# Nutrition Effects of the Supermarket Revolution on Urban Consumers and Smallholder Farmers in Kenya

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AAEA Annual Meetings, 27-29 July 2014, Minneapolis, USA

Invited Paper Session "Transforming Food Markets – Implications for Nutrition and Livelihoods in Developing Countries"

**Abstract.** Food systems in developing countries are transforming, involving a rapid expansion of supermarkets. This supermarket revolution may affect dietary patterns and nutrition, but empirical evidence is scarce. The few existing studies have analyzed implications for food consumers and producers separately. We discuss a more integrated framework that helps to gain a broader understanding. Reviewing recent evidence from Kenya, we show that buying food in supermarkets instead of traditional outlets contributes to overnutrition among adults, while reducing undernutrition among children. For farm households, supplying supermarkets causes improvements in dietary quality. The results underline that supermarkets influence nutrition in multiple ways and directions.

*Keywords*: supermarkets, obesity, malnutrition, nutrition impacts, developing countries, Kenya

*JEL codes*: D12, I15, O12, O15, Q12

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## Introduction

Over the last 20 years, agriculture and food systems in developing countries have undergone a profound transformation (Reardon et al. 2009; Reardon and Timmer 2012). Rising consumer incomes, urbanization, and changing lifestyles have contributed to a shift in preferences towards higher food quality, variety, and convenience (Pingali 2007; Mergenthaler, Weinberger, and Qaim 2009). As a response, and also fueled by the growing openness for foreign direct investment, traditional food supply chains are modernizing. This often involves new technologies, new contractual arrangements between farmers and agribusiness firms, and a rising share of supermarkets in food retailing (Timmer 2009; Saenger, Torero, and Qaim 2014). In several developing countries, the spread of supermarkets has happened so rapidly that the term 'supermarket revolution' was coined (Reardon et al. 2003). The rise of supermarkets is associated with many changes, not only in terms of the place of food purchase, but also with respect to food prices, types of foods offered, shopping atmosphere, and the way procurement systems are organized. The supermarket revolution may have profound implications for food consumption and nutrition. Given that malnutrition is a widespread problem in developing countries, understanding these implications is important, but so far they have hardly been analyzed (Popkin 2014).

While the influence of supermarkets on the diets of urban consumers has been studied in the USA and Europe, nutrition impacts in developing countries have rarely been examined (Hawkes 2008; Timmer 2009). One study for Guatemala suggests that supermarkets contribute to unhealthy diets and rising waistlines (Asfaw 2008). Problems of overweight and obesity are growing in many developing countries, often coexisting with undernutrition in the same locations (Popkin 2004). On the other hand, a study for Tunisia finds that supermarkets may contribute to improved dietary quality (Tessier et al. 2008). There are not many other published studies that have analyzed nutrition impacts of supermarkets among urban consumers in developing countries.

Beyond consumers, supermarkets may affect nutrition in farming households through changing market access and incomes. In many developing countries, smallholder farmers make up a large proportion of the undernourished population. Several studies evaluated impacts of farmer participation in supermarket procurement channels on farm productivity, employment, and household income (Hernandez, Reardon, and Berdegue 2007; Neven et al. 2009; Rao and Qaim 2011; Rao and Qaim 2013; Michelson 2013). The results predominantly suggest that supermarkets cause income gains in rural areas. However, whether supermarkets also contribute to better nutrition in farming households has not been analyzed (Gomez and Ricketts 2013). Agricultural commercialization may affect food availability and gender roles within the household (von Braun and Kennedy 1994). Thus, a focus on income alone may be insufficient to assess nutrition impacts.

To address these research gaps, we have recently carried out different studies in Kenya. We have analyzed the impact of supermarkets on food purchase behavior of urban consumers (Rischke et al. 2014), as well as on the nutrition status of supermarket customers (Kimenju et al. 2014). In a separate project, we have examined how supplying supermarkets affects food security and dietary quality among smallholder farmers (Chege, Andersson, and Qaim 2014). Here, we review this empirical research and discuss the findings in the context of a conceptual framework that combines consumer and producer issues. Given that the supermarket revolution is a megatrend with diverse implications along food supply chains, such a broader perspective can help to shape a more integrated research and policy agenda.

Kenya is an interesting country for this type of research. It has recently witnessed a rapid spread of supermarkets that now account for about 10% of national grocery sales (Planet Retail 2014). This retail share of supermarkets in Kenya is lower than in many middle-income countries, but it is already higher than in most other low-income countries in Sub-Saharan Africa and Asia. Hence, trends observed in Kenya may be helpful to predict future developments in other poor regions. In the following, we first introduce the conceptual framework of nutrition impacts and impact pathways, before discussing the empirical studies and drawing some broader conclusions.

## Conceptual Framework

### *Possible Impact Pathways*

A framework of the main pathways how supermarkets could affect nutrition is shown in Figure 1. We start the discussion with the consumer pathways, which are shown on the left-hand side of the Figure. In comparison to traditional food retailers in developing countries – including wet markets, kiosks, and other small shops – supermarkets offer different types of foods at different prices (Hawkes 2008; Timmer 2009). In general, choices of processed foods and beverages, as well as average packaging sizes, are larger in supermarkets, while the availability of fresh foods depends. In larger cities, supermarkets nowadays also sell fresh fruits, vegetables, whole grains, and meat, but in smaller towns this is often not yet the case. As a general pattern, new supermarkets start to sell processed products first, dealing with fresh foods only at a later stage (Reardon et al. 2003). In terms of food prices, comparison between supermarkets and traditional retailers is not easy, because products are often not identical. Prices in supermarkets tend to be more stable. Converted to a per-calorie basis, prices in supermarkets also seem to be lower on average, especially for highly processed foods (Rischke et al. 2014). Finally, the shopping atmosphere can be quite different. Supermarkets are often air-conditioned, well-lit, with music in the background, and various point-of-sale promotions.

