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Supplementary Materials for

Targeting health subsidies through a non-price mechanism: A randomized controlled trial in Kenya

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Materials and Methods

<u>Experimental design</u>

The research team partnered with three local shops near the clinics where respondents were recruited, and staff at one of the clinics (which was located too far from any shop), to provide WaterGuard in exchange for vouchers. Redemption points were monitored to ensure stock-outs would not prevent voucher redemption, and shopkeepers and nurses were trained to collect voucher stubs and to record the unique ID assigned to each voucher along with its redemption date. This information was collected every two weeks by the research team.

Three to five months after enrollment, enumerators visited study participants in their homes to assess whether the water treatment solution, if obtained, was in use, and conducted a survey on household water treatment practices. Enumerators used HACH colorimeters to test for the presence of residual total chlorine in the household water supply. Protocols used for water testing were identical to those described in the appendix of Kremer et al. *(47)*. Chlorine decays over time after it is added to water, and may reach undetectable levels after 24 hours. Because most people store their water for two to three days after treating it, we would expect some treated water to test negative for residual chlorine. Thus, observed residual chlorine in the water, used here as a measure of chlorine solution usage, is a lower bound on actual usage *(48)*.

Political violence in Kenya at the time of the December 2007 presidential election delayed follow-up data collection for the 32% of study participants enrolled prior to the period of this unrest. The average gap between baseline and follow-up for these participants is 139 days (4.5 months), whereas the average gap for those enrolled after the post-election crisis is 109 days (3.6 months).

Attrition in the follow-up survey was non trivial, given that respondents recruited through clinics were traced at their homes, but not differential by treatment arms. Including both respondents who were not interviewed (9.8% of the sample), and those who had no water stored at the time of the survey and whose usage could therefore not be verified (a further 3.4%), and controlling for baseline covariates shown in Table S1 and stratification variables, attrition was 12.8% in the *COST SHARING* group, 11.8% in the *VOUCHERS* group, and 13.4% in the *FREE DELIVERY* group; the p-values are 0.586 and 0.736 respectively for the test of equality in attrition rates between COST *SHARING* and each of the other groups. Unadjusted rates (p-values) for the *VOUCHERS* and *FREE DELIVERY* groups are 12.0% (0.7504) and 14.0% (0.633). This suggests that selection bias is unlikely to account for the differential outcomes across groups.

An additional 854 households were recruited in the same manner as those in the present study, and randomly assigned to two additional experimental arms intended to test a separate hypothesis about whether receiving a free sample stimulated continued use. We exclude these two arms from the analysis since the amount of dilute chlorine they received was smaller: only one free 150 mL bottle was provided in a *FREE SAMPLE* arm, together with a sippy cup in a *BABY BOTTLE* arm, and not intended to last until the follow-up visit.

<u>Method for Calculation of Cost per Life and DALY</u>

We consider the case of a policymaker who estimates that a household treating its water with chlorine for one year saves 0.055 DALYs, or 0.18% of a statistical life, based on the reduction in mortality achieved through chlorination. This sets aside any possible value in reduction of morbidity. A policymaker could arrive at this figure using the under-five mortality rate in Kenya at the time of the study as estimated by the UN Inter-agency Group for Child Mortality Estimation (70.1 per 1000 live births) *(32)*, and the proportion of these due to diarrheal disease (20.5%) estimated by the Health Epidemiology Reference Group *(33)*. The policymaker could then multiply the diarrhea-specific child mortality rate by 0.39, based on Arnold and Colford's *(12)* estimate of a 29% (intent to treat) reduction in the risk of diarrhea, adjusted for an average compliance rate of 0.74. Assuming that the reduction in diarrheal deaths achieved through chlorine treatment of drinking water is proportional to diarrhea cases averted based on results from the Global Enteric Multicenter Study (GEMS), this calculation implies that consistently treating water with chlorine reduces the probability that a child dies in the first five years of life by 0.56 percentage points.

Multiplying this reduction in mortality risk by 1.62, the average number of children below the age of five years per household in our sample, results in a per-household reduction in the probability of a child death of 0.92% over five years, or 0.18% per year. The average age of child death due to diarrhea is 1.65 years, as calculated from Figure 1 in *(54)*. Using the standard assumption that healthy life expectancy at birth is 81.25 years, and applying a 3% discount rate to future years of life as is standard practice for computing DALY values *(55)*, each averted child death is equivalent to 30.28 DALYs *(56, 57)*.

This analysis neglects any potential community-wide benefits of reductions in transmission in diarrheal disease. Clearly one should interpret these estimates as rough, but even with a fair degree of adjustment it seems fairly clear that over a wide range of DALY valuations policymakers are likely to prefer a voucher system to free household delivery and vouchers to a subsidized price of 10 Ksh per bottle.

