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Overcoming Budget Constraints to Healthy Diets

Evidence from Urban Tanzania

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Abstract

This study investigates the impact of temporary subsidies for nutrient-dense foods on the diets of low-income households in Dar es Salaam, Tanzania. Vouchers for eggs, milk, and unflavored yogurt were provided to randomly selected households over a three-month period. The subsidies significantly increased the consumption of the targeted healthy foods while discounts were offered. These effects persisted up to 9 months after the end of the subsidy period and were accompanied by a shift in preferences for the targeted foods. Consumption of unhealthy complements, specifically sugar added to yogurt and milk, increased during the subsidy period. Finally, while poorer households initially benefited most, sustained impacts were greater among wealthier households. In sum, the findings demonstrate that subsidies for healthy foods can lead to sustained improvements in diets, while suggesting a role for accompanying interventions such as nutrition education to maximize net health benefits, and pointing to the need for ongoing support to the most vulnerable.

Keywords: Tanzania, affordability, healthy foods, consumers, vouchers

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1 Introduction

Over the past five decades, global food systems and dietary patterns have undergone significant transformations. In much of the world, traditional diets are being replaced by modern diets characterized by the consumption of processed foods (Development Initiatives, 2018). And while significant progress has been made in reducing the prevalence of food insecurity, diets in low- and middle-income countries (LMICs) continue to be low in micronutrients while increasingly including ultra-processed foods, leading to both undernutrition and overnutrition (Popkin *et al.*, 2020). It is estimated that between 2 and 3 billion people cannot afford a healthy diet, suggesting that subsidies for healthy foods could be a key strategy to improving diets (Headey *et al.*, 2024a).

Like many other LMICs, Tanzania is experiencing substantial changes in dietary patterns. Diets in Tanzania are characterized by low dietary diversity, and consumption of processed foods is rising. Regular meals in Tanzania are predominantly composed of cereals, roots, and tubers (56%), with very low contributions from micronutrient rich foods such as fruits and vegetables (7%) or animal source foods (6%) (National Bureau of Statistics, 2019). Historical data on food consumption patterns in Tanzania show that in the 1960s and 1970s, roots and tubers contributed about 30 percent of the daily diet, but this proportion declined to an average of 14 percent between 2000 and 2011 (Food and Agriculture Organization of the United Nations, 2012).

This study seeks to address one of the dietary challenges faced by Tanzanians, namely low consumption of animal source foods, by providing vouchers for these foods to households.[1] We specifically evaluate the impact of providing vouchers for healthy convenience foods on dietary patterns among households in a low-income area of Dar es Salaam. Vouchers could be exchanged for eggs, milk, and unflavored yogurt at participating local shops.[2] While food subsidies can be costly, governments often provide food or cash assis-

[1]The products chosen for the study are nutrient-dense and can help fill important dietary gaps. For example, Iannotti *et al.* (2017) demonstrate that increased egg consumption improves child growth as infants begin complementary feeding, and Headey *et al.* (2024b) describe the benefits of increased milk consumption.

[2]The vouchers only covered shelf-stable milk, to ensure that the vouchers did not lead to harm through the provision of unsafe food.

tance to poor households. This research provides evidence about whether targeting this type of aid to nutrient-dense foods has the potential to improve dietary habits in LMICs.

We set out to answer the following research questions: 1) Does providing vouchers for eggs, milk, and unflavored yogurt increase the consumption of these products? Of milk in general? 2) Do these changes persist after subsidies are withdrawn, beyond the end of the intervention? 3) Does providing vouchers affect consumption of other foods, by crowding out the consumption of healthy or unhealthy substitutes, or increasing the consumption of healthy or unhealthy complements? and 4) Does the project affect neighbors' consumption of targeted foods or potential substitutes?

To do so, we conducted a randomized controlled trial through which households were provided with vouchers redeemable for specific healthy foods for six weeks. To measure the dynamic impacts of voucher receipt on consumption patterns, households were surveyed four times: before the distribution of vouchers, during the period that vouchers could be redeemed, two weeks after the voucher redemption period, and nine months later to test whether habits had formed around consumption of any of the foods targeted by the intervention.

We find strong impacts on the consumption of targeted healthy foods during the voucher redemption period, and no crowding out of healthy substitutes. Targeted foods continued to be consumed more frequently by households in the treatment group at two weeks and nine months post-intervention. However, household members in the treatment group were more likely to consume sugar as an additive to the targeted foods during the intervention, but this effect faded by two weeks post-intervention to near zero, and lost its statistical significance. Consumption of unhealthy substitutes was not, on the whole, significantly affected by the intervention, though we observe higher consumption of flavored yogurt two weeks after the end of the voucher redemption period, suggesting a possible impact on this close substitute for unflavored yogurt. There is no evidence that the intervention had any impact on the neighbors of households assigned to the voucher intervention.

The paper proceeds as follows. In the next section, we review the literature on food

subsidies in LMICs and identify gaps in the literature. We then describe the study methods in Section 3, and then the results. Section 5 concludes with a summary of key findings and recommendations for policy and future research.

2 Literature Review

While an extensive literature documents the impacts of subsidies for nutritious foods in high-income countries (HICs), the evidence base in LMICs is far weaker. In this section, we review prior studies in this area and describe gaps in the evidence which we aim to fill through the present study.

2.1 Prior Studies on Food Subsidies for Nutrition

Two recent review articles describe evidence about impacts of food subsidy programs (Mansilla *et al.*, 2023; Huangfu *et al.*, 2024). Among other forms, subsidies include vouchers, cash back rebates, discounts, and changes to the value added tax, and they are typically targeted to low-income households. Almost all the examples described are in HICs. Mansilla *et al.* (2023) conclude that subsidies for fruits and vegetables can significantly improve dietary intake among low-income populations, leading to better health outcomes and reduced healthcare costs. In a meta-analysis of 14 studies, Huangfu *et al.* (2024) similarly find that reducing the price of fruits and vegetables by 20% increases fruit and vegetable purchases by 16.6%.