*Figure 1 about here*

All these factors influence consumers in their decisions about the type and quantity of foods to purchase (Chandon and Wansink 2012). The common hypothesis is that supermarkets encourage higher consumption of unhealthy, calorie-dense foods among urban consumers and thus contribute to rising rates of obesity (Asfaw 2008), although concrete evidence is thin. For undernourished people, higher calorie consumption would imply nutritional improvements. Beyond food intake, nutritional status of individuals is also a function of physical activity levels, sanitation conditions, and other factors, which are probably less influenced by supermarkets. Dashed lines in Figure 1 indicate that indirect effects are possible.

The right-hand side of Figure 1 shows pathways of how supermarkets could affect nutrition among food producers, especially smallholder farmers in developing countries. The rise of supermarkets may change the structure of food markets in rural areas (Timmer 2009). While in traditional markets there are often many buyers of farm output, supermarkets may have monopsony power in certain subsectors. This could potentially lead to unfavorable prices and conditions for farmers. On the other hand, farmers are not forced to supply supermarkets. If they choose to do so, they expect higher profits or other related benefits. Indeed, studies show that farmers who participate in supermarket channels benefit through higher incomes and price stability (Neven et al. 2009; Rao and Qaim 2011; Michelson, Reardon, and Perez 2012). Higher incomes may contribute to improved nutrition in smallholder farm households.

However, nutrition in smallholder farm households does not depend on income alone. Many small farms are semi-subsistence producers, meaning that there is a direct relationship between production and consumption diversity (Jones, Shrinivas, and Bezner-Kerr 2014). Supplying supermarkets may be associated with specialization on certain commodities, which could narrow down the diversity of foods available for home consumption. On the other hand, if suppliers specialize on nutritious foods such as horticultural crops or dairy, positive effects for dietary quality are also possible.

Furthermore, participation in supermarket channels may involve higher levels of commercialization and use of improved production technology (Rao, Brümmer, and Qaim 2012). Both aspects can affect gender roles within the farm household. Research has shown that men often take greater control of agricultural income with rising levels of commercialization (von Braun and Kennedy 1994). And men tend to spend less than women on dietary quality (Hoddinott and Haddad 1995). All these factors may influence nutritional outcomes. Income, farm commodity choices, and gender roles are also likely to have indirect effects on household members' physical activity and sanitation.

*Indicators of Nutritional Outcomes*

To make this framework of possible impact pathways useful for quantitative empirical analysis, nutritional outcomes need to be measured. Different indicators are available to measure nutrition at individual and population levels, all with certain advantages and drawbacks (de Haen, Klasen, and Qaim 2011). One common approach is to use detailed food consumption data obtained through household surveys to calculate the availability of calories and nutrients. These values can be compared with average human requirements to assess levels of undernutrition. Food and nutrient consumption data provide a good overview of food security and dietary quality. A drawback is that consumption data are often captured at the household level, so that issues of intra-household distribution cannot be analyzed. Moreover, consumption data alone are not suitable to assess overnutrition. Anthropometric indicators, such as the body mass index (BMI) that is calculated based on height and weight measurements, are more precise to assess individual nutritional status, including undernutrition and overnutrition. On the other hand, anthropometric data alone are not suitable to analyze issues of dietary quality. Hence, the choice of the best nutritional indicator depends on the concrete research question and the conditions in a particular context.

In the following, we will build on this conceptual framework to empirically analyze nutrition impacts of supermarkets in Kenya, first focusing on urban consumers and then on smallholder farmers.

## Nutrition Impacts on Urban Consumers

### *Consumer Survey*

In 2012, we conducted a survey of 453 households in urban areas of Central Province of Kenya. We decided to sample households from small towns, some of which already have a supermarket, while others do not. This provided a quasi-experimental setting, which we exploit for the analysis. Three towns were purposively selected: Ol Kalou, where a supermarket has been operating since 2002, Mwea, where a supermarket was opened in 2011, and Njabini, where no supermarket had yet been established at the time of the survey. The three towns are similar in other characteristics. Within these three towns, households were selected randomly. Data on socioeconomic characteristics, including food consumption quantities, expenditures, and place of purchase were collected at the household level. In addition, we collected individual-level data such as food eaten away from home, as well as work and leisure related physical activity from household members. In each household, up to three household members were randomly selected for anthropometric measurement: one male adult, one female adult, and one child or adolescent in the 5-19 years age range. In total, we took individual data from 615 adults and 216 children and adolescents (Kimenju et al. 2014).

*Statistical Methods*

The main objective is to analyze the impact of supermarket purchase on nutrition. We estimate models of the following type:

$$N_i = \beta_0 + \beta_1 S_i + \beta_2 \boldsymbol{Z_i} + \varepsilon_i \tag{1}$$

where $N_i$ is the nutritional outcome variable of individual $i$, $S_i$ is supermarket purchase, $\boldsymbol{Z}_i$ is a vector of control variables, including individual and household characteristics, and $\varepsilon_i$ is a random error term.

Equation (1) is estimated separately for adults and for children and adolescents. The hypothesis is that supermarkets contribute to overnutrition, which can be assessed by using anthropometric data. The nutritional outcome variable that we use for adults is BMI. Adults with a BMI ≥ 25 are classified as overweight or obese (a BMI < 18.5 would indicate underweight). For children, we use two nutritional outcome variables, namely BMI-for-age Z-scores (BAZ) and height-for age Z-scores (HAZ), which were calculated based on the World Health Organization (WHO) growth reference for school-aged children and adolescents. Childhood overweight/obesity is defined as a BAZ > 1. Childhood stunting, which is a common indicator of undernutrition, is defined as HAZ < -2 (WHO 2006).

Supermarket purchase is measured in two different ways, first as a dummy that takes a value of one for households that purchased at least some of their food in supermarkets, and second as a continuous variable measuring the share of supermarket purchases in total household food expenditure. Households that did not buy in supermarkets (i.e., the dummy and the supermarket share are equal to zero) obtained all of their food from traditional sources.