In this paper we compare the cost effectiveness of different approaches to distribution of point-of-use water treatment solution. These are likely to be the most relevant options for improving water safety in environments where incomes are low and population density is low, with few users per water source. Clearly, in environments with more users per water source and higher population density, community-level solutions such as spring protection, deep wells, chlorine dispensers, and piped water may become cost effective relative to the options examined here.

Supplementary Text

Characteristics of Study Sample and Randomization Check

In this section we provide descriptive statistics of the study sample at baseline, test for balance of these characteristic across treatment arms, and describe the primary outcomes among two treatment arms excluded from the main analysis.

Table S1 describes characteristics of the sample at baseline. Roughly half those visiting a clinic had a sick child who needed care, while the remainder brought their child for a routine visit such as well-baby check-ups or vaccinations. Almost all respondents are mothers of the child who was brought to the clinic; their average age is 24 years and they have eight years of education on average, corresponding to having completed primary school. Average GPS distance from their home to the clinic is 4 km *(49)*, and 68 percent walked to the clinic on the day of their visit. 30% of respondents report that they had used chlorine to treat their water in the past six months, and 21% report boiling in the past week. Note, however that previous work in the study area found no difference in E coli levels between households which reported boiling water and those which did not *(47)*, suggesting that self-reported water treatment may be greatly inflated by social desirability bias.

Table S1 presents tests of balance across the three experimental groups described in the paper. Characteristics generally appear balanced across treatments, with the exception that those in the *VOUCHER* and *FREE SAMPLE* groups are approximately one year older than those in the *COST SHARING* group. One of the 33 comparisons are significant at the five percent level, no more than one would expect if treatment were random. There are also differences across treatments in the proportion of respondents for whom the clinic visit was prompted by illness versus routine care, and whether the respondent walked to the clinic, but neither of these are large in magnitude or significant at the 5% level.

<u>Determinants of Take-up and Results by Months Since Enrollment</u>

This section explores the mechanisms behind the main results presented in the paper. First, we investigate the targeting of water treatment solution in the *COST SHARING* and *VOUCHERS* groups, to understand which potential users are screened out through these two mechanisms. Second, we present results on usage, disaggregated by the time elapsed between enrollment and the follow-up survey, to assess whether the strong performance of the *VOUCHERS* treatment relative to *FREE DELIVERY* was driven by some households in the *FREE DELIVERY* arm running out of chlorine.

To understand which households access water treatment under the two screening approaches tested in the paper, Table S2 shows the relationship between household wealth and take-up of water treatment solution in the *COST SHARING* and *VOUCHERS* groups. For each of these treatment group, variables indicating procurement of at least one bottle of WaterGaurd at least two, and the total number procured, are regressed on a wealth index plus baseline controls from table S1, excluding whether the participant walked to the clinic on the day of recruitment *(50)*. The wealth index was constructed using data from the follow-up survey, and is simply a count of the number of distinct assets owned by the household *(51)*.

We see the expected relationship between wealth and willingness to pay in the COST SHARING group: one additional point on the asset index corresponds to a 2.2 percentage point increase in the likelihood of buying at least one bottle of WaterGuard, and an increase of 0.037 bottles purchased in total ($p<0.1$). In contrast, household wealth is negatively associated with take-up in the *VOUCHERS* group. While wealth level has no bearing on whether a participant redeemed at least one voucher (almost all did), those with a lower asset score were significantly more likely to redeem at least two vouchers ($p<0.05$). When considering the total number of vouchers redeemed, the relationship between wealth and redemption is not statistically significant, indicating that other personal and household characteristics may be more important predictors of sustained demand for water treatment.

The main result in the paper is that a voucher-based screen imposes very few errors of exclusion relative to free delivery. According to the original study design, the follow-up survey should have occurred three months after enrollment, but civil unrest in the study area caused a delay in follow-up for some households. As a result, the time between receiving the first 500 mL bottle of chlorine (in the *FREE DELIVERY* group), the booklet of 12 vouchers (in the *VOUCHERS* group), or the opportunity to purchase up to five bottles of chlorine (in the *COST-SHARING* group) ranged from three to five months. If households used chlorine at the rate of one month per bottle as suggested by PSI, those in the *FREE DELIVERY* group who were surveyed toward the end of this period would have already run out of chlorine. This is in contrast to those in both the *VOUCHERS* group, who had access to a 12-month supply through voucher redemption, and the *COST SHARING* group, who had the option of buying up to five bottles at enrollment.