However, the evidence on food vouchers from randomized control trials is somewhat mixed. On one hand, the Healthy Incentives Pilot (HIP) program in the United States, which provided financial incentives for the purchase of fruits and vegetables to Supplemental Nutrition Assistance Program (SNAP) participants, resulted in increased consumption of these foods (Bartlett *et al.*, 2014). On the other hand, Aktary *et al.* (2023) provided coupons worth $21 for a 16-week period to randomly selected participants in the British Columbia Farmers' Market Nutrition Coupon Program who had been on the waiting list for the program. They found no impacts on diet quality. Nonetheless, given that

the latter sample was relatively small (285 individuals), it remains fair to conclude that the evidence base from HICs shows that subsidies and financial incentives are typically effective for improving dietary behaviors in high-income settings.

In LMICs, the impact of food subsidies on nutrition has received less attention. Existing research in LMICs has primarily focused on general food assistance programs rather than targeted subsidies for healthy foods. For example, Thow *et al.* (2010) reviewed the impact of fiscal policies, including subsidies and taxes, on diet and health outcomes in LMICs, and found limited but promising evidence that subsidies for healthy foods could improve dietary intake. (Chakrabarti *et al.*, 2018) examined the addition of pulses to the public distribution system in India. Their study found that the inclusion of pulses led to an immediate increase in pulse consumption among low-income households, improving protein intake and overall dietary diversity.

A small number of studies have assessed the impact of food subsidies or voucher distribution on dietary outcomes in LMICs. For example, a series of papers tests the effects of food transfers versus cash among populations eligible to receive aid from the World Food Programme (WFP), with mixed results on dietary changes (Hidrobo *et al.*, 2014; Hoddinott *et al.*, 2018; Schwab, 2019). Hidrobo *et al.* (2014) compare food transfers, food vouchers, and cash transfers provided to beneficiaries in northern Ecuador, finding vouchers lead to a larger increase in dietary diversity than the other two transfer modes. Meanwhile, Hoddinott *et al.* (2018) compare food transfers and cash transfers in Niger, finding food transfers lead to higher dietary diversity, while Schwab (2019) finds exactly the opposite in Yemen.

2.2 Evidence Gaps and Contribution

None of the studies in LMICs referenced above evaluated dietary changes after the withdrawal of transfers. In the study most similar to the present one of which we are aware, Ambler *et al.* (2025) conducted a randomized controlled trial to study the impact of fruit voucher distribution in two urban areas (Ibadan, Nigeria and Hanoi, Vietnam). The study reported immediate increases in fruit consumption in both countries. However, there was

only evidence of sustained effects after the voucher period in Vietnam, suggesting that local context plays a crucial role in the effectiveness of food voucher programs. These findings highlight the need for more research to understand the factors that influence the sustainability of dietary changes induced by food subsidies.

We make two further contributions to the literature on nutrition targeted subsidies. First, we test for impacts on the consumption of foods not targeted through the intervention, but which may be complements to or substitutes for the targeted foods. We test for potential impacts on healthy substitutes and both healthy and unhealthy complements. Second, we test for impacts on the consumption patterns of neighboring households. Spillover effects have been found in literature on food transfers (Cunha *et al.*, 2018, e.g.), but not in the context of interventions targeting nutritious foods in non-crisis situations.[3] By capturing any spillover effects on neighbors, whether through gifted vouchers or peer effects on consumption preferences, we ensure that the full effect of the intervention on study communities is measured.

3 Methodology

3.1 Study Setting, Sample Selection, and Treatment Assignment

The study was conducted in three wards of Temeke District, a low-income area of Dar es Salaam, Tanzania (Figure 1).[4] The primary sample consisted of 21,058 households randomly selected from the National Bureau of Statistics (NBS) sampling frame. Of the households in the NBS sampling frame, Of those 21,058 households, we initially sampled 1,058 households for inclusion in the baseline survey. An additional 1,037 neighboring households (the nearest available outside the compound of the primary household) were recruited during the baseline survey to analyze potential spillover effects of the intervention. Primary households were stratified by ward and then randomized into treatment or control status using Stata 18. For the purposes of analysis, the treatment status of

[3]There are several papers documenting spillover effects into local economies from cash transfers (Dietrich and Schmerzeck, 2019; Egger *et al.*, 2022; Filmer *et al.*, 2023).

[4]The study wards were Temeke, Tandika, and Mbagala.

neighboring households followed that of the associated primary household.

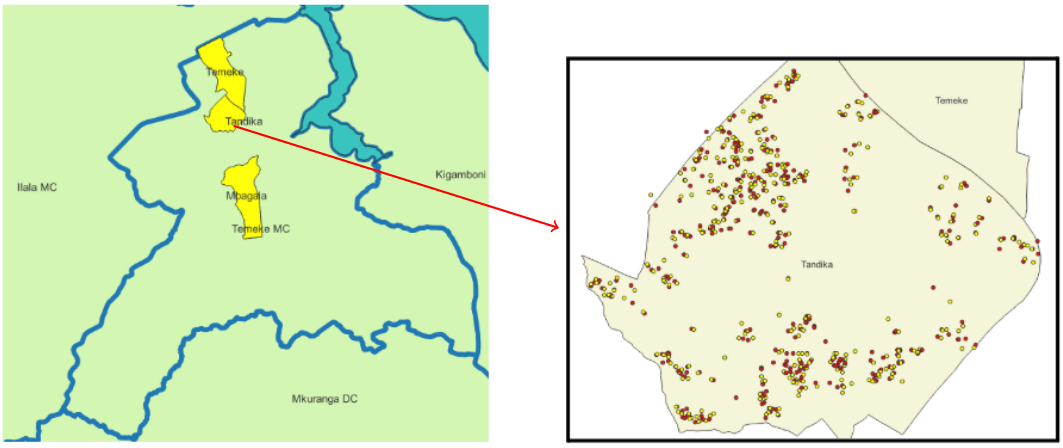

Figure 1: Map of study households.
Red = Primary HH
Yellow = Neighbor HH

3.2 Intervention

During the intervention period, households in the treatment group were visited weekly and given vouchers which could be redeemed at participating shops for eggs, UHT milk, or unflavored yogurt. Teams called ahead to arrange a suitable time to deliver vouchers to a household member or nearby proxy, and made two additional delivery attempts if no one was available to receive them. Each coupon was valued at 300 TZSh, with 42 coupons distributed per week for six weeks (Figure 2). This allowed participants to obtain, for example, approximately 5 eggs, 0.5 liters of milk, and 0.5 liters of yogurt per household member per week, at no cost. Each voucher was marked with the unique code identifying the household to which it had been provided, and contained images of each category of food item for which it could be redeemed.

