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Patterns and Drivers of Packaged (Fortified) Maize Flour Purchase in Urban and Peri-Urban Kenya

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Abstract

This study focuses on tackling micronutrient deficiencies, a significant public health issue in Kenya, by examining the purchase rates of industrially processed and packaged maize flour, which is required by law to be fortified with micronutrients. The research was conducted among households in Kisumu and Nairobi to explore how factors such as the food environment, household characteristics, and perceptions of shoppers affect the consumption of this fortified product, with the goal of enhancing public health outcomes. We find that across Kisumu and Nairobi, two-thirds of households purchase packaged maize flour, with higher rates seen in urban Nairobi. While almost all households have some access to packaged maize flour in their home food environment, the intensity of access varies. Moreover, households that purchase packaged maize flour reside in neighborhoods with a higher density of outlets selling this product. The local price of packaged maize flour is a particularly strong and statistically significant driver of the purchase decision. This study offers insights for policymakers focused on increasing the consumption of fortified maize flour among the Kenyan population, a critical measure for enhancing public health.

Keywords: diet quality, food choice, food environment, large-scale food fortification, packaged maize flour, Kenya.

JEL Codes :



1. Introduction

Despite recent improvements, malnutrition rates in Kenya remain high, posing concerns due to its impact on healthcare costs, productivity, and economic growth. This also perpetuates a cycle of poverty and ill-health. Large-scale food fortification—the process of adding select micronutrients to commonly consumed foods during processing—aims to reduce micronutrient deficiencies by improving the nutritional quality of the food supply. It is broadly regarded as cost-effective, wide-reaching, safe, and a vital step toward improving public health.¹ A recent meta-analysis showed that large-scale food fortification with iron and folic acid led to a sizable reduction in anemia and neural tube defects in low- and middle-income countries.²

Given these public health benefits, the Government of Kenya has embraced large-scale food fortification to promote adequate micronutrient intake in the population. In 2012, the National Food Security and Nutrition Policy mandated the fortification of maize flour (as well as wheat flour and vegetable oils/fats), and the standards were made explicit in 2015 in CAP 254, Notice No. 157.³ Maize flour is widely consumed in Kenya and is the main ingredient in *uji*, a soft porridge commonly eaten for breakfast, and *ugali*, a stiff porridge eaten for lunch and dinner.⁴ This mandate applies to all packaged dry milled maize products, regardless of the size of the processing firm, and the mandated micronutrients for maize flour fortification include iron, zinc, folic acid, and vitamins A, B1, B2, B3, B6, and B12.⁵ Though compliance to national standards in terms of the level of each micronutrient is low,^{6,7,8} Kenya's fortification program remains strategically important, and there is a growing commitment to strengthen enforcement and increase millers' capacity to comply with fortification standards.³

Processed maize flour available in packaged form remains the only channel to deliver the benefits of large-scale food fortification using maize. However, alternatives to processed and packaged maize flour may be preferred, especially among poor consumers who find packaged foods to be prohibitively expensive,⁹ those who prefer whole flour, or those who do not trust processed products. Thus, fortified maize flour would not reach consumers who pay to mill their own maize grain, purchase unpackaged maize flour from local *posho* mills (small maize milling outlets), or choose a different food product entirely. If packaged maize flour is the vehicle to realize the public health benefits of mass fortification in Kenya, it becomes imperative to track the rate at which it is purchased and consumed and to identify drivers of consumption.¹⁰ This can help policy makers characterize packaged food users; acknowledge their understandings and motivations; and develop marketing strategies and other interventions to increase the uptake of fortified products.

This paper aims to characterize patterns and determine the drivers of packaged (and presumably fortified) maize flour purchase in Kisumu and Nairobi, two large cities in Kenya. It characterizes the extent to which households have access to packaged maize flour, as well as the extent to which they purchase this product, two gaps in policy makers' knowledge. Our study provides insights into enhancing the effectiveness and reach of Kenya's national food fortification program. Additionally, it offers practical advice for Kenyan companies involved in producing, marketing, and increasing consumer demand for healthy foods, like packaged (fortified) maize flour, all aimed at improving public health outcomes.

The rest of this paper is organized as follows: Section 2 provides background on the drivers of fortified foods purchase and consumption, especially in developing country contexts. Our research questions are stated in section 3, and section 4 describes the data and methods used to answer these questions. Sections 5 and 6 present our descriptive and econometric results, respectively, while section 7 offers a discussion of these results, and section 8 concludes.

2. Background

Factors that may influence the likelihood of purchasing fortified foods include socio-demographics, knowledge of fortified foods, degree of health-consciousness, and prices. Consumers' socio-demographic characteristics, such as age, gender, education, income, and occupation, can influence their preference for fortified or "functional" foods.^{11,12} Particularly in developed countries, studies have found that women are more interested than men in attaining healthy diets^{13,14,15} and demonstrate a higher acceptance and purchase intention towards nutritionally enriched foods.^{16,17} In some settings, older consumers also tend to be more eager to adopt disease-preventative eating habits,¹⁷ and studies have further documented a positive relationship between consumer acceptance of healthy products and higher levels of education¹³ and income.¹⁸