In equation (1), supermarket purchase may potentially be endogenous, since there could be unobserved factors that determine supermarket purchase and nutritional status simultaneously. To avoid endogeneity bias, we use an instrumental variable (IV) approach. Supermarket purchase is instrumented with the household distance to the nearest supermarket (measured through GPS coordinates). Distance to supermarket is a valid instrument, since it is exogenous, significantly correlated with supermarket purchase, and not directly correlated with nutritional status.[1]

*Results*

While 41% of the adults in the sample are either overweight or obese, only 10% of the children and adolescents fall into this category. On the other hand, 21% of the children are stunted, pointing at widespread undernutrition. Table 1 compares nutrition variables between individuals from households that buy and do not buy in supermarkets. Adults in supermarket-buying households have a higher BMI and are more likely to be overweight or obese. They also consume more calories, and a greater share of their calories comes from processed foods. For children and adolescents, the patterns are different. There is only a very small difference in mean BAZ. Yet we observe considerably higher HAZ among children from households that buy in a supermarket, and a lower prevalence of stunting.

*Table 1 about here*

The mean differences in Table 1 are a first indication that buying food in a supermarket may contribute to increasing BMI and a higher prevalence of overnutrition among adults. To test

[1] In large cities, social stratification of neighborhoods is common, and supermarkets tend to establish their stores in locations with the best market potential. In such situations, distance to supermarket may be correlated with other household characteristics. However, in the small towns analyzed here, the only supermarket that exists is located in the town's center where other retailers are also found. Hence, supermarket location is not closely related to household characteristics in any particular neighborhood.

this hypothesis, we estimate equation (1), using BMI and the probability of being overweight or obese as dependent variables. Independent of the exact specification, supermarket purchase has significant effects on nutritional outcomes (Table 2). Buying in a supermarket increases BMI by 1.7 and the probability of being overweight or obese by 13 percentage points. Similarly, an increase in the share of supermarket purchases by one percentage point increases BMI by 0.08 and the probability of being overweight or obese by one percentage point. Most of the control variables have the expected signs, with age and living standard (measured by total household expenditures) contributing to higher BMI, and physical activity to lower BMI.

*Table 2 about here*

Table 1 did not reveal significant differences in overweight and obesity between children/adolescents from households that buy and do not buy in supermarkets. The regression results in Table 3 confirm that supermarket purchase does not affect BAZ significantly. However, supermarket purchase has a positive and significant effect on HAZ.[2] Buying in a supermarket increases HAZ by 0.63. Similarly, an increase in the share of supermarket purchases by one percentage point increases HAZ by 0.03. This is evidence that supermarkets contribute to reducing problems of undernutrition among children and adolescents. The supermarket coefficient in the stunting model is negative, but not statistically significant. This may be related to the relatively small sample size. Moreover, how many individuals can be lifted above a threshold depends on the variable distribution and the magnitude of the threshold. Using the threshold for severe stunting (HAZ < -3), we do find significant effects as shown in the last column of Table 3. Buying in a supermarket decreases the probability of severe stunting by 23 percentage points.

[2] Control variables for these child/adolescent models were chosen based on the nutrition and health literature. Factors that contribute to overnutrition may be somewhat different from factors that contribute to undernutrition, which is why model specifications in Table 3 vary.

*Table 3 about here*

We also estimated additional models to better understand impact pathways. The models shown in Table 4 are based on IV regressions with households as the unit of observation. The estimates confirm that the average food price expressed per calorie is lower for households that buy a larger share of their food in a supermarket. This price incentive contributes to higher total calorie consumption. We also observe a shift in the types of foods consumed. Since the supermarkets in the small towns analyzed here sell primarily processed items, the share of processed foods in total food expenditure increases with supermarket purchase. Likewise, the calorie share of processed foods increases. This does not automatically mean lower dietary quality. More disaggregated analysis reveals that the supermarket-induced consumption increase is stronger for lightly processed than for strongly processed foods (Rischke et al. 2014). Further, we find that supermarket purchase leads to a larger number of food groups consumed (Table 4), pointing towards higher dietary diversity. Both, total calorie consumption and the share of calories from processed foods increase the nutritional outcome measures – BMI for adults and HAZ for children and adolescents (Kimenju et al. 2014).

*Table 4 about here*

*Discussion*

The results show that buying in supermarkets increases BMI and the probability of being overweight or obese among adults, but not among children and adolescents. Rather, supermarket purchase reduces child undernutrition through a positive impact on HAZ. For both groups, impacts occur through the same mechanisms, namely higher calorie consumption and a higher share of calories from processed foods. The fact that the same mechanisms lead to nutritional outcomes that differ by age cohort is interesting. For adults who have already reached their final body height, increasing calorie consumption can only lead to higher BMI. For children and adolescents, the situation is different, because higher calorie consumption can also lead to gains in body height. It should be mentioned that – beyond calories – certain micronutrients also play an important role for child growth. While not analyzed in detail, dietary changes through buying in supermarkets may potentially be associated with higher micronutrient consumption. This could be true especially for children from poor households who otherwise have relatively low dietary diversity.

The impact of supermarkets on urban consumers will much depend on people's initial nutritional status. In Kenya, we observe relatively high overweight rates among adults, while stunting is a more widespread problem among children and adolescents. This so-called dual burden of malnutrition is common in many developing countries (Doak et al. 2005). Reducing child stunting and controlling the global obesity pandemic are both important public health objectives. The results here suggest that the supermarket revolution is not just a business response to the rapid nutrition transition in developing countries, but that supermarkets also contribute to changing food consumption habits and nutritional outcomes. Yet the types of outcomes can be diverse.