Prior to the roll-out of the intervention, a listing of all shops stocking the targeted goods in the study wards was conducted. From this list, two shops on each major street, which already stocked the targeted food items and had refrigerated storage available, were randomly selected as voucher redemption points.[5] Shop managers were provided 200,000

[5]All the selected vendors were close to households. Ambikapathi *et al.* (2021) find that household fruit and vegetable consumption is associated positively with proximity to fruit and vegetable vendors in Dar es Salaam.

Figure 2: Picture of the Coupon Used

Tanzanian Shillings (TSh) (approximately $86 US at the time) of working capital to expand their inventory of targeted food items ahead of the redemption period.

Voucher recipients could redeem their vouchers for eligible foods at any of the participating shops. Vendors were asked to note down the date of redemption and serial number of each voucher received, and to circle the food item for which the voucher was exchanged. To ensure vouchers were not redeemed for non-targeted items, and that the item purchased was correctly recorded, members of the research team posing as study participants visited vendors to monitor their compliance with the protocol. Vendors were paid the cash value of any vouchers that had been redeemed during weekly visits, plus a bonus of 10,000 TSh ($4.29 US) per week that was conditional on compliance with the study protocol. Vendors were informed of the monitoring and conditional payment system ahead of time, and warned that protocol violations would result in cancellation of their shop's status as a redemption point. No vendor violations of the protocol were observed.

3.3 Timeline and Data

The baseline survey was conducted between November 8, 2023 and November 23, 2023, and captured respondent demographics, household assets, income, and food sufficiency, as well as household-level consumption of and expenditures on the foods targeted by the intervention and potential substitutes and complements. We focus on two healthy substitute foods: non-UHT milk and chicken, the lowest-cost meat available in the study area. Unhealthy substitutes are soda, juice, and flavored yogurt (all of which contain high levels of added sugar), while unhealthy complements captured in the data are sugar

added to milk or yogurt, and chips (often eaten together with eggs).

The intervention period, during which vouchers were delivered and could be redeemed, started on January 24, 2024 and ended on March 6, 2024. The first follow-up survey was conducted during this period, from February 14, 2024 to February 27, 2024, to assess the immediate impact of the targeted subsidy. Two additional follow-up surveys were conducted after the end of the intervention period, the first from March 18, 2024 to March 29, 2024 (approximately two weeks post-intervention), and the second from November 25, 2024 to December 3, 2024 (nine months post-intervention). The first two follow-up surveys covered consumption of both targeted and non-targeted foods and included both primary and neighboring households. Due to budget and time constraints, the final follow-up focused on consumption of targeted foods only among primary sample households.

3.4 Analytical Approach

The impact of the intervention was estimated using ordinary least squares (OLS) regression, controlling for baseline values of the outcome variables, household demographics, and stratification bin (ward) indicators. Robust standard errors were used to account for clustering at the household level. The estimation equation is as follows:

$$Y_{pi} = \beta_0 + \beta_1 \cdot T_i P_i + \beta_2 \cdot N_i + \beta_3 \cdot T_i N_i + \beta_4 \cdot Y_{0i} + \beta_5 \cdot S_i + \varepsilon_i \tag{1}$$

Y_{pi} represents the outcome variable measured at follow-up survey round $p \in \{1, 2\}$, T_i is an indicator for assignment to the treatment group, P_i signifies a primary household selected from the census list, and N_i indicates the household was identified as a neighbor a primary household. Y_{0i} refers to the value of the outcome variable measured at baseline. S_i represents a set of binary stratification bin (ward) indicators, and ε_i denotes the error term. Since not all households were expected to redeem all of their coupons, we interpret β_1 and β_3 as intent-to-treat effects.

Due to differential attrition across experimental groups, as described below, Lee bounds of treatment effects on the primary sample are presented in addition to point

estimates (Lee, 2009).[6]

To address multiple hypothesis testing, indices combining consumption outcomes for the four categories of foods (targeted foods, healthy substitutes, unhealthy substitutes, unhealthy complements) were constructed following the procedure described in Anderson (2008), using the Stata command developed by (Schwab *et al.*, 2020): targeted foods, unhealthy complements, healthy substitutes, unhealthy substitutes.[7] As pre-specified, we calculate sharpened q-values to correct for multiple hypothesis testing among the primary outcomes (the index of targeted foods, measured at first, second, and third follow-up).

We finally pre-specified tests for heterogeneous effects on the main study outcomes. Rather than using a machine learning technique like generalized random forests Athey *et al.* (2018) to find variables, we instead use variables that could affect the efficacy of the intervention, or could be used in targeting for an expanded program. We hypothesize that ownership of a refrigerator could make the intervention more effective, and fo targeting purposes we also estimate heterogeneous effects by demographics (sex, age category) and income (below median income, experience of food insufficiency). We consider the heterogeneity analysis as exploratory, as we did not design the trial with sample sizes required to rigorously test these hypotheses. As a result, this part of the analysis does not apply corrections for multiple hypothesis testing.

[6]The registered pre-analysis plan specified that in addition to the ANCOVA specification described here, a version that included baseline controls selected via post-double selection LASSO would also be estimated (Belloni *et al.*, 2013). However, selecting controls in this way greatly complicates the estimation of Lee bounds. Further, (Cilliers *et al.*, 2024) show that adding controls from LASSO selection often does not reduce the variance of the estimation process much. So it is not surprising that estimates of treatment effects from models including these controls are qualitatively identical to those estimated from models that include only the outcome measured at baseline. These results are available from the authors upon request.

[7]The four indices are constructed from the following variables, respectively: any consumption by a household member of eggs, UHT milk, and unflavored yogurt over the past seven days and the number of days each of these foods was consumed by a member of the household; number of days sugar, and number of days chips, were consumed over the past seven days, expenditures on each of these foods; number of days non-UHT milk, and number of days chicken, were consumed over the past seven days, expenditures on each of these foods; number of days soda, juice, and flavored yogurt were consumed over the past seven days

4 Results

4.1 Coupon Redemption Rates

Overall, 93% of the distributed coupons were redeemed. This high redemption rate underscores the acceptability and accessibility of the intervention among the target population. Most coupons (57%) were used to purchase eggs, while (28%) were used to purchase milk, and just (15%) were used to buy yogurt (Figure 3).