To examine whether our results are driven by the *FREE DELIVERY* group running out of chlorine prior to the follow-up survey, Table S3 replicates the verified usage results shown in Table 2, separately by months since enrollment. There is some evidence that the relative performance of the *VOUCHERS* intervention improves with the time since enrollment, consistent with some households in the *FREE DELIVERY* arm running out of their initial supply of chlorine solution. The finding that the adjusted gap in usage is only 1.4 percentage points at three months since enrollment, and only 2.7 points at 4 months, however, confirms the main result from Table 2, which is that the *VOUCHERS* intervention has a minimal effect on errors of exclusion, despite greatly reducing errors of inclusion. As in the main analysis, comparing raw means by month yields results very similar results.

While the share of households with verified chlorine in their stored drinking water is comparable between the *VOUCHERS* and *FREE DELIVERY* group, we cannot know whether those who use chlorine under the *FREE DELIVERY* scheme would be those who use chlorine under a *VOUCHERS* scheme. We can however test for whether the characteristics that predict verified chlorine vary across users in the two schemes. Table S4 performs this analysis. Those who select themselves into using chlorine under the two schemes are statistically indistinguishable from each other on almost all characteristics.

Finally, Table S5 provides summary statistics on whether the enumerator could physically see the Aquaguard bottle and found chlorine in it at the follow-up, overall and by month of follow-up. It also provides summary statistics on other self-reported outcomes for the study-provided chlorine bottle in all three groups. Among those surveyed after three months, as many as 72.6% of respondents could show a non-empty Aquaguard bottle to the enumerator, yet only 34.4% had verified chlorine in their stored drinking water at the time.

Supplementary Tables

Table S1.

Table S1. Baseline Characteristics and Balance Tests

	Experimental Arm:					
	COST SHARING	*VOUCHERS*	*FREE DELIVERY*			
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	P-val (*VOUCHERS* = *COST SHARING*)	P-val (*DELIVERY* = *COST SHARING*)	P-val (*VOUCHERS* = *DELIVERY*)
Characteristics of Clinic Visit during which Respondent was sampled						
Visit prompted by illness (not routine care)	0.45	0.48	0.51	0.293	0.083	0.488
Distance from home to clinic (km)	4.02	3.97	4.11	0.643	0.810	0.473
	(2.91)	(4.01)	(3.17)			
Walked to clinic	0.68	0.71	0.65	0.434	0.423	0.106
Characteristics of Respondent						
Female	0.99	1.00	0.99	0.298	0.749	0.165
Age (in years)	23.39	24.41	23.99	0.018	0.153	0.333
	(5.40)	(5.73)	(5.10)			
Years of Education	8.58	8.57	8.57	0.949	0.959	0.905
	(2.66)	(2.61)	(2.80)			
Baseline Health Behavior						
Gave birth at health facility (last birth)	0.36	0.35	0.38	0.708	0.711	0.446
Child slept under a bednet previous night	0.82	0.83	0.86	0.490	0.155	0.458
Boiled drinking water last week	0.21	0.21	0.21	0.803	0.971	0.827
Used chlorine in past 6 months	0.29	0.31	0.29	0.505	0.915	0.428
Bought chlorine in past 6 months	0.24	0.27	0.26	0.331	0.507	0.750
Observations (Cost-Sharing, Vouchers & Free Delivery = 1118)	351	382	385			

Sources: Baseline survey; GPS data from follow-up home visit used to calculate distance from home to clinic.
Note: p-values are from separate linear regressions of each baseline variable on treatment group indicators, with controls for recruitment wave and clinic.

Table S2.

Table S2. Wealth and take-Up

	(1)	(2)	(3)	(4)	(5)	(6)
	COST SHARING			*VOUCHERS*		
	Purchased at least one bottle at clinic	Purchased at least two bottles	Number of bottles purchased	Redeemed at least one voucher	Redeemed at least two vouchers	# of vouchers redeemed (0 if none)
Asset index	0.022*	0.005	0.037*	-0.008	-0.021**	-0.061
	(0.013)	(0.009)	(0.022)	(0.008)	(0.011)	(0.093)
Observations	315	315	315	347	347	347
R-Squared	0.068	0.064	0.067	0.053	0.097	0.108

Notes: Standard errors in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Coefficients are from linear regressions of each outcome variable among participants in the relevant treatment group on household asset index, controlling for clinic, enrollment wave, time since interview, and baseline controls shown in Table S1, excluding whether the respondent had walked to the clinic at the time of enrollment since that is highly correlated with the asset index.

Table S3.