## Nutrition Impacts on Smallholder Farmers

### *Farm Survey*

To analyze supermarket nutrition impacts on agricultural producers, we carried out a survey of smallholder farmers in Kiambu District, Central Province of Kenya. Kiambu is relatively close to Nairobi and is the capital's main source of horticultural produce. Some of the farmers in this region produce vegetables for supermarkets, while others sell their vegetables in traditional channels. We used a stratified random sampling procedure to select vegetable farmers to be interviewed. In total, the sample comprises 384 farm households – 85 that participate in supermarket channels and 299 that sell in traditional channels. Sample households are typical smallholder farmers with an average farm size of 2 acres. These households produce exotic vegetables, such as kale, spinach, and cabbage, as well as indigenous vegetables like black night-shade and amaranth. In addition, they are engaged in other agricultural activities such as the production of staple and cash crops like maize, beans, tea, and coffee. Many are also involved in small-scale livestock farming (Chege, Andersson, and Qaim 2014).

Using a structured questionnaire, we collected data on general household characteristics, details on vegetable production and marketing, other farm and non-farm economic activities, food and non-food consumption, and various institutional variables. The questionnaire also included a module on gender roles within the household, especially capturing information about who controls vegetable production and revenues. While overnutrition is an emerging issue also in rural areas of Kenya, undernutrition and micronutrient deficiencies are still more widespread. We therefore decided not to collect anthropometric data. Instead, nutritional outcomes are assessed based on calorie and nutrient consumption data (see below).

*Statistical Methods*

To analyze impacts of supermarkets on farm household nutrition, we use regression models of the following type:

(2) $$N_i = \alpha_0 + \alpha_1 SM_i + \alpha_2 \boldsymbol{X_i} + \mu_i$$

where $N_i$ is the nutritional outcome variable of household $i$, $SM_i$ is a dummy representing participation in supermarket channels, $\boldsymbol{X}_i$ is a vector of control variables, including farm and household characteristics, and $\mu_i$ is a random error term.

We use different nutritional outcome variables based on a 7-day food consumption recall that we implemented as part of the farm survey. These data were used to calculate daily calorie availability as well as consumption levels of certain micronutrients at the household level (Chege, Andersson, and Qaim 2014). We concentrate on vitamin A, iron, and zinc, because deficiencies in these micronutrients are widespread and constitute serious public health problems in Kenya and other developing countries. To make calorie and micronutrient consumption levels comparable across households of different size and demographic structure, all values are expressed per adult equivalent (AE). We estimate separate models for calorie, vitamin A, iron, and zinc consumption.

In equation (2), the supermarket participation variable may be endogenous. To control for possible endogeneity bias, we use an IV approach, instrumenting $SM_i$ with the number of supermarket participants among the five nearest neighbors of the farm household $i$. The five nearest neighbors refer to other farmers in the sample based on GPS coordinates. Farmers cannot choose who their neighbors are, so this instrument is exogenous. Previous research has shown that farmers are influenced by their social network when making innovation adoption decisions (Maertens and Barrett 2013). Our data confirm that individuals with more supermarket farmers in their neighborhood are more likely to participate in supermarket channels themselves. On the other hand, the participation decisions by neighbors do not have a direct effect on household nutrition, so that the variable is a valid instrument.[3]

In addition to the reduced-form models in equation (2), we estimate structural models to analyze impact pathways as follows:

(3) $$N_i = \alpha_0 + \alpha_1 Y_i + \alpha_2 SV_i + \alpha_3 G_i + \alpha_4 \boldsymbol{X_{3i}} + \mu_3$$

(4) $$Y_i = \beta_0 + \beta_1 SM_i + \beta_2 \boldsymbol{X_{4i}} + \mu_4$$

[3] All farmers in the sample are from the same district. We do not observe systematic regional patterns of supermarket participation that could be correlated with other agroecological or social factors influencing nutrition.

(5) $$SV_i = \sigma_0 + \sigma_1 SM_i + \sigma_2 \boldsymbol{X_{5i}} + \mu_5$$

(6) $$G_i = \delta_0 + \delta_1 SM_i + \delta_2 \boldsymbol{X_{6i}} + \mu_6$$

(7) $$SM_i = \varphi_0 + \varphi_1 SMN_i + \varphi_2 \boldsymbol{X_{7i}} + \mu_7$$

where nutrition in household $i$ ($N_i$) depends on income ($Y_i$), the share of farm land under vegetables ($SV_i$), which we use as a measure of specialization, the gender of the household member who controls vegetable revenues ($G_i$), and a vector of control variables ($\boldsymbol{X_{3i}}$), including household size, education, and other socioeconomic factors. Following the discussion of possible impact pathways above (Figure 1), $Y_i$, $SV_i$, and $G_i$ are influenced by supermarket participation ($SM_i$) and additional covariates ($\boldsymbol{X_{4i}}$ to $\boldsymbol{X_{6i}}$). Finally, $SM_i$ is a function of the number of supermarket farmers among the five nearest neighbors ($SMN_i$), which was identified as a valid instrument, and other exogenous variables ($\boldsymbol{X_{7i}}$). This system of simultaneous equations is estimated with a mixed-process maximum likelihood procedure (Roodman 2011). We estimate separate systems for each nutritional outcome indicator (calorie, vitamin A, iron, and zinc consumption).

*Results*

About 20% of the farm households in our sample are undernourished, which we define as daily calorie consumption of less than 2400 kcal per AE. The prevalence of vitamin A and zinc deficiency is in a similar magnitude, while iron deficiency affects more than 60% of the households. Table 5 compares nutritional indicators between households with and without participation in supermarket channels. While supermarket participants consume somewhat higher amounts of calories and micronutrients on average, the differences are relatively small. However, in this simple mean value comparison confounding factors are not controlled for.

*Table 5 about here*

Table 6 shows results from regression models that are based on equation (2). Supermarket participation has a positive and significant net effect on all nutritional indicators. Participation increases calorie consumption by 598 kcal per AE, which implies a 19% increase over mean consumption levels of traditional channel households. Iron and zinc consumption levels are both raised by around 3 mg per AE, implying increases of 15-18%. The increase in vitamin A of 1302 μg RE per AE involves almost a doubling of mean consumption levels. Most of the control variables have the expected signs.