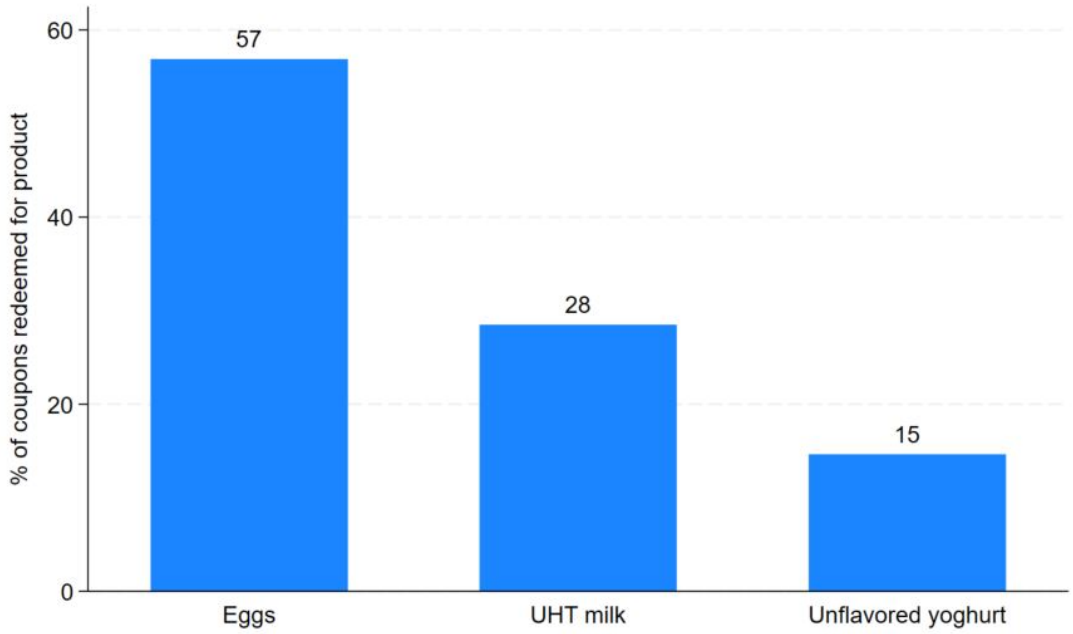

Figure 3: Coupon redemption by product

4.2 Baseline Balance and Attrition

The data demonstrate a high degree of balance, with only three out of fifty baseline comparisons showing statistically significant differences between treatment arms, and joint tests for differences across groups are insignificant (***Table A1***).

Lower attrition rates (between 4 and 5.3 percentage points) were observed among treatment group households in the primary sample relative to their control counterparts (***Table A2***). This pattern may be due to the high level of engagement with treatment group households during the intervention, specifically through the weekly delivery of coupons. To account for the effects of differential attrition in the analysis, we estimate Lee

bounds of treatment effects in the primary sample. This approach drops observations from the experimental group with lower attrition (in our case, the treatment group). To obtain the upper bound, we trim the smallest outcomes the treatment sub-sample to make the treatment and control groups the same size, and the lower bound is obtained by similarly dropping the highest values of the treatment sub-sample until the treatment and control groups are the same size. To account for stratified treatment assignment, this trimming is applied per ward. Observations with the same outcome value are randomly selected for trimming across 1,000 iterations, and means values of bounds across these iterations are reported. Attrition is balanced across the neighbors of treated and untreated primary households.

4.3 Consumption of Targeted Foods

The results show the voucher intervention had a strong impact on the consumption of targeted nutrient-dense foods during the intervention (Table 1, Panel A). Treated households consumed eggs on average 2.36 more days per week, milk 1.63 more days, and yogurt 0.81 more days relative to the control group, with all effects significant at the 1% level. Since we are interested in the consumption of any additional nutrient dense foods, we choose to both report and interpret the impacts of the intervention on consumption of any milk, whether UHT or not. Nonetheless, during the intervention period we observe the days that UHT milk are consumed are higher, at 1.76 days per week.[8] Relative to the control means, these effects are large in magnitude and substantiate the central hypothesis that subsidies can alleviate economic barriers to consumption of high-nutrient foods in low-income settings.

More importantly, the data demonstrate the persistence of treatment effects into the medium term, with increased consumption of both eggs and milk observable both two weeks and nine months after the intervention ended. Two weeks post-intervention, we continue to observe positive impacts on consumption of eggs and milk; egg consumption increases by 0.283 days per week on average, while milk consumption increases by 0.223

[8] As pre-specified, we also create an index of target foods, relative to the control group, which measures standard deviations from mean control group consumption.

days per week (significant at the 10 percent level). These effects persisted 9 months after the intervention ended. By then, treatment households consumed eggs an 0.25 additional days per week, and milk an 0.31 additional days per week relative to those assigned to the control group. Sharpened q-values for the indices summarizing consumption of targeted goods are below 0.01 for all three rounds. It is possible that differential attrition between the treatment and control groups can explain a small portion of these estimated effects for eggs, as the midpoint of the lower and upper Lee bounds are slightly lower than the naive point estimates. Nonetheless, the midpoints remain positive at 0.17 days per week for eggs and 0.22 days per week for milk at 9 months post-intervention.

These sustained behavioral changes are consistent with the theory of habit formation and intertemporal consumption adjustment, as discussed in Charness and Gneezy (2009), Dupas (2011), and Atkin (2013). Notably, there was no significant effect on food consumption behavior among untreated neighboring households during the intervention or shortly thereafter, suggesting that behavioral diffusion through social networks was limited in this context. This finding reinforces earlier research distributing vouchers by Ambler *et al.* (2025), which emphasizes that direct participation and exposure to nutritional interventions are necessary for measurable dietary change.

4.4 Consumption of Substitutes and Complements

The findings do not indicate an impact on the frequency of consumption of healthy substitutes (chicken and non-UHT milk) during the intervention or 2 weeks after coupons could no longer be redeemed (Table 2).