Awareness of fortified foods also influences the likelihood of consumption. For example, those with prior purchase experience have been found to exhibit a stronger willingness to pay for nutritionally fortified products.¹⁹ Health professionals and educators play a vital role in raising awareness of functional foods,²⁰ and awareness can also spread through social groups and via social pressure.^{21,22} Relatedly, the extent to which consumers are "health-conscious" is relevant for their willingness to purchase fortified foods. Health-conscious consumers are concerned about their wellness or health and are motivated to prevent diseases and retain or improve their quality of life.²³ Not surprisingly, health consciousness is associated with acceptance of functional foods.^{22,24} In general, a consumer's attitude toward healthy foods is a strong predictor of food-related behaviors.²⁵

Considerable evidence indicates that consumers' food purchase decisions are influenced by product attributes, including product labels, taste, texture, and price.^{26,27} Price expectations influence the choice of which food outlets to frequent, and prices affect a consumer's decision to purchase different brands and food products.²⁸ Affordability is especially important in low-income populations.²⁹ In fact, in informal settlements in urban Kenya, food prices were regarded as the most salient factors influencing food choices, with food affordability superseding all other considerations, including taste preferences.³⁰

Overall, the literature suggests a diverse set of factors that may influence consumers' likelihood of purchasing fortified foods. In this paper, we examine which of these factors are relevant for the purchase of packaged (fortified) maize flour in urban and peri-urban Kenya.

3. Research questions

We explore the following research questions:

- i. To what extent do residents of urban and peri-urban Nairobi and Kisumu purchase packaged/sealed (and presumably fortified) maize flour?
- ii. To what extent do they have access to packaged maize flour, in terms of food outlets selling this product near their homes and the relative prices of packaged and unpackaged maize flour?
- iii. From where do they purchase packaged maize flour, in terms of food outlets visited and distances traveled?
- iv. What characteristics of the home food environment, main shopper, and household are associated with the purchase of packaged maize flour?

4. Methodology

4.1 Study area and sample design

The study covers urban and peri-urban areas of Nairobi and Kisumu, with combinations of city and urban-status referred to as the four “study-regions”. A multi-stage sampling design was followed, with the four study-regions identified in the first stage. Then, across all wards (referred to locally as “locations”), we used the 2019 population census to construct an index of neighborhood wealth, which was used to segment the wards into wealth quartiles. (For urban Nairobi, the top wealth quartile was discarded (as these neighborhoods are not comparable to other areas and a low response rate was expected), and the remaining wards were again segmented into wealth quartiles.) In the next stage, we randomly selected two ward per wealth quartile. In urban and peri-urban Kisumu there were, respectively, 8 and 7 wards, and all were selected, giving us a total of 31 ward across the four study-regions. Thereafter, two enumeration areas (EAs) per selected ward were randomly selected. In the next stage, all households residing within each selected EA were listed, and 23 households per EA were randomly selected to be included in the sample in urban and per-urban Nairobi and urban Kisumu, while 27 household per EA were selected in peri-urban Kisumu to reach a target of about 375 households per study-region. Due to some attrition between listing and interview, the actual number of households varies from this target.

To delineate each household’s home food environment (FE), we identified the ‘geographic center’ of each EA (i.e., the average x- and y-coordinates of all sampled households in the EA). For the households in each EA, the home FE is the area within a certain radius of this point. For urban and peri-urban Nairobi, as well as urban Kisumu, this radius is 0.4 kilometers, while it is 0.6 kilometers in peri-urban Kisumu. This radius was determined based on an analysis of household shopping behavior which showed that over half of the outlets where households shopped were located within a 0.4 (or 0.6) km radius of the geographic center of the EA. Hence, the area of the home food environment is 0.5 km² except in peri-urban Kisumu where it is 1.1 km².

4.2 Data

Data collection took place from May–June 2022, with 1,507 households in the sample. A structured questionnaire was administered to the main shopper in each household, that is, the adult who is primarily responsible for making decisions about household food purchases. The survey collected data on the household’s demographics, socio-economic status, and food shopping behavior, as well as the main shopper’s values and priorities related to food. The main shopper provided detailed information on food purchases over the previous week, as well as large food purchases that occurred over the previous month that were not already captured. Information was gathered on food items purchased, the outlets from which they were purchased (with geo-coordinates noted), quantities procured, prices paid, distances traveled, whether the product was packaged and sealed, and (where relevant) whether the main shopper noticed whether the product displayed a fortified foods logo.

Shoppers in Kisumu and Nairobi may not know with certainty whether the maize flour they purchased was fortified. Because Kenyan law mandates that maize flour that is distributed in a packaged and sealed form must be fortified, we assume that maize flour purchased in a packaged and sealed form is fortified and that all other maize flour is not fortified.

To characterize the home food environment (FE), a census was conducted of food outlets in each home FE in June–August 2022. For each food outlet we collected information on the foods sold and, where appropriate, the products’ fortification status.