Table S3. Proportion testing positive at follow-up by month since enrollment

	COST SHARING	*VOUCHERS*	*FREE DELIVERY*	*Obser-vations*	*P-value, PRICE vs. VOUCHERS*	*P-value, PRICE vs. FREE DELIVERY*	*P-value, VOUCHERS vs. FREE DELIVERY*
Surveyed 3 months after enrollment				293			
Raw means	0.156	0.404	0.427		0.000	0.000	0.731
	(0.042)	(0.050)	(0.046)				
Adjusting for baseline controls	0.156	0.386	0.404		0.002	0.001	0.790
	(0.042)	(0.085)	(0.082)				
Surveyed 4 months after enrollment				475			
Raw means	0.127	0.326	0.323		0.000	0.000	0.959
	(0.027)	(0.035)	(0.041)				
Adjusting for baseline controls	0.127	0.308	0.341		0.000	0.000	0.510
	(0.027)	(0.053)	(0.057)				
Surveyed 5 months after enrollment				185			
Raw means	0.091	0.267	0.243		0.013	0.017	0.778
	(0.036)	(0.067)	(0.067)				
Adjusting for baseline controls	0.091	0.272	0.241		0.009	0.031	0.510
	(0.036)	(0.078)	(0.062)				

Notes: Adjusted differences are computed from regression of outcome on treatment indicators controlling for clinic, enrollment wave, time since interview, and baseline controls shown in Table S1. Standard errors in parentheses.

Table S4.
Baseline Determinants of Chlorine Usage: Do they differ between the *VOUCHER* and *FREE* delivery treatments?

	Positive Chlorine Test at Follow-up
Visit prompted by illness (not routine care)	-0.050
	(0.054)
x VOUCHER TREATMENT	**0.040**
	(0.076)
Distance from home to clinic (km)	-0.011
	(0.009)
x VOUCHER TREATMENT	**-0.003**
	(0.012)
Walked to clinic	-0.127**
	(0.061)
x VOUCHER TREATMENT	**0.109**
	(0.085)
Age (in years)	0.000
	(0.005)
x VOUCHER TREATMENT	**0.014****
	(0.007)
Years of Education	-0.001
	(0.011)
x VOUCHER TREATMENT	**0.008**
	(0.016)
Asset index	0.013
	(0.012)
x VOUCHER TREATMENT	**-0.010**
	(0.017)
Gave birth at health facility (last birth)	0.033
	(0.057)
x VOUCHER TREATMENT	**-0.033**
	(0.079)
Child slept under a bednet previous night	-0.138*
	(0.078)
x VOUCHER TREATMENT	**0.116**
	(0.103)
Boiled drinking water last week	-0.032
	(0.064)
x VOUCHER TREATMENT	**0.069**
	(0.090)
Used chlorine in past 6 months	-0.047
	(0.160)
x VOUCHER TREATMENT	**0.087**
	(0.203)
Bought chlorine in past 6 months	0.201
	(0.166)

x VOUCHER TREATMENT	**-0.205**
	(0.212)
Reports child had diarrhea in past 7 days	0.089*
	(0.054)
x VOUCHER TREATMENT	**-0.036**
	(0.076)
P-value, Joint test for all interaction terms	0.500

Notes: N=663. Sample restricted to those assigned to FREE DELIVERY or VOUCHER treatments. Depdendent variable is a dummy equal to 1 if the household water container tests positive for chlorine at follow-up. This is regressed on baseline characteristics as well as interactions for the baseline characteristics and being assigned to the VOUCHER treatment. Most of the interaction coefficients are not significantly different from zero, suggesting that chlorine users under the VOUCHER treatment are similar on observables to chlorine users under the FREE delivery treatment.

Table S5.

Table S5. Status of study-provided chlorine at time of follow-up

	COST SHARING	*VOUCHERS*	*FREE DELIVERY*
All those surveyed at follow-up			
Currently has non-empty Aquaguard bottle on compound			0.627
Reports giving bottle/coupons away	0.022	0.205	0.118
Declares running out of chlorine	0.108	0.055	0.151
Surveyed 3 months after enrollment			
Currently has non-empty Aquaguard bottle on compound			0.726
Reports giving bottle/coupons away	0.038	0.176	0.137
Declares running out of chlorine	0.150	0.108	0.136
Surveyed 4 months after enrollment			
Currently has non-empty Aquaguard bottle on compound			0.628
Reports giving bottle/coupons away	0.025	0.209	0.117
Declares running out of chlorine	0.130	0.052	0.144
Surveyed 5 months after enrollment			
Currently has non-empty Aquaguard bottle on compound			0.500
Reports giving bottle/coupons away		0.229	0.077
Declares running out of chlorine	0.056	0.000	0.244

Notes: Data from follow-up survey.