We do, however, observe a marginally significant increase in the index representing the consumption of unhealthy substitutes (Table 3, column 4) both during the intervention and two weeks later. This finding suggests that treated households may have increased their total food intake, including items classified as unhealthy, potentially as a result of increased disposable income. Nonetheless, none of the individual coefficients on the three components (soda, juice, flavored yogurt) are statistically different from zero (columns 1-3), and the coefficient on neighbors' consumption of unhealthy substitutes is

also significant at the 10 percent level (row 2, column 4). While the lower bound of these effects are below zero in both rounds, the positive point estimates on all coefficients are consistent with the findings of Alderman (2016) and Popkin *et al.* (2020), who emphasize the phenomenon of dual risk in nutrition programs, where interventions improve the intake of one food group but can simultaneously increase the risk of unhealthy dietary substitution.

Further, we observe a statistically significant increase in the consumption of sugar added to milk and yogurt during the intervention phase (an increase of 0.79 days per week, on average, p <0.01; Table 3, column 5). This effect is robust to the application of Lee bounds. However, by 2 weeks after the intervention period, when the treatment effect on milk and yogurt consumption had fallen in magnitude, this effect was no longer detectable. This finding is corroborated in the index for unhealthy complements (column 7; composed of added sugar and chips), which has a positive statistically significant estimate during the intervention but no longer significant two weeks thereafter.

4.5 Impacts on Expenditures

While the frequency of consumption of targeted foods substantially increased, the associated expenditures did not increase in parallel. In particular, household expenditures on unflavored yogurt and non-UHT milk decreased during the intervention period, by 254 and 398 TSh respectively (p <0.05)–effects which persisted two weeks after the intervention (Table 4, columns 3 and 4). These declines likely reflect substitution from full-cost to subsidized purchases, and align with economic models of household demand, where price (or cost) reductions from subsidies lead to higher consumption but may simultaneously reduce average unit costs and aggregate expenditures de Janvry and Sadoulet (2006). The findings support the view that well-targeted subsidies can generate economic savings for low-income households while improving dietary quality. In contrast, neighboring households did not show statistically significant changes in expenditures, confirming that spillover effects were minimal and that subsidy benefits remained concentrated among direct beneficiaries. These dynamics are consistent with broader empirical findings in cash

transfer evaluations from Latin America and Sub-Saharan Africa (e.g. Stampini *et al.*, 2025; Tiwari *et al.*, 2016), where targeted subsidies altered both the composition and level of food expenditures without necessarily increasing total spending.

The total decrease in spending on targeted items amounted to 610-650 TSh, approximately 5% of the value of the weekly vouchers, indicating that this substitution effect was minimal. On the other hand, the fact that a substitution effect persisted beyond the end of the intervention period suggests that even for perishable foods such as yogurt, storage behavior should be considered when evaluating effects of subsidies for nutritious foods on consumption patterns.

4.6 Impacts on Preferences

To understand the mechanism behind the lasting effects of the intervention on consumption patterns, during the final follow-up survey, respondents were asked to rate, on a scale of one to ten, the taste of two foods targeted by the intervention (UHT milk and unflavored yogurt), and close substitutes for these foods (non-UHT milk and flavored yogurt). Respondents in the treatment group rated UHT milk an average of 0.62 points higher, and unflavored yogurt an average of 0.46 points higher, than those in the control group (Table 5, columns 1 and 2). There were no differences across treatment groups in the ratings of non-targeted items. These results, which remain statistically significant when accounting for imbalanced attrition across groups, provide additional evidence for a long-term effect of the intervention, and show that limited-duration interventions promoting specific foods can shift preferences toward healthier foods.

4.7 Heterogeneous Effects

We text explore whether treatment effects are heterogenous based on five potential mediating variables: access to refrigeration, the respondent's age, the respondent's gender, household income, and household food sufficiency at baseline (Table 6). The outcome for all regressions presented in this table is the index summarizing consumption of targeted foods shown in column 5 of Table 1. The interaction term should be considered additive

in these regressions.

First, we find that during the intervention period, treatment effects were stronger for households who had reported less than the sample median income at baseline, and for those who reported having insufficient food during at least one month of the year (Table 6, Panel A). The intervention more than made up for the relatively low consumption frequency of targeted foods among these households in the control group. However, these differential treatment effects were no longer present by two weeks post-intervention (Panel B). Indeed, the sign of the interaction effect reverses for households facing food insufficiency.

We find some evidence of medium term effects as well. The effect of the intervention at nine months is significantly larger in magnitude for households well-off enough to own a fridge at baseline (Panel C). We do not find any other significant interactions after nine months. This result suggests that while alleviating budgetary constraints is particularly important for improving the diets of low-income households, such households may not be able to sustain improvements to their diets once subsidies end.

5 Conclusion

The results revealed five key patterns with important implications for the design and evaluation of nutrition-sensitive programs.

First, the program significantly increased the consumption frequency of targeted nutritious foods– eggs, milk, and unflavored yogurt– during the intervention period. These increases were both statistically and economically significant, with treated households consuming these items between 0.8 and 2.4 additional days per week. Crucially, the effects persisted up to nine months post-intervention for some items, specifically eggs and milk, suggesting that temporary subsidies can engender medium- to long-term changes in dietary behavior. Impacts on respondent preferences for targeted items are also observed at nine months. These long-term impacts align with theoretical models of habit and taste formation and empirical evidence from similar interventions in comparable settings.

Second, while frequency of consumption rose, household expenditures on targeted foods did not increase in proportion and, in some cases, declined — most notably for yogurt and non-UHT milk. This pattern indicates a substitution effect wherein subsidized goods replaced previous full-cost purchases. The finding is consistent with predictions from consumer demand theory, and suggests that well-targeted subsidies can improve access to nutritious foods without imposing additional financial burdens.

Third, the intervention generated heterogeneous effects on non-targeted foods. Although consumption of healthy substitutes such as chicken remained unchanged, there was evidence of substitution toward unhealthy complements. For instance, consumption of added sugar and flavored yogurt increased significantly during and after the intervention, respectively. These patterns raise concerns regarding how much positive net dietary change occurs with an intervention to subsidize healthy diet components, and underscores the importance of considering broader food environments when designing targeted subsidy schemes. Moreover, it may highlight the need for behavior change communication to accompany subsidy programs such as this one.