4.3 Data analysis

We first conduct a descriptive analysis with statistics disaggregated by study-region, household poverty status, and/or status as a consumer of packaged maize flour. Key variables used in analysis are summarized in Table 1. A probit regression is then used to determine the differential influence of various factors on the households' likelihood of purchasing packaged (presumably fortified) maize flour. The probit model is estimated as:

$$Y_{ijk} = \alpha + \beta[HH_{ijk}] + \gamma[Home FE_{jk}] + \delta[Region_k] + \mu_{ijk} \quad (1)$$

where Y_{ijk} is a binary variable indicating whether household i in home food environment j and region k purchased any packaged maize flour; HH_{ijk} is a vector of household characteristics; $Home FE_{jk}$ is a vector of characteristics of the home FE (consistent for all households sampled in each EA); $Region_k$ is a vector of region indicators; β , γ , and δ are vectors of coefficients to be estimated; α is a constant term; and μ_{ijk} is an error term. Equation (1) is first applied to all households, regardless of whether they purchase maize flour, and then to the subset of households that purchase maize flour in any form. A Heckman technique is used to test for bias from having a non-randomly selected sample of maize flour purchasers (finding no bias). Population weights are used in all analyses, and standard errors are clustered at the level of EA.

Table 1: Summary of key household variables

Variable	Description	Variable type
Purchase of maize flour		
Purchased packaged (fortified) maize flour	1= Household purchased maize flour in packaged and sealed form	Dummy
Price paid	Average price paid for maize flour (KES/gram)	Continuous
Distance traveled	Average distance traveled to purchase maize flour (km)	Continuous
Main shopper characteristics		
Age of main shopper	Age of the main shopper in the household (years)	Continuous
Secondary school education	1= Main shopper has at least some secondary school education	Dummy
Female	1= Main shopper is female	Dummy
Notice signs	1= Main shopper notices signs that encourage healthy purchases when shopping	Dummy
Notice nutrition information	1= Main shopper notices nutrition information or nutrition labels on packaged foods	Dummy
Notice fortified status	1= Main shopper notices the fortification status of food products before purchase	Dummy
Fortified status: Most important ^a	1= Main shopper reports that fortification is among the most important food attributes	Dummy
Fortified status: Least important ^a	1= Main shopper reports that fortification is among the least important food attributes	Dummy
Household characteristics		
Female-headed household	1= Household head is female	Dummy
No. adults	Number of adults in the household	Continuous
No. children	Number of children in the household	Continuous

Variable	Description	Variable type
Poverty likelihood ^b	Likelihood (%) that a household is below \$3.20/day international poverty level	Continuous
More poor	1= Household is above the median poverty likelihood value	Dummy
Less poor	1= Household is below the median poverty likelihood value	Dummy
Farm household	1= Household is involved in farming	Dummy
Food environment characteristics		
Packaged (fortified) maize flour in FE	1= Home food environment has at least one outlet selling packaged (fortified) maize flour	Dummy
No. outlets selling packaged (fortified) maize flour	Number of outlets in the home food environment that offer packaged (fortified) maize flour	Continuous
Density of outlets selling packaged (fortified) maize flour in home FE	Number of outlets per km ² that offer packaged (fortified) maize flour in the home food environment	
Price of packaged (fortified) maize flour	Median purchase price of packaged (fortified) maize flour in the enumeration area (KES/kg)	Continuous
Price premium for packaged (fortified) maize flour	Gap between median price of packaged and unpackaged maize flour in the enumeration area (KES/kg)	Continuous
Geographic characteristics		
Nairobi urban	1= Household resides in urban Nairobi	Dummy
Nairobi peri-urban	1= Household resides in peri-urban Nairobi	Dummy
Kisumu urban	1= Household resides in urban Kisumu	Dummy
Kisumu peri-urban	1= Household resides in peri-urban Kisumu	Dummy

^a Respondents were presented with a list of 18 food attributes and asked to select their four most important and four least important attributes.

^b This measure of each household's likelihood of poverty is based on scores given to 10 indicators, including household size, number of habitable rooms and wall material of the dwelling unit, ownership of a television or mobile phone, whether the household contains any member with a disability, and the nature of household members' work, literacy, and education. The resulting score is converted into probabilities of falling below the \$3.20/day poverty line.³¹ These probabilities are then used to categorize households as having a low or high likelihood of poverty, based on whether they are below or above the median poverty likelihood score.

5. Descriptive results

5.1 Rate of purchase of packaged (fortified) maize flour

We now address our first research question, "To what extent do residents of urban and peri-urban Nairobi and Kisumu purchase packaged (fortified) maize flour?" Results in Table 2 show that 81% of households in urban Nairobi purchased maize flour (of any type) in the previous month, while 66% in peri-urban Kisumu did so. In peri-urban Kisumu, many people still depend on agricultural activities and may draw on their own production rather than purchasing maize flour from retail outlets. In contrast, households in Nairobi generally access food products from retail outlets, such as a supermarket or *duka* (small traditional retail shop).

About two thirds (67%) of all households purchased maize flour that was packaged and sealed (presumably fortified). This value was highest in peri-urban Nairobi (at 70%) and lowest in peri-urban

Kisumu (at 34%). Even when focusing on the subset of households that purchased any maize flour, the share that purchased packaged maize flour was 87% in peri-urban Nairobi and 51% in peri-urban Kisumu. It is clear that fortified maize flour is overall less common in Kisumu. Among households that purchased any packaged maize flour, they purchased this product 4.3 times per month, on average. Poorer households purchased packaged maize flour more times per month (5.0) than less poor households (3.7). Less poor households may be more likely to have regular income and storage space for products purchased in bulk, whereas poorer households may make more frequent purchases if they have irregular income and limited storage space.

