The former result may reflect the fact that milk and milk products are often obtained from own livestock and own processing in rural areas. The low price elasticity for fish and eggs in urban areas should be interpreted in conjunction with the low income elasticity for this food group. The consumption of both fish and eggs is generally very low, and its share in household food budgets is small. Marginal income or price changes are therefore associated with relatively small average consumption changes across the urban population.

Conclusions

The findings from this chapter's analysis have four important policy implications.

First and foremost, Kenya's diet problem—the underconsumption of nutritious foods and high consumption of calorie-rich foods with increasing amounts of empty-calorie foods—is primarily a poverty problem, as most Kenyans simply cannot afford a healthy diet. Low household incomes are a significant constraint to dietary improvement, and poverty reduction measures are therefore likely to have nutritional benefits as well.

8 This explanation may also hold for the found own-price elasticities for the "bananas" food group, which includes plantains. Plantains are consumed as a staple food in some parts of Kenya.

Second, our diet costing exercise has shown large differences between the costs of meeting dietary guidelines for highly nutritious foods and the costs of obtaining adequate amounts of staple foods and maximum amounts of calories from nutritionally non-required foods such as added sugars and sugary foods. These cost discrepancies have particularly strong effects on household diets because the food choices of many Kenyans are essentially driven by food insecurity and geared toward satisfaction of calorie requirements. This finding points to a relative food price problem, which interacts with the poverty problem. The relative food price problem is most apparent for animal-source protein foods and somewhat less so for vegetables. Observed consumption gaps for both food groups are large across Kenya's rural, peri-urban, and urban populations, and their prices per calorie are high. Although the reference intakes of the healthy reference diet and flexitarian diet for meat, fish, and eggs are low compared with the global average consumption (Willet et al. 2019), the costs for obtaining the reference intakes amount to at least one-third of the total costs of these EAT–*Lancet* diets in Kenya. Thus, policy interventions and technological innovations that address this relative food price problem can help narrow the consumption gaps for some nutritious food groups. While most households' consumption of nutritious food groups is moderately or highly responsive to price signals (as our estimated price elasticities of food demand suggest), more detailed analysis is necessary to assess the dietary effects of specific policies and innovations.

Third, our analysis of revealed food preferences highlights that Kenya's nutrition challenge goes beyond economic issues. This is most obvious for plant-based protein foods, including pulses and nuts, which are also important calorie sources. The per calorie price of this food group is low, and the costs of obtaining the reference intakes of either EAT–*Lancet* diet are similar to, or even lower than, the costs of obtaining the starchy staple reference intakes. However, compared with other foods groups, the observed consumption gaps for pulses and nuts are the largest in urban areas and among the largest in rural and peri-urban areas. Our income elasticity estimates reveal that current consumer preferences for pulses and nuts are relatively weak, indicating that these highly nutritious foods are less desired than others. Hence, income growth is also unlikely to lead to large increases in their consumption. This is different for meat, for instance, where consumption can be expected to increase faster than total food consumption in urban areas and in rural areas—even faster than household incomes grow. Moreover, the estimated own-price elasticities for pulses and nuts are larger in magnitude than those for total food demand in urban areas, rising above unity in rural areas. This means that pulse and nut consumption is also more sensitive to price changes than the rest of the

food basket among urban households and is price-elastic in rural areas. Thus, seasonal price fluctuations or price shocks from poor harvests, for example, are likely to have significant impacts on pulse and nut consumption. Weak consumer preferences for pulses and nuts, as well as high price sensitivity, may be an indication of a lack of consumer knowledge of the nutritional value of these foods and their importance for healthy diets. Nutrition education, for example, in schools and through public information campaigns, may aid in changing consumer behavior. Our estimation results also suggest that the weak preference problem is common across the entire country—and largely independent of household wealth.

Fourth and finally, our analysis calls for a strategic focus of food systems transformation policy on consumers and their dietary needs. Transforming Kenya's current food systems for better nutrition and health will require a paradigm shift that puts consumer diets at the center of policymaking. As agriculture is by far the dominant sector in Kenya's food systems, such a shift will entail striking a balance between traditional objectives like agricultural productivity growth, export stimulation, and farmer support, on the one hand, and the new responsibility for better nutrition and health for all Kenyans, on the other hand.

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