*Table 6 about here*

Estimation results of the structural models to analyze impact pathways (equations 3 to 7) are shown in Table 7. The upper part of the Table confirms that household income has a positive and significant effect on calorie and micronutrient consumption. Likewise, the share of the farm area grown with vegetables influences nutrition positively. Especially the effect for vitamin A is relatively large: an increase in the area share by 10 percentage points increases vitamin A consumption by almost 400 μg RE per AE. This sizeable effect should not surprise given that vegetables are a very important source of vitamin A in the local context. The main staple food in Kenya is white maize, which does not contain vitamin A. Other sources of vitamin A are livestock products, which are only consumed in small quantities due to income constraints. The results further indicate that male control of vegetable revenues has large negative effects on calorie and micronutrient consumption, which we attribute to gender differences in income use.

*Table 7 about here*

The lower part of Table 7 shows how supermarket participation affects these determinants of household nutrition. Selling vegetables in supermarket channels increases annual household income by 300,000 Kenyan shillings, implying a gain of over 60%. This is consistent with earlier research on supermarket impacts in Kenya (Rao and Qaim 2011; Andersson et al. 2013).

Moreover, as expected, supermarket participation contributes to a higher degree of specialization on vegetables. Controlling for other factors, the share of the area grown with vegetables is around 20 percentage points higher for supermarket suppliers than for traditional channel farmers. Finally, supermarket participation has a significant effect on gender roles within the household. Selling to supermarkets increases the likelihood of male control of vegetable revenues by over 20 percentage points.

*Discussion*

The results show that participation in supermarket channels has positive nutrition impacts among smallholder farmers in Kenya. We have used detailed food recall data to derive several nutrition indicators, such as calorie, vitamin A, iron, and zinc consumption. While these are not precise measures of individual nutrition status, they provide a reasonable overview of food security and dietary quality at the household level. We have also analyzed impact pathways, demonstrating that supermarket participation affects farm household nutrition mainly via three pathways, namely through (i) income, (ii) crop production choices at the farm level, and (iii) gender roles.

The first pathway has a positive effect on nutrition. Farmers who participate in supermarket channels benefit from income gains, and higher incomes improve the economic access to food. The second pathway has a positive nutrition effect as well. Supermarket farmers sell vegetables under contract. As these contracts provide market assurance and price stability, farmers have an incentive to specialize on vegetable production. More vegetable production also entails higher quantities of vegetables consumed at the household level. Vegetables are an important source of vitamin A in particular, which explains the large positive impact of supermarket participation on vitamin A consumption. In contrast, the third pathway has a negative effect on nutrition. Supermarket participation contributes to a shift from female to male control of vegetable revenues, and male household members tend to spend less on nutrition and dietary quality. Such a change in gender roles within the household is not uncommon in the process of agricultural commercialization. The total nutrition effects of supermarket participation are clearly positive, but they could be even more positive if a loss of female control of vegetable revenues could be prevented.

**Conclusion**

Agriculture and food systems in many developing countries are experiencing a profound transformation, with a rapidly growing role of supermarkets in food retailing and procurement of farm produce. This supermarket revolution may have far-reaching nutrition impacts on food consumers and producers, but such impacts have never been analyzed systematically. In this article, we have discussed a framework to analyze supermarket nutrition impacts and impact pathways for consumers and producers. This framework was employed to review empirical evidence from Kenya. Using survey responses and anthropometric data from urban consumers, we have shown that buying food in supermarkets instead of traditional outlets contributes to overweight among adults, while reducing undernutrition among children. These results suggest that the rise of supermarkets is not just a business response to changing consumer preferences, but that supermarkets actually contribute directly to the nutrition transition. Supermarket shoppers consume higher amounts of calories, and they change their dietary composition towards more processed foods. Depending on the initial nutrition status of individuals, these consumption changes can lead to positive or negative nutrition and health outcomes.

Using survey data from smallholder farmers, we have shown that supplying supermarkets helps to improve food security, dietary quality, and micronutrient consumption. Smallholder farmers constitute a large fraction of the undernourished population in Kenya and other developing countries. Participation in supermarket supply chains contributes to farm income gains, thus improving economic access to food. Furthermore, we found that supplying supermarkets can lead to on-farm specialization and changes in gender roles; both these factors play an important role for nutrition outcomes.

The concrete results reviewed in this article are specific to the settings in Kenya and should not be generalized. However, similar trends are also observed in many other developing countries, so that a few general conclusions are justified. The supermarket revolution affects nutrition and is therefore a phenomenon worth considering from a food policy perspective. The types of impacts can be diverse, so that simple statements on whether supermarkets are good or bad for nutrition and public health are not appropriate. Research as discussed here can help to better understand the multiple impact pathways. There is scope for further improvement in terms of methodology and data.