Table 2: Household purchase of packaged (fortified) maize flour

	Study-region (city/urban status)					Poverty status	
	All	Nairobi urban	Nairobi peri-urban	Kisumu urban	Kisumu peri-urban	More poor	Less poor
Household purchased maize flour (%)	80	81	80	70	66	83	77
Household purchased packaged (fortified) maize flour (%)	67	68	70	50	34	66	67
Household purchased packaged (fortified) maize flour if any maize flour was purchased (%)	84	84	87	72	51	80	87
Number of times packaged (fortified) maize flour was purchased in a month, if any (mean)	4.3	4.2	4.3	5.3	4.7	5.0	3.7
Observations	1,507	375	357	383	392	817	690

5.2 Access to packaged (fortified) maize flour

Our second research question is, “To what extent do people in urban and peri-urban Nairobi and Kisumu have access to packaged (fortified) maize flour?” Table 3 characterizes the availability of packaged maize flour in households’ home food environments (FEs). Almost all (~100%) of the home FEs in Nairobi and urban Kisumu contain selling points for this product. However, it is somewhat less common (at 92%) for households in peri-urban Kisumu to have any access to packaged maize flour in their immediate food environments. Table 3 also displays the average number of outlets selling packaged maize flour in the households’ home FEs. Recall that the size of the home FEs is 0.5 km², except in peri-urban Kisumu where it is 1.1 km². On average, households in urban Nairobi have 54 outlets within their home FE that sell packaged maize flour, while this value is 29 in peri-urban Nairobi, 17 in urban Kisumu, and 12 in peri-urban Kisumu. When the density of selling points is presented per km², the relative scarcity in peri-urban Kisumu is even more stark, with just 10 per km²—one third the density observed in urban Kisumu and less than one tenth the density observed in urban Nairobi.

Another aspect of households’ access to packaged (fortified) foods is the relative prices of packaged and unpackaged products.

Table 4 shows the average prices paid per gram among households that purchased maize flour. Contrary to our expectations, packaged maize flour does not generally seem more expensive on a per-gram basis. The price of packaged maize flour tends to be higher, on average, in Kisumu than Nairobi, and while average prices in Nairobi for packaged flour are similar or slightly lower than unpackaged flour, there is a sizable gap in the prices in Kisumu. Specifically, the average price of packaged maize flour is 11 KES/gram

higher than unpackaged flour in urban Kisumu and 19 KES/gram higher in peri-urban Kisumu. To our knowledge, medium- and large-scale maize milling companies are far more prevalent in Nairobi, which may imply that relatively higher transport costs are incurred in Kisumu.

Table 3: Availability of packaged (fortified) maize flour in the home food environment

	Study-region (city/urban status)					Poverty status	
	All	Nairobi	Nairobi	Kisumu	Kisumu	More	Less
		urban	peri-urban	urban	peri-urban	poor	poor
% of households whose home FE contains any selling points for packaged (fortified) maize flour	100	100	100	100	92	100	100
Average number of outlets in the households' home FE that sell packaged (fortified) maize flour	42	54	29	17	12	42	41
Average number of outlets per km ² in home FE that sell packaged (fortified) maize flour	82	107	58	33	10	84	81

Table 4: Prices paid for packaged (fortified) and unpackaged maize flour (mean KES/gram)

Maize flour	All	Study-region (city/urban status)				Poverty status	
		Nairobi		Kisumu		More	Less
		Nairobi	peri-urban	Kisumu	peri-urban		
		urban	urban	urban	urban	poor	poor
Packaged (fortified)	71	71	68	79	83	69	72
Unpackaged (unfortified)	72	74	68	68	64	70	74

Note: To produce these values, the quantities purchased, and expenditures made for maize flour over the previous month were first summed within each household to generate a within-household average, and the average was then calculated across households.

5.3 Sources of packaged (fortified) food products

Our third research question is, “From where households purchase packaged (fortified) maize flour, in terms of types of food outlets visited and distances traveled?” Table 5 presents the share of households (among those that purchased any maize flour) that sourced either packaged or unpackaged maize flour from each outlet type. Among households that purchased unpackaged (presumably unfortified) maize flour, 36% purchased it from a *duka*, 42% from a posho mill, and 11% from a market. Among households that purchased packaged (presumably fortified) maize flour, most (66%) purchased it from a *duka*, while 21% purchased it from a large supermarket.

Generally, most households in Nairobi and Kisumu purchase maize flour from informal food outlets, especially the *duka*. This may be because informal food outlets tend to offer items on credit to regular customers, which is especially important for households with irregular incomes. Moreover, while supermarkets tend to sell larger packages of fixed sizes, a more flexible arrangement is seen among traditional retailers.³² Additionally, *dukas* are more common in the food environment and located at closer proximity to consumers than supermarkets. These two features of the *duka*—proximity and small package size—are especially conducive to low-income Kenyan consumers who mostly purchase food in small quantities at high frequencies (commonly referred to as “*kadogo*” in the local language or “small” in English).³²

It is not surprising that it is more common to source packaged maize flour from supermarkets, as these modern food outlets are most likely to sell industrially processed products that are packaged and sealed. Likewise, it is not surprising that the most common source of unpackaged maize flour is a posho mill, as most of the processed flours offered by these small mills are sold in bulk or in unsealed packages that are exempt from the national fortification mandate.