Fourth, the study found limited evidence of spillover effects on neighboring households not directly exposed to the intervention. This finding suggests that direct participation is important for behavior change, and indirect behavioral diffusion through social networks was minimal in this context.

Fifth, the effect of the intervention was initially strongest for poorer and less food-secure households, but this differential impact was not sustained beyond the subsidy period. Indeed, impacts appeared to be longer-lasting for households with greater asset wealth. While short-term interventions have the potential to shift dietary habits for some people, budget constraints are a primary impediment for the poorest households.

In summary, the results demonstrate that targeted subsidies for nutrient-dense foods can produce sustained improvements in diet quality. However, the findings also highlight the need for holistic program design that anticipates behavioral responses, including potential substitution toward less healthy foods. Future interventions may benefit from integrating price subsidies with complementary components such as behavior change

communication, market-based incentives for supply chain integration, and nutritional education to promote balanced dietary improvements.

Our results suggest that subsidies for healthy foods could play a role in policies meant to improve diets. That said, implementing a voucher subsidy like this one is expensive, so it is important to find cost-effective ways of distributing vouchers and reimbursing merchants. Nonetheless, the results here and elsewhere (Ambler *et al.*, 2025) suggest that when implemented well, vouchers can lead to lasting diet changes.

One option would be to use existing cash transfer programs and either convert a small portion of those transfers to vouchers for healthy foods underrepresented in diets, or to add vouchers as amounts to be transferred increase. The results here suggest that it is also important to keep in mind whether targeted foods are typically consumed together with unhealthy complements. If so, then it would seem essential to pair vouchers with behavior change communication meant to make consumers aware of the dietary implications of adding sugar to foods, for example, when consuming healthy foods.

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Table 1: Impacts of Coupon Receipt on Consumption of Targeted Foods, past seven days, Temeke District, Tanzania

	(1)	(2)	(3)	(4)	(5)
Panel A: During intervention period					
	Days eggs	Days UHT milk	Days any milk	Days unflavored yogurt	Index target foods
Treated	2.355***	1.759***	1.635***	0.814***	1.192***
	(0.116)	(0.113)	(0.140)	(0.099)	(0.070)
Neighbor of Treated HH	0.001	0.063	-0.017	0.059	0.021
	(0.091)	(0.075)	(0.120)	(0.066)	(0.055)
Observations	1909	1913	1908	1912	1912
Upper bound	2.739	2.096	2.056	1.084	1.421
Lower bound	1.934	1.304	1.157	0.388	0.907
Control mean	0.775	0.407	1.235	0.501	-0.000
Panel B: Two weeks post intervention					
	(1)	(2)	(3)	(4)	(5)
	Days eggs	Days UHT milk	Days any milk	Days unflavored yogurt	Index target foods
Treated	0.283***	0.208**	0.223*	0.077	0.168**
	(0.093)	(0.090)	(0.123)	(0.067)	(0.067)
Neighbor of Treated HH	-0.083	-0.086	-0.060	-0.023	-0.043
	(0.081)	(0.068)	(0.115)	(0.048)	(0.056)
Observations	1874	1871	1869	1874	1873
Upper bound	0.548	0.438	0.551	0.239	0.354
Lower bound	-0.126	-0.210	-0.330	-0.235	-0.133
Control mean	0.771	0.445	0.929	0.310	0.000
Panel C: Nine months post intervention					
	(1)	(2)	(3)	(4)	(5)
	Days eggs	Days UHT milk	Days any milk	Days unflavored yogurt	Index target foods
Treated	0.248**	0.196**	0.308**	0.070	0.147**
	(0.100)	(0.078)	(0.128)	(0.074)	(0.060)
Observations	979	979	979	979	979
Upper bound	0.507	0.377	0.628	0.246	0.301
Lower bound	-0.165	-0.156	-0.186	-0.233	-0.095
Control mean	0.906	0.273	1.015	0.489	-0.000

Notes: OLS regressions of HH consumption treatment indicators. Standard errors in parentheses; * p< 0.1 ** p<0.05 *** p<0.01. Control variables include neighbor and ward (stratification bin) indicators and outcome at baseline. Expenditures winsorized at mean + 3 SD.

Table 2: Impacts of Coupon Receipt on Consumption of Healthy Substitute Foods, past seven days, Temeke District, Tanzania

	During intervention			**Two weeks post-intervention**		
	(1)	(2)	(3)	(1)	(2)	(3)
	Non-UHT milk	Days chicken	Index healthy subs	Non-UHT milk	Days chicken	Index healthy subs
Treated	-0.029	0.089	0.029	0.030	0.051	0.038
	(0.110)	(0.080)	(0.058)	(0.100)	(0.079)	(0.064)
Neighbor of Treated HH	-0.064	0.027	-0.016	-0.005	0.069	0.031
	(0.101)	(0.077)	(0.055)	(0.100)	(0.074)	(0.063)
Observations	1913	1911	1913	1874	1873	1874
Upper bound	0.239	0.289	0.178	0.275	0.262	0.210
Lower bound	-0.490	-0.226	-0.201	-0.448	-0.297	-0.256
Control mean	0.880	0.757	0.000	0.579	0.686	0.000

Notes: OLS regressions of HH consumption treatment indicators. Standard errors in parentheses; * p < 0.1 ** p<0.05 *** p<0.01. Control variables include neighbor and ward(stratification bin) indicators and outcome at baseline. Expenditures winsorized at mean + 3 SD.