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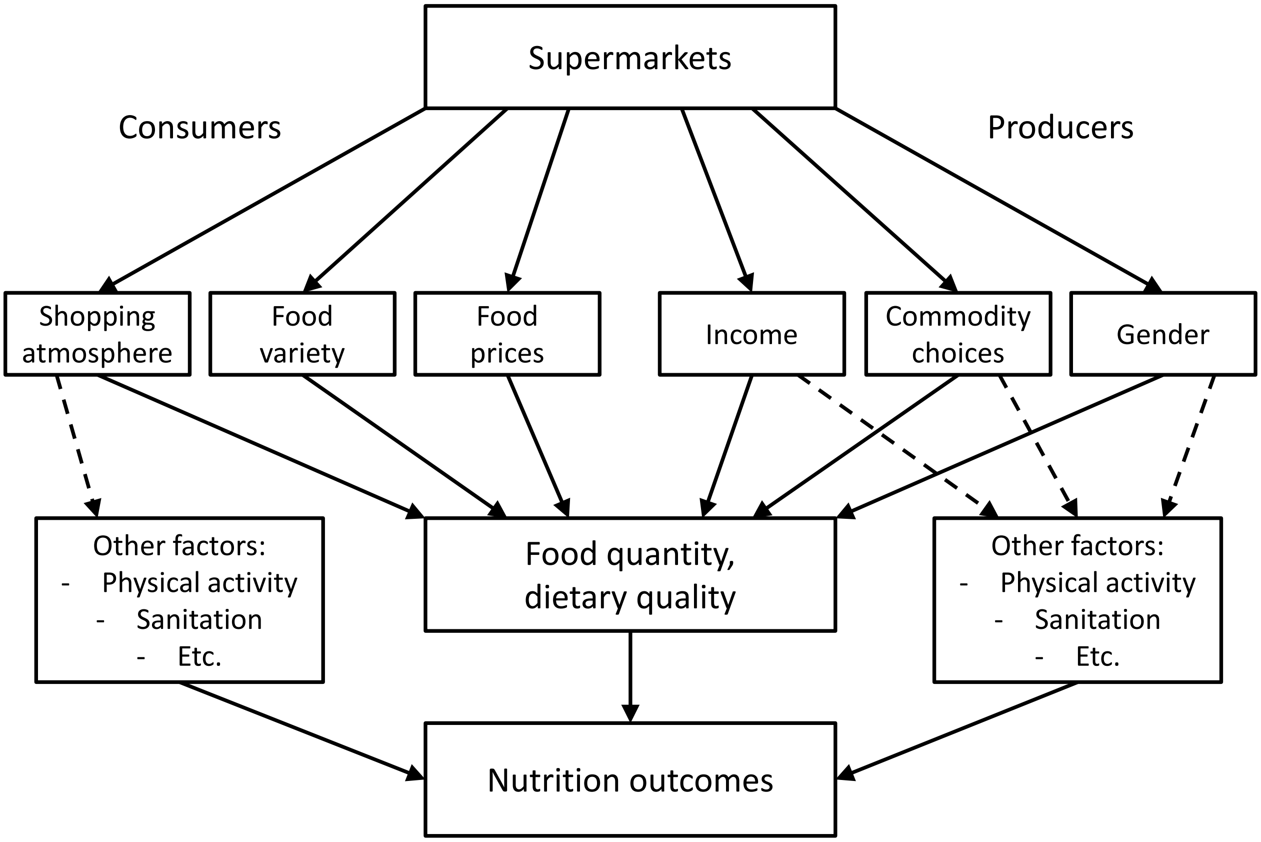


**Figure 1. Pathways of supermarket nutrition impacts on food consumers and producers**

## Table 1. Consumer nutrition with and without supermarket purchase

| Variable | Household buys in supermarket | Household does not buy in supermarket |
|---|---|---|
| *Adults* | | |
| BMI | 25.22 (4.73) | 24.43 ( 4.98) |
| Overweight or obese (share) | 0.45 (0.50) | 0.36 (0.48) |
| Underweight (share) | 0.04 (0.19) | 0.04 (0.20) |
| Calorie consumption per day (kcal) | 3500.70 (1230.79) | 3143.32 (1426.80) |
| Share of calories from processed foods | 0.51 (0.11) | 0.44 (0.20) |
| Number of observations | 357 | 258 |
| *Children/adolescents* | | |
| BMI-for-age Z-score | -0.26 (1.09) | -0.36 (0.90) |
| Overweight or obese (share) | 0.10 (0.30) | 0.09 (0.30) |
| Height-for-age Z-score | -0.76 (1.09) | -1.35 (1.43) |
| Stunted (share) | 0.14 (0.34) | 0.28 (0.45) |
| Calorie consumption per day (kcal) | 2531.67 (959.88) | 2310.54 (1428.13) |
| Share of calories from processed foods | 0.52 (0.10) | 0.44 (0.22) |
| Number of observations | 110 | 106 |

*Notes:* Mean values are shown with standard deviations in parentheses. BMI, body mass index.

## Table 2. Impact of supermarket purchase on adult nutrition

| Explanatory variables | BMI | BMI | Overweight/ obese (dummy) | Overweight/ obese (dummy) |
|---|---|---|---|---|
| Buys in supermarket (dummy) | 1.69** (0.72) | -- | 0.13* (0.07) | -- |
| Supermarket purchase share (%) | -- | 0.08* (0.04) | | 0.01** (0.00) |
| Age (years) | 0.11*** (0.02) | 0.11*** (0.02) | 0.01*** (0.00) | 0.01*** (0.00) |
| Female (dummy) | 0.50 (1.08) | 0.59 (1.09) | 0.15 (0.12) | 0.15 (0.12) |
| Female-age interaction | 0.07** (0.03) | 0.07** (0.03) | 0.00 (0.00) | 0.00 (0.00) |
| Heavy work (dummy) | -0.89** (0.35) | -0.95*** (0.36) | -0.09** (0.04) | -0.10*** (0.04) |
| Leisure-time physical activity (hours per week) | -0.05** (0.02) | -0.04* (0.02) | -0.00 (0.00) | -0.00 (0.00) |
| Household expenditure (1000 Ksh per month) | 0.08*** (0.03) | 0.08** (0.03) | 0.01 (0.00) | 0.01 (0.00) |
| Education of person responsible for food (years) | 0.17*** (0.05) | 0.17*** (0.06) | 0.02*** (0.01) | 0.02*** (0.01) |
| Married household head (dummy) | 0.92** (0.39) | 1.07*** (0.40) | 0.10** (0.04) | 0.11*** (0.04) |
| Distance to hospital (log of km) | 0.32** (0.13) | 0.39** (0.17) | 0.02 (0.01) | 0.03* (0.02) |
| Constant | 15.40*** (0.98) | 15.28*** (1.01) | -- | -- |
| Number of observations | 615 | 615 | 615 | 615 |

*Notes:* Marginal effects are shown with robust standard errors in parentheses. Estimates are based on IV regression models. *, **,***, statistically significant at the 10%, 5%, and 1% level, respectively. BMI, body mass index; Ksh, Kenyan shillings.