Table 5: Outlets at which packaged (fortified) and unpackaged maize flour are purchased (%)

Outlet	Maize flour	
	Unpackaged (unfortified)	Packaged (fortified)
Duka	36	66
Large supermarket	4	21
Small supermarket	1	8
Posho mill	42	1
Wholesale	2	4
Kiosk	4	3
Market	11	1
Other	4	1

Note: Each value indicates the percent of households (among those that purchase a given type of maize flour) that procure the product from a given outlet. Because households typically frequent multiple types of outlets, these values sum to more than 100%. N = 374 households (unpackaged) and 820 households (packaged).

Table 6 shows the average Euclidean distances traveled to purchase packaged and unpackaged maize flour. (A very similar pattern is seen when Table 6 is produced using self-reported distances traveled.) Households traveled longer distances, on average, to purchase packaged maize flour, compared to unpackaged maize flour. Recall from Table 5 that packaged products are more likely to be purchased in formal outlets such as supermarkets; because these are less common, they are less likely to be found in the immediate vicinity of someone’s home. Households in peri-urban Kisumu travelled the longest distances, on average, for the purchase of maize flour, presumably because food outlets in peri-urban Kisumu are more dispersed.

Results also indicate that less poor households travelled longer distances, on average, for the purchase of packaged maize flour (0.8 km), whereas poorer households purchased packaged maize flour at an average distance of 0.4 km. Less poor households are more likely to shop in supermarkets which are likely to be located far from where they reside,³² and they may use a private car or other transport to reach more distant shops. On the other hand, poorer households are more likely to access shops on foot and visit food outlets within their neighborhood.

Table 6: Mean distances traveled for maize flour purchases (km)

Maize flour	Study-region (city/urban status)				Poverty status		
	All	Nairobi	Nairobi	Kisumu	Kisumu	More poor	Less poor
		urban	peri-urban	urban	peri-urban		
Packaged (fortified)	0.5	0.5	0.6	0.7	1.2	0.4	0.8
Unpackaged (unfortified)	0.4	0.2	0.6	0.5	1.0	0.4	0.3

Note: To produce these values, we first calculated the within-household average distance traveled to purchase each product across the different purchases made in the previous month, and then calculated an average across households.

5.4 Characteristics of households that purchase packaged (fortified) maize flour

Table 7 presents characteristics of households in Nairobi and Kisumu, disaggregated by whether the household purchased any packaged maize flour or not. Households that purchased packaged maize flour had a main shopper who was younger than households that did not purchase any packaged maize flour (35 and 37 years, respectively, $P=0.016$). Households that purchased packaged maize flour were also more likely than others to have a female main shopper (at 73% and 63%, respectively, $P=0.034$).

Households that purchased packaged maize flour were slightly less likely than others to have their own farm (at 14% and 19%, respectively), a difference that is close to statistically significant ($P=0.118$). Farm households may be more likely to produce their own maize and bring their home-produced product to a *posho* mill to have it turned into flour.

The two categories did not differ significantly in the number of adult and child household members or the household’s likelihood of being poor. This is not consistent with some earlier findings that household size and the presence of children are important factors influencing fortified food purchase,³⁴ or that households in Kenya with infants and lactating mothers had higher preferences for fortified foods.³⁵ The lack of difference seen around poverty is somewhat surprising. As fortified foods are sold in sealed packages that often come in large sizes (hence requiring a considerable sum of money at the time of purchase), it might be expected that less poor households would more readily purchase these products. However, that is not the pattern we observe in Kisumu and Nairobi.

The survey asked the main shopper to indicate their level of agreement with a statement that ‘they notice the fortification label/logo on food products while they shop.’ As seen in Table 7, among all shoppers, just 32% either “agreed” or “somewhat agreed” that they notice the fortification status of foods before they buy them. Other studies have also found low levels of information-seeking behavior among food shoppers in Nairobi, with few reading nutrition information or looking for the fortification logo,³⁶ and few showing awareness of the term “fortification”.³⁷ Contrary to our expectations, a lower share (30%) of shoppers in households that purchased packaged (fortified) maize flour reported that they notice these logos, compared to 37% among other households. This suggests that the logo does not play an important role in food purchase decisions—and may even dissuade shoppers from selecting fortified products. The survey also asked the main shopper to consider a list of 18 food attributes and indicate the four most important and four least important attributes. Just 6% of shoppers indicated that fortification status was most important, and 28% indicated that this was their least important concern. These values do not differ in a statistically significant way across households that did and did not purchase packaged (fortified) maize flour.

In terms of the home food environments, households that purchased packaged maize flour resided in neighborhoods with a higher density of outlets that sold fortified maize flour, compared to other households

(at an average of 86 and 75, respectively, $P=0.006$). This suggests that households with greater access to packaged flour tend to purchase more of this product.

The local prevailing prices for packaged and unpackaged maize flour are captured using the median observed purchase price within each EA. As seen in Table 7, households that purchased packaged maize flour faced a lower price for this product, on average, than households that did not purchase packaged maize flour (at an average of 68 KES/kg and 70 KES/kg, respectively, $P=0.000$). This is consistent with the expectation that consumers—especially in low- and lower middle-income countries—are sensitive to price when shopping. Households that opted not to purchase packaged maize flour also faced a larger local price premium for the packaged product, and this difference is statistically significant ($P=0.069$).