Table 3: Impacts of Coupon Receipt on Consumption of Unhealthy Substitutes and Complements, past seven days, Temeke District, Tanzania

				Panel A: During intervention period			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Soda	Juice	Flavored yogurt	Index unhealthy subs	Added sugar	Chips	Index unhealthy comps
Treated	0.138	0.194	0.038	0.116*	0.794***	0.071	0.185***
	(0.107)	(0.123)	(0.041)	(0.068)	(0.166)	(0.078)	(0.069)
Neighbor of Treated HH	0.169*	0.052	0.048	0.106*	0.001	0.085	0.059
	(0.102)	(0.120)	(0.032)	(0.064)	(0.105)	(0.074)	(0.060)
Observations	1913	1913	1913	1913	1499	1913	1913
Upper bound	0.405	0.511	0.128	0.292	1.314	0.264	0.368
Lower bound	-0.323	-0.307	-0.126	-0.170	0.468	-0.264	-0.116
Control mean	0.913	1.133	0.100	0.000	0.760	0.641	-0.000
				Panel B: Two weeks after intervention			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Soda	Juice	Flavored yogurt	Index unhealthy subs	Added sugar	Chips	Index unhealthy comps
Treated	0.139*	-0.082	0.062**	0.127*	0.033	-0.016	0.004
	(0.079)	(0.105)	(0.026)	(0.076)	(0.092)	(0.063)	(0.063)
Neighbor of Treated HH	-0.067	-0.160*	0.015	-0.063	0.013	-0.005	-0.007
	(0.082)	(0.094)	(0.017)	(0.061)	(0.090)	(0.064)	(0.063)
Observations	1875	1875	1875	1875	1642	1875	1875
Upper bound	0.341	0.176	0.122	0.327	0.264	0.139	0.167
Lower bound	-0.222	-0.532	-0.033	-0.206	-0.148	-0.299	-0.286
Control mean	0.497	0.838	0.028	0.000	0.445	0.431	0.000

Notes: OLS regressions of HH consumption treatment indicators. Standard errors in parentheses; * p< 0.1 ** p<0.05 *** p<0.01. Control variables include neighbor and ward (stratification bin) indicators and outcome at baseline. Expenditures winsorized at mean + 3 SD.

Table 4: Impacts of Coupon Receipt on Expenditures, past seven days, Temeke District, Tanzania

				Panel A: During intervention period				
	(1) Eggs	(2) UHT milk	(3) Any millk	(4) Unflavored yogurt	(5) Non-UHT milk	(6) Chicken	(7) Sugar	(8) Chips
Treated	-98	7	-268	-254**	-398***	-461	-308	-297
	(189)	(145)	(273)	(128)	(142)	(386)	(206)	(199)
Neighbor of Treated HH	-29	32	124	35	-103	100	-195	-117
	(203)	(160)	(278)	(142)	(164)	(428)	(224)	(219)
Observations	2095	2095	2095	2095	2095	2095	2095	2095
Upper bound	365	356	428	48	-71	487	243	192
Lower bound	-824	-551	-1192	-720	-932	-1874	-1018	-1022
Control mean	1763	1103	3128	1150	1225	4151	3226	2092
				Panel B: Two weeks after intervention				
	(1) Eggs	(2) UHT milk	(3) Any millk	(4) Unflavored yogurt	(5) Non-UHT milk	(6) Chicken	(7) Sugar	(8) Chips
Treated	-267	-141	-358	-315***	-295**	-501	-219	-376**
	(175)	(148)	(249)	(115)	(133)	(306)	(244)	(168)
Neighbor of Treated HH	103	59	94	58	96	491	361	93
	(188)	(154)	(254)	(124)	(146)	(331)	(260)	(178)
Observations	2095	2095	2095	2095	2095	2095	2095	2095
Upper bound	205	246	315	-29	32	321	498	60
Lower bound	-923	-706	-1307	-709	-726	-1627	-1058	-993
Control mean	1916	1307	2813	1036	1052	3491	3675	1713

Notes: OLS regressions of outcomes on treatment indicators. Standard errors in parentheses; * p< 0.1 ** p<0.05 *** p<0.01. Indices are constructed per period based other outcomes reported following Anderson (2008). Control variables include neighbor and ward (stratification bin) indicators and outcome at baseline. Expenditure values are Winsorized at mean + 3 SD. Lee bound confidence intervals are the mean 95% CI bounds from 1000 replications dropping the highest and lowest portion of the outcome distribution, with tied observations selected randomly.

Table 5: Impacts of Coupon Receipt on Preferences, nine months post-intervention, Temeke District, Tanzania

	(1) UHT milk	(2) Unflavored yogurt	(3) Fresh milk	(4) Flavored yogurt
Treated	0.619***	0.464**	0.118	-0.062
	(0.175)	(0.219)	(0.150)	(0.238)
Observations	881	837	953	774
Upper bound	1.224	1.215	0.690	0.762
Lower bound	0.253	0.034	-0.240	-0.529
Control mean	7.564	6.679	8.277	6.601

Notes: OLS regressions of HH consumption treatment indicators. Standard errors in parentheses; * p<0.1 ** p<0.05 *** p<0.01. Control variables include neighbor and ward (stratification bin) indicators and outcome at baseline. Expenditures winsorized at mean + 3 SD.

Table 6: Heterogenous Treatment Effects, Impacts of Coupons on Outcomes, Temeke District, Tanzania

Outcome: Index target foods					
Panel A: During intervention period					
	(1)	(2)	(3)	(4)	(5)
	Fridge	Below median age	Female	Below median income	Insufficient food
Treated	1.220***	1.225***	1.202***	1.088***	1.073***
	(0.087)	(0.089)	(0.125)	(0.096)	(0.100)
Heterogeneity variable	0.190**	0.058	-0.091	-0.215***	-0.079
	(0.092)	(0.088)	(0.094)	(0.083)	(0.087)
Treated x Heterogeneity	-0.066	-0.080	-0.018	0.251*	0.242*
	(0.146)	(0.145)	(0.151)	(0.140)	(0.140)
Observations	1912	1912	1912	1912	1912
Control mean	-0.144	-0.031	0.063	0.127	0.080
Panel B: Two weeks after intervention					
	(1)	(2)	(3)	(4)	(5)
	Fridge	Below median age	Female	Below median income	Insufficient food
Treated	0.097	0.275***	0.142	0.161*	0.230**
	(0.072)	(0.095)	(0.120)	(0.090)	(0.095)
Heterogeneity variable	0.265***	0.033	-0.133	-0.004	-0.066
	(0.096)	(0.086)	(0.094)	(0.087)	(0.086)
Treated x Heterogeneity	0.203	-0.265**	0.039	0.015	-0.119
	(0.150)	(0.130)	(0.145)	(0.135)	(0.134)
Observations	1873	1873	1873	1873	1873
Control mean	-0.177	-0.020	0.090	0.048	0.074
Panel C: Nine months post intervention					
	(1)	(2)	(3)	(4)	(5)
	Fridge	Below median age	Female	Below median income	Insufficient food
Treated	0.029	0.162**	0.142	0.126	0.193**
	(0.064)	(0.079)	(0.105)	(0.087)	(0.088)
Heterogeneity variable	0.033	0.019	-0.171*	-0.251***	-0.042
	(0.096)	(0.088)	(0.091)	(0.087)	(0.089)
Treated x Heterogeneity	0.318**	-0.039	0.007	0.059	-0.100
	(0.135)	(0.122)	(0.127)	(0.116)	(0.120)
Observations	979	979	979	979	979
Control mean	-0.099	-0.017	0.108	0.133	0.073