*Source:* Adapted from Kimenju et al. (2014).

**Table 3. Impact of supermarket purchase on child/adolescent nutrition**

| Explanatory variables | BAZ | HAZ | HAZ | Stunted (dummy) | Severely stunted (dummy) |
|---|---|---|---|---|---|
| Buys in supermarket (dummy) | 0.18 (0.34) | 0.63** (0.27) | -- | -0.06 (0.10) | -0.23*** (0.05) |
| Supermarket purchase share (%) | -- | -- | 0.03*** (0.01) | -- | -- |
| Age (months) | -4E-03** (0.00) | -0.01*** (0.00) | -0.01*** (0.00) | 2E-3*** (0.00) | 2E-01** (0.00) |
| Female (dummy) | 0.12 (0.13) | 0.08 (0.15) | 0.13 (0.15) | -0.02 (0.05) | -0.00 (0.03) |
| Household expenditure (1000 Ksh per month) | 0.00 (0.01) | 0.03* (0.02) | 0.02 (0.02) | -0.01** (0.01) | 0.00 (0.00) |
| Education of person responsible for food (years) | 0.03 (0.02) | 0.00 (0.03) | 0.00 (0.03) | -0.00 (0.01) | -0.01*** (0.00) |
| Married household head (dummy) | -0.12 (0.16) | 0.14 (0.20) | 0.18 (0.20) | -0.07 (0.05) | -0.03 (0.03) |
| Malaria or respiratory infection (dummy) | -- | -0.44* (0.26) | -0.43* (0.24) | 0.04 (0.09) | 0.18*** (0.04) |
| Height of female adult (cm) | -- | 0.06*** (0.02) | 0.06*** (0.02) | -0.01*** (0.00) | -0.01 (0.00) |
| Age of female adult when the child was born (years) | -- | 0.03** (0.01) | 0.03** (0.01) | -0.00 (0.00) | -3E-03* (0.00) |
| Household treats drinking water (dummy) | -- | 0.36** (0.15) | 0.35** (0.15) | -0.07 (0.05) | -0.02 (0.04) |
| Distance to nearest health care center (log of km) | -- | -0.04 (0.07) | 0.03 (0.07) | 0.05* (0.03) | 0.05** (0.02) |
| Age of female adult (years) | 0.01* (0.01) | -- | -- | -- | -- |
| Physical education at school (hours per week) | -0.02 (0.03) | -- | -- | -- | -- |
| Leisure-time physical activity (hours per week) | -0.00 (0.01) | -- | -- | -- | -- |
| Distance to hospital (log of km) | 0.01 (0.06) | -- | -- | -- | -- |
| Constant | -0.61 (0.45) | -10.76*** (2.57) | -10.72*** (2.54) | -- | -- |
| Number of observations | 216 | 216 | 216 | 216 | 216 |

*Notes:* Marginal effects are shown with robust standard errors in parentheses. Estimates are based on IV regression models. *, **,***, statistically significant at the 10%, 5%, and 1% level, respectively. BAZ, BMI-for-age Z-score; HAZ, height-for-age Z-score; Ksh, Kenyan shillings.

*Source:* Adapted from Kimenju et al. (2014).

**Table 4. Effects of supermarkets on food consumption behavior in urban households**

| Explanatory variables | Price per calorie (Ksh/kcal) | Daily calorie consumption (log) | Expenditure share of processed foods | Calorie share of processed foods | Number of food groups consumed |
|---|---|---|---|---|---|
| Supermarket purchase share | -0.05*** (0.01) | 0.85* (0.50) | 0.38*** (0.10) | 0.19* (0.11) | 2.86*** (1.08) |
| Household expenditure (log) | 0.02*** (0.00) | 0.34*** (0.07) | -0.07*** (0.01) | -0.05*** (0.01) | 0.19 (0.15) |
| Constant | -0.09*** (0.02) | 4.78*** (0.58) | 1.05*** (0.09) | 1.00*** (0.12) | 9.26*** (1.18) |
| Number of observations | 448 | 448 | 448 | 448 | 448 |

*Notes:* Coefficient estimates are shown with robust standard errors in parentheses. Estimates are based on IV regression models. Not all control variables shown for brevity. *, **,***, statistically significant at the 10%, 5%, and 1% level, respectively. Ksh, Kenyan shillings.

*Source:* Adapted from Rischke et al. (2014).

**Table 5. Farm household nutrition with and without participation in supermarket channels**

| | Farm participates in supermarket channel | Farm does not participate in supermarket channel |
|---|---|---|
| Calorie consumption per day (kcal/AE) | 3348.27 (1206.17) | 3232.37 (1044.65) |
| Undernourished (share) | 0.19 (0.39) | 0.21 (0.41) |
| Vitamin A consumption per day (µg RE/AE) | 1449.10 (825.52) | 1353.53 (953.26) |
| Vitamin A deficient (share) | 0.14 (0.35) | 0.17 (0.38) |
| Iron consumption per day (mg/AE) | 17.17 (7.40) | 16.62 (7.11) |
| Iron deficient (share) | 0.62 (0.49) | 0.65 (0.48) |
| Zinc consumption per day (mg/AE) | 21.67 (8.73) | 20.88 (7.52) |
| Zinc deficient (share) | 0.24 (0.43) | 0.24 (0.43) |
| Number of observations | 85 | 299 |

*Notes*: Mean values are shown with standard deviations in parentheses. AE, adult equivalent; RE, retinol equivalent. Undernourishment is defined as less than 2400 kcal/AE, vitamin A deficiency as less than 625µg RE/AE, iron deficiency as less than 18.27 mg/AE, and zinc deficiency as less than 15 mg/AE.