Table 7: Characteristics of households that do and do not purchase packaged (fortified)maize flour

	Did household purchase package (fortified) maize flour?						t-test
	All		No		Yes		No = Yes
	Mean	SD	Mean	SD	Mean	SD	P-value
Main shopper characteristics:^a							
Age (years)	35.83	12.11	37.36	12.64	35.06	11.77	0.016
1= Secondary school education	0.64	0.48	0.61	0.49	0.65	0.48	0.333
1= Female	0.68	0.47	0.63	0.48	0.71	0.45	0.034
1= Notice signs	0.56	0.50	0.58	0.49	0.55	0.50	0.450
1= Notice nutrition information	0.46	0.50	0.49	0.50	0.44	0.50	0.286
1= Notice fortification status	0.32	0.47	0.37	0.48	0.30	0.46	0.083
1= Fortified status: Most important	0.06	0.24	0.06	0.23	0.06	0.24	0.771
1= Fortified status: Least important	0.28	0.45	0.30	0.46	0.27	0.45	0.427
Household characteristics:							
1= Female-headed household	0.29	0.46	0.30	0.46	0.29	0.45	0.679
No. adults	1.98	0.96	2.00	1.06	1.97	0.90	0.785
No. children	1.43	1.43	1.39	1.45	1.46	1.42	0.594
Poverty likelihood (%)	34.07	26.25	34.15	26.30	34.04	26.24	0.959
1= Farm household	0.16	0.37	0.19	0.39	0.14	0.35	0.118
Food environment (FE) characteristics:							
Density of outlets selling packaged (fortified) maize flour in home FE (number/km ²)	82.25	53.74	74.83	56.61	85.97	51.87	0.006
Price of packaged (fortified) maize flour (KES/kg)	68.92	5.41	69.97	7.38	68.39	3.97	0.000
Price premium for packaged (fortified) maize flour (KES/kg)	1.64	5.92	2.20	7.54	1.35	4.89	0.069
Geography:							
1= Nairobi urban	0.55	0.50	0.53	0.50	0.57	0.50	0.342
1= Nairobi peri-urban	0.36	0.48	0.33	0.47	0.38	0.49	0.206
1= Kisumu urban	0.05	0.22	0.07	0.26	0.04	0.19	0.000
1= Kisumu peri-urban	0.03	0.18	0.07	0.25	0.02	0.13	0.000
Observations	1,507		687		820		

^a In households with more than one shopper, the age, education, gender, indicators of awareness, and food values of the main shopper refer to the shopper who responded to the survey on behalf of the household.

6. Econometric results

Our final research question is, “What characteristics of the home food environment, main shopper, and household are associated with the purchase of packaged (fortified) maize flour?” This section presents an econometric analysis of the correlates of packaged maize flour purchase, employing a probit model as in equation (1). In **Error! Reference source not found.**, column 1 displays the results of an unconditional model, and column 2 displays the results of a model focused only on the subset of households that purchased

any maize flour. The two models are then applied separately to households in Nairobi (columns 3 and 4) and Kisumu (columns 5 and 6).

The conditional model could yield biased results if purchase of any maize flour (i.e., self-selection into the sample) is non-random. We therefore applied a Heckman probit model in which the first-stage selection model predicts the likelihood of selecting into the sample of maize flour purchasers. Because the selection equation should have at least one variable that is not in the second equation, measures of shelf space in the home FE allocated to whole grains and refined grains were included in the first stage. The Wald test of independent equations indicated that the outcome is not significantly different from the outcome obtained by fitting the probit and selection models separately ($\lambda^2 = 0.77, P = 0.3799$). This implies that the results of conditional models reported in Table 8 are not biased.

Among all households, those with older main shoppers are less likely to purchase packaged maize flour, with an additional year in age decreasing the likelihood by 0.3% ($P=0.031$). Households with younger shoppers may have more exposure to nutrition information and therefore be more inclined to purchase packaged (fortified) maize flour. Along these lines, studies have found that younger caretakers have greater access to nutrition information stemming from exposure to social media and television.³⁸

Holding all else equal, households with female main shoppers are 13% more likely to purchase packaged maize flour (column 1), and this pattern is most evident in Nairobi (column 3). As noted, it is common in many contexts to find that women are more interested than men in healthy diets and more accepting of nutritionally enriched foods,^{13,14,15,16} and women in Kenya have elsewhere been found to play a significant role in the decision to consume fortified maize flour.³⁶

Results indicate that a main shopper who takes note of food's fortification status before making a purchase is 9% less likely to purchase packaged (fortified) maize flour for their household. This correlation is statistically significant only in Nairobi (column 3). Other studies have found that providing information on food products may backfire if consumers distrust a certain technological process or development.³⁹ While nutrition labels that raise consumers' familiarity with a product or product attribute can positively influence their purchase intentions,^{40,41} we seem to observe the reverse effect in Kenya. At the same time, shoppers who cited fortification as a most important food attribute are 12% more likely to purchase packaged (fortified) maize flour only in the conditional model for Kisumu (column 6). Meanwhile, shoppers who cited fortification as a least important food attribute are 5% less likely than others to purchase packaged maize flour only in the conditional model for Nairobi (column 4).