Notes: OLS regressions of HH consumption treatment indicators. Standard errors in parentheses; * p< 0.1 ** p<0.05 *** p<0.01. Control variables include neighbor and ward (stratification bin) indicators and outcome at baseline. Expenditures winsorized at mean + 3 SD.

6 Appendix

Table A.1: Group means and balance at baseline

Variable	**Primary Sample**			**Spillover Sample**		
	(1) Control	(2) Treatment	(1)-(2)	(3) Control	(4) Treatment	(3)-(4)
Age	41.9	43.0	-1.14	38.9	38.9	0.05
	(0.65)	(0.65)		(0.64)	(0.60)	
Gender	1.3	1.4	-0.01	1.1	1.2	-0.01
	(0.02)	(0.02)		(0.02)	(0.02)	
Completed at least primary education	0.9	0.9	0.04**	0.9	0.9	-0.02
	(0.01)	(0.01)		(0.01)	(0.01)	
Completed at least secondary education	0.3	0.3	0.03	0.2	0.3	-0.04
	(0.02)	(0.02)		(0.02)	(0.02)	
Completed any tertiary education	0.1	0.1	0.03	0.0	0.0	-0.01
	(0.01)	(0.01)		(0.01)	(0.01)	
HH monthly income (000s)	193.1	172.5	20.63	98.5	117.2	-18.70*
	(12.61)	(11.99)		(6.33)	(8.07)	
HH weekly food exp (000s)	64.8	63.0	1.80	55.9	62.4	-6.44**
	(2.38)	(1.78)		(1.35)	(2.58)	
Days eggs	1.1	1.1	-0.04	0.9	1.0	-0.05
	(0.07)	(0.07)		(0.07)	(0.07)	
Days UHT milk	0.4	0.4	-0.04	0.2	0.3	-0.05
	(0.06)	(0.06)		(0.04)	(0.05)	
Days unflavored yogurt	0.4	0.3	0.06	0.3	0.3	0.07
	(0.05)	(0.05)		(0.05)	(0.04)	
Expenditure eggs	1596.4	1449.4	146.99	1153.5	1119.4	34.15
	(124.27)	(107.13)		(99.57)	(96.42)	
Expenditure UHT milk	480.2	476.7	3.58	299.5	276.4	23.06
	(71.61)	(68.45)		(57.84)	(54.01)	
Expenditure unflavored yogurt	475.6	438.9	36.65	456.3	348.1	108.22
	(63.01)	(57.93)		(61.54)	(51.75)	
Days chips	1.1	1.1	0.02	1.0	0.9	0.06
	(0.07)	(0.07)		(0.07)	(0.07)	
Expenditure chips	6.9	6.8	0.13	6.7	6.6	0.04
	(0.07)	(0.07)		(0.06)	(0.06)	
Days added sugar	0.6	0.7	-0.11	0.6	0.6	-0.02
	(0.06)	(0.07)		(0.06)	(0.07)	
Expenditure sugar	1998.1	1996.5	1.60	1916.0	1727.8	188*
	(77.83)	(75.15)		(71.16)	(73.46)	
Days HH consumed any non-UHT milk	0.9	0.9	-0.02	0.7	0.8	-0.12
	(0.08)	(0.09)		(0.07)	(0.08)	
Expenditure non-UHT milk	830.6	773.7	56.86	524.6	690.7	-166.17
	(106.60)	(100.49)		(81.24)	(99.95)	
Days any milk	1.2	1.2	0.00	0.9	1.0	-0.09
	(0.09)	(0.10)		(0.08)	(0.09)	
Expenditure any milk	3207.1	3061.8	145.32	2728.7	2640.5	88.20
	(252.60)	(247.78)		(248.17)	(248.07)	
Days chicken	1.1	1.2	-0.04	1.0	1.0	-0.02
	(0.07)	(0.07)		(0.07)	(0.07)	
Expenditure chicken	3725.3	3335.1	390.18	3066.2	2906.6	159.65
	(250.61)	(230.64)		(222.22)	(222.64)	
Days soda	1.2	1.1	0.07	1.0	1.0	-0.01
	(0.08)	(0.08)		(0.08)	(0.08)	
Days juice	1.7	1.8	-0.13	1.6	1.6	-0.01
	(0.10)	(0.10)		(0.10)	(0.10)	
Days flavored yogurt	0.1	0.1	-0.08**	0.1	0.1	-0.05
	(0.02)	(0.03)		(0.02)	(0.03)	
Expenditure flavored yogurt	62.0	97.6	-35.59	67.6	116.1	-48.52
	(16.82)	(21.70)		(17.49)	(24.93)	
p-value, joint test			0.227			0.202
Observations	522	527	1049	492	488	980

Notes: Individual significance levels are based on per-variable t-tests comparing means across groups, based on an OLS regressions with ward (stratification bin) dummies. Joint test statistics are from a regression of the treatment indicator on all covariates. Standard errors are shown in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Attrition by round and treatment group

	(1) During intervention	(2) 2 weeks post-intervention	(3) 9 months post-intervention
Treated	-0.041***	-0.053***	-0.040**
	(0.016)	(0.017)	(0.016)
Neighbor of Sampled HH	0.025	-0.003	
	(0.019)	(0.020)	
Neighbor of Treated HH	-0.021	0.020	
	(0.019)	(0.020)	
Observations	2095	2095	1058
Control Mean	0.105	0.116	0.095

Notes: OLS regressions of attrition on treatment indicators. Standard errors in parentheses; * p< 0.1 ** p<0.05 *** p<0.01. Ward (stratification bin) indicators included as controls.

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