**Table 6. Impact of farmer supermarket participation on calorie and nutrient consumption**

| Explanatory variables | Calorie (kcal/AE) | Vitamin A (μg/AE) | Iron (mg/AE) | Zinc (mg/AE) |
|---|---|---|---|---|
| SM participation (dummy) | $597.46^{**}$ | $1302.41^{***}$ | $3.01^{*}$ | $3.21^{*}$ |
| | (244.81) | (325.79) | (1.72) | (1.71) |
| Male household head (dummy) | 20.40 | 25.85 | $3.19^{*}$ | -3.38 |
| | (265.22) | (274.47) | (1.71) | (2.14) |
| Age of household head (years) | $-104.29^{***}$ | $-88.23^{***}$ | $-0.40^{**}$ | $-0.45^{**}$ |
| | (32.39) | (32.21) | (0.19) | (0.20) |
| Age squared | $1.02^{***}$ | $0.84^{***}$ | $0.00^{**}$ | $0.00^{**}$ |
| | (0.32) | (0.30) | (0.00) | (0.00) |
| Education of household head (years) | 3.31 | 7.87 | 0.13 | 0.09 |
| | (17.18) | (12.43) | (0.11) | (0.12) |
| Education of main female (years) | 0.41 | 35.49 | -0.01 | -0.20 |
| | (25.78) | (24.04) | (0.17) | (0.22) |
| Household size (AE) | $-270.56^{***}$ | $-155.55^{***}$ | $-1.24^{***}$ | $-2.95^{***}$ |
| | (39.11) | (42.57) | (0.16) | (0.38) |
| Farm land owned (acres) | $-42.12^{*}$ | -17.32 | -0.11 | -0.14 |
| | (22.65) | (20.69) | (0.14) | (0.14) |
| Household assets (100,000 Ksh) | $27.02^{**}$ | 4.39 | 0.08 | $0.18^{**}$ |
| | (12.17) | (7.86) | (0.07) | (0.08) |
| Access to piped water (dummy) | 21.47 | 57.11 | -0.01 | -0.05 |
| | (37.49) | (50.50) | (0.23) | (0.23) |
| Distance to tarmac road (km) | 29.18 | -0.05 | $0.26^{**}$ | $0.34^{***}$ |
| | (20.38) | (15.68) | (0.11) | (0.12) |
| Public transport in village (dummy) | $-221.63^{*}$ | -102.08 | -0.40 | -1.10 |
| | (113.60) | (95.59) | (0.72) | (0.77) |
| Distance to market (km) | 15.81 | 5.35 | 0.01 | 0.04 |
| | (10.36) | (10.99) | (0.07) | (0.08) |
| Constant | $6691.20^{***}$ | $3714.59^{***}$ | $29.49^{***}$ | $42.73^{***}$ |
| | (753.61) | (862.82) | (4.80) | (5.01) |
| Number of observations | 384 | 384 | 384 | 384 |

*Notes:* Marginal effects are shown with robust standard errors in parentheses. Estimates are based on IV regression models. *, **,***, statistically significant at the 10%, 5%, and 1% level, respectively. SM, supermarket; AE, adult equivalent; Ksh, Kenyan shillings.

*Source:* Adapted from Chege, Andersson, and Qaim (2014).

**Table 7. Impact pathways of farmer supermarket participation**

| | Calorie (kcal/AE) | Vitamin A (μg/AE) | Iron (mg/AE) | Zinc (mg/AE) |
|---|---|---|---|---|
| *Effect on nutrition* | | | | |
| Annual household income (1000 Ksh) | 0.50** | 0.94*** | 3E-03** | 4E-03** |
| | (0.21) | (0.23) | (0.00) | (0.00) |
| Share of area grown with vegetables (%) | 26.77*** | 39.56*** | 0.15*** | 0.17*** |
| | (8.20) | (9.35) | (0.05) | (0.06) |
| Male control of vegetable revenue (dummy) | -1013.31*** | -1346.74*** | -8.52*** | -7.34*** |
| | (285.98) | (151.24) | (1.27) | (2.09) |
| Constant | 3774.76*** | 86.55 | 15.31** | 25.23*** |
| | (1235.63) | (1352.08) | (7.40) | (8.59) |
| *Effect on annual household income (1000 Ksh)* | | | | |
| SM participation (dummy) | 361.89*** | 297.79** | 342.56*** | 368.01*** |
| | (129.95) | (123.62) | (127.76) | (131.64) |
| Constant | -48.63 | -14.87 | -19.84 | -16.40 |
| | (230.85) | (227.00) | (229.49) | (225.13) |
| *Effect on share of area with vegetables (%)* | | | | |
| SM participation (dummy) | 20.23** | 23.14*** | 23.14*** | 17.65** |
| | (8.89) | (7.21) | (8.43) | (8.90) |
| Constant | 104.84*** | 102.61*** | 101.23*** | 106.07*** |
| | (19.55) | (19.28) | (19.72) | (19.55) |
| *Effect on male control over revenue (dummy)* | | | | |
| SM participation (dummy) | 0.22** | 0.38*** | 0.21** | 0.21** |
| | (0.10) | (0.07) | (0.09) | (0.10) |
| Constant | 0.60 | 0.60 | 0.37 | 0.56 |
| | (0.48) | (0.45) | (0.45) | (0.48) |
| *Effect on SM participation (dummy)* | | | | |
| SM farmers among 5 nearest neighbors | 0.08*** | 0.08*** | 0.08*** | 0.09*** |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| Constant | -2.71* | -1.92 | -2.79** | -2.319 |
| | (1.41) | (1.19) | (1.36) | (1.48) |
| Number of observations | 384 | 384 | 384 | 384 |

*Notes:* Coefficient estimates are shown with standard errors in parentheses. Not all control variables shown for brevity.
*, **,***, statistically significant at the 10%, 5%, and 1% level, respectively. SM, supermarket; AE, adult equivalent; Ksh, Kenyan shillings.

*Source:* Adapted from Chege, Andersson, and Qaim (2014).