The local price premium observed for packaged maize flour relative to unpackaged flour is a negative and statistically significant determinant of purchase, particularly in Kisumu (columns 5 and 6). Specifically, an increase in the price premium by 10 KES/kg is associated with a 9% lower likelihood of purchasing packaged maize flour in Kisumu ($\beta=-0.009, P=0.046$). This is consistent with expectations that consumers respond to price signals. While price stands out as a strong driver of purchase decisions, the physical availability (i.e., density) of fortified maize meal selling points in the home FE does not seem to influence the likelihood of purchase, once other factors are held constant. However, this coefficient is sometimes statistically significant when other controls, such as prices, are omitted from the equation.

In the conditional model (columns 2, 4, and 6), we also control for the outlet types at which the household purchased any maize flour. (Recall that this variable is not mutually exclusive, as households can procure maize flour from multiple types of outlets. Thus, all outlet types are included in the model.) Those who procured maize flour from a posho mill were significantly less likely to purchase packaged maize flour, compared to those who purchased maize flour only from other types of outlets. In the other

direction, households that purchased maize flour in a *duka* or small or large supermarket were more likely to purchase the packaged version.

Table 8: Correlates of the purchase of fortified maize flour (probit models)

	(1)	(2)	(3)	(4)	(5)	(6)
	All		Nairobi		Kisumu	
	Unconditional	Conditional	Unconditional	Conditional	Unconditional	Conditional
Age of main shopper (years)	-0.003** (0.031)	-0.001 (0.176)	-0.003** (0.044)	-0.001 (0.252)	-0.003** (0.038)	-0.003*** (0.006)
1= Secondary school education	0.020 (0.639)	0.039 (0.182)	0.021 (0.653)	0.040 (0.206)	0.054 (0.230)	0.017 (0.577)
1= Female	0.130** (0.016)	0.020 (0.522)	0.140** (0.011)	0.018 (0.599)	-0.029 (0.536)	0.012 (0.683)
1= Notice signs	-0.023 (0.612)	0.044* (0.076)	-0.025 (0.615)	0.044 (0.107)	-0.009 (0.798)	0.047** (0.038)
1= Notice nutrition information	-0.015 (0.709)	-0.033 (0.178)	-0.013 (0.768)	-0.037 (0.163)	-0.002 (0.969)	-0.015 (0.655)
1= Notice fortification status	-0.091** (0.029)	-0.021 (0.343)	-0.095** (0.025)	-0.021 (0.390)	-0.021 (0.721)	-0.023 (0.416)
1= Fortified status: Most important	0.043 (0.609)	-0.042 (0.439)	0.048 (0.617)	-0.044 (0.429)	-0.035 (0.587)	0.119* (0.058)
1= Fortified status: Least important	-0.035 (0.305)	-0.050* (0.055)	-0.041 (0.268)	-0.054** (0.047)	0.008 (0.859)	0.012 (0.702)
1= Female-headed household	-0.052 (0.331)	-0.022 (0.440)	-0.051 (0.371)	-0.021 (0.481)	-0.014 (0.817)	0.027 (0.227)
No. adults	-0.012 (0.663)	-0.004 (0.801)	-0.016 (0.597)	-0.005 (0.735)	0.017 (0.441)	0.010 (0.602)
No. children	-0.006 (0.635)	-0.007 (0.528)	-0.009 (0.542)	-0.010 (0.455)	0.015 (0.229)	0.011 (0.162)
Poverty likelihood (proportion)	0.029 (0.763)	0.006 (0.912)	0.023 (0.834)	0.019 (0.776)	0.074 (0.398)	-0.018 (0.811)
1= Farm household	0.003 (0.938)	-0.001 (0.949)	0.022 (0.613)	0.006 (0.824)	-0.128*** (0.001)	-0.037 (0.161)
Density of outlets selling fortified maize flour (10s/km ²)	0.004 (0.594)	0.003 (0.283)	0.003 (0.679)	0.004 (0.267)	0.008 (0.560)	-0.004 (0.469)
Price of fortified maize flour in EA (KES/kg)	-0.004 (0.652)	0.001 (0.845)	-0.003 (0.801)	0.001 (0.920)	-0.001 (0.808)	0.010*** (0.007)

Price premium for fortified maize flour (KES/kg)	-0.003 (0.639)	-0.008* (0.080)	-0.001 (0.905)	-0.009* (0.085)	-0.009** (0.046)	-0.006** (0.022)
1= Purchased maize flour in <i>duka</i>		0.244*** (0.000)		0.226*** (0.002)		0.423*** (0.000)
1= Purchased maize flour in posho mill		-0.150** (0.017)		-0.156** (0.031)		-0.121** (0.027)
1= Purchased maize flour in market		-0.051 (0.493)		-0.079 (0.344)		0.120 (0.115)
1= Purchased maize flour in large supermarket		0.327*** (0.000)		0.306*** (0.000)		0.521*** (0.000)
1= Purchased maize flour in small supermarket		0.285*** (0.000)		0.258*** (0.000)		0.609*** (0.000)
1= Purchased maize flour in other type of outlet		0.147*** (0.007)		0.129** (0.037)		0.303*** (0.000)
1= Nairobi peri-urban	0.030 (0.601)	0.062* (0.091)	0.024 (0.706)	0.061 (0.105)		
1= Kisumu peri-urban	-0.239*** (0.005)	0.047 (0.242)			-0.079 (0.234)	-0.015 (0.654)
1= Kisumu urban	-0.087 (0.321)	0.036 (0.381)				
Observations	1,507	1,125	732	578	775	547
Wald χ^2	138.21	772.28	49.49	1432.50	225.23	2019.05
P > χ^2	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
Pseudo- R^2	0.0460	0.3964	0.0302	0.3761	0.0839	0.5540

Average marginal effects; P-values in parentheses; standard errors clustered at enumeration area; *** p<0.01, ** p<0.05, * p<0.1

7. Discussion

This study employed descriptive and econometric analysis to characterize the packaged (fortified) maize flour purchasing patterns of consumers in Kisumu and Nairobi. Several interesting themes emerge from this analysis.

Nearly all households in Kisumu and Nairobi have some access to packaged (fortified) maize flour in terms of physical availability. However, the intensity of access varies considerably across neighborhoods, and households that purchased packaged maize meal resided in home food environments with a higher density of outlets selling this product. If the goal is to enhance uptake of fortified maize meal, the government might focus on encouraging the private sector to invest more in food outlets that sell packaged maize flour. This is especially the case in peri-urban Kisumu, where the average resident faces a home food environment with just 10 outlets per km² that offer packaged maize flour (Table 3).

The price premium for packaged (fortified) maize flour was a statistically significant driver of the purchase decision, with households less likely to purchase this product when the prevailing price premium in their neighborhood was higher (**Error! Reference source not found.**). Although the price gap between packaged and unpackaged flour was limited in the pooled sample, packaged maize flour was strikingly more expensive than unpackaged maize flour in Kisumu, where households were least likely to purchase packaged maize flour. It follows that policy makers intent on advancing Kenya's large-scale food fortification program should aim to bring down the retail cost of packaged maize flour, perhaps by waiving import duties on fortification premix or assisting millers in financing the purchase of fortification equipment.⁴²

Our results indicate that people in Kisumu and Nairobi are, in general, not concerned with fortification. Just 6% of main shoppers viewed fortification as a most important food attribute, while 28% viewed it as least important (Table 7). If the goal is to increase uptake of fortified flour, the government should collaborate with private companies involved in the production and marketing of fortified maize flour to raise awareness. As uptake is lowest in peri-urban Kisumu, marketing efforts should be deliberately inclusive of this region.

We found a somewhat unexpected pattern whereby noticing the fortification status of products is negatively and significantly associated with purchase of packaged (fortified) maize meal (**Error! Reference source not found.**). As noted, providing information on a food-related technological process can backfire if consumers distrust the technology.³⁹ In the Kenya context, some consumers are reported to harbor suspicions regarding the fortification process.⁴² It follows that the government should design educational campaigns so that consumers understand the fortification process and come to recognize the benefits.

Our results show that packaged maize flour tends not to be purchased in the type of shops where poorer people most commonly access maize meal—i.e., posho mills (Table 5). One policy implication is that the government could provide subsidized fortification technologies to posho mills, especially in peri-urban areas where many people access their maize flour through such mills. This recommendation is consistent with other authors who argue that the government can improve uptake of fortified maize flour by making relevant technologies available at the scale of smaller mills.⁴³

In this study, we focused on the purchase of maize flour that was packaged and sealed, noting that this is mandated by Kenyan law to be fortified. However, when asked to report whether the sealed packages contained a fortification logo, respondents did not know in 39% of cases, strongly indicating that many shoppers are not attentive to this feature when making their food choices. Future research on this topic

could more directly capture shoppers' intentions related to the purchase of fortified products in order to explicitly discern what drives their decisions.

8. Conclusion

Micronutrient deficiencies constitute a heavy disease burden that is borne disproportionately by people living in developing countries. Mass food fortification has been demonstrated to be an effective public health intervention to increase micronutrient intake and improve nutrition status. To avail these benefits, the government of Kenya has implemented a policy of fortifying all industrially processed maize flour and mandated it to be sold in sealed packages through retail shops. In this paper, we document that two out of three residents living in and around two major cities—Nairobi and Kisumu—are potentially reached by this policy, and as intended, both poor and non-poor consumers benefit equally from this fortification mandate. On these two metrics, the mass fortification strategy appears to be somewhat effective.

On the flip side, our results show that one out of three people are not being reached by this policy. These are people who reside predominantly in peri-urban Kisumu, in areas with a lower density of food retail outlets, and where packaged maize flour is sold at a relatively higher price compared to non-packaged maize flour. On a more positive note, we find some shopper characteristics—i.e., shoppers younger in age, female, and those who notice signs that encourage healthy eating and value fortification as an important food attribute—to be strongly associated with decisions to purchase packaged (fortified) maize flour. We hope these positive and negative determinants of the packaged maize flour purchase decision will provide guidance on where and how governments should target their efforts to promote and expand the availability and affordability of healthy food products, such as packaged (fortified) maize flour.

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