The Role of Social Signaling in Community Mass Deworming

Evidence from a Field Experiment in Kenya

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Abstract

This document describes the analysis plan for a randomized control trial (RCT) assessing the effectiveness of social incentives on adult deworming. Working with the Kenyan Government, we implemented a new community deworming program that offered free deworming treatment to adults and explicitly emphasized the public good aspect of deworming. We distributed two types of social incentives in the form of colorful bracelets and ink. The bracelets and ink made the decision to deworm or abstain from treatment observable and allowed adults to signal to others that they contributed to protecting their community from worms. We further introduced a calendar as private incentive that was comparable in its consumption value to the bracelet but could not easily be observed by others. Communities were randomized into being eligible for the ink, calendar or bracelet incentive or a control arm where no incentive was offered. In a second stage, we offered free text messages to a random subset of adults living in these communities, reminding them of the availability of free deworming treatment and providing information about deworming treatment take-up in their community. This pre-analysis plan outlines the empirical specifications, outcome variables, and covariates that will be considered in this analysis.

Contents

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1 Introduction

Over the last decade there has been important progress in the treatment of neglected tropical diseases (NTDs), as a result of unprecedented attention by governments, funders, and the private sector. The enduring prevalence of Soil Transmitted Helminths (STHs), however, still constitutes a massive development burden for both children and adults in many developing countries, including Kenya. Recent efforts to reduce contamination rates in the country have focused on deworming school-aged children, but the remaining reservoir of worms among the adult population fosters reinfection. Epidemiologists have recently postulated that it may be scientifically feasible to reach a transmission breakpoint for STHs[1].Preventing transmission and eliminating STHs using mass drug administration (MDA) covering the entire population, including children and adults, might be a viable strategy to eliminate worms moving forward.

This study explores cost-effective ways to achieve high deworming take-up among adults by offering free deworming treatment at central locations and incentives. The evaluation of the incentivized community deworming program relates three separate strands of the literature: compliance with mass drug administration (MDA), incentives and volunatry good contributions.

[1] Anderson, Roy, T Deirdre Hollingsworth, James Truscott, and Simon Brooker. 2012. Optimisation of Mass Chemotherapy to Control Soil-Transmitted Helminth Infection. Lancet 379 (9813). Elsevier Ltd: 289-90.

Different to previous MDA, this study is focused on deworming treatment at a central location, not through door-to-door visits. Kremer and Glennerster[2] observe that for preventive and non-acute care such as deworming, insecticide-treated bednet use and water chlorination there is a dramatic drop in demand at non-zero prices. Since a large number of people have such an abrupt cutoff at the same point, they conclude that they are not likely motivated by a simple cost-benefit analysis, but instead have a strong present bias; future benefits are heavily discounted compared to immediate benefits. One approach that has been widely tested and shown to be successful, is to provide a small reward when coming for treatment to offset any inconvenience costs individuals might face, as well as to address present bias. Kremer and Glennerster[3] review a wide number of studies on the use for incentives to increase education and health service take-up. They find strong evidence in favor of incentives compared to education only interventions.

One possibility is to incentivize compliance with MDA by focusing the program's message on social returns, emphasizing the benefit of taking treatment to reduce reinfection of community members, especially school-aged children. The community deworming program could therefore be viewed as a voluntary collective action game, where an individual's treatment compliance decision can be modeled as the decision to contribute to a pool shared by all community members. One approach to increase contribution in such a setting is to allow for signaling, thus introducing social approval/disapproval as a reward/punishment[4] [5].We are testing how social signaling can be leveraged to increase demand for deworming treatment among adults, by introducing two signals in the form of colourful ink and bracelets. Both allow individuals to show to others that they have taken deworming treatment.

This pre-analysis plan outlines our strategy to test the theory of social signaling through a randomized field experiment in the context of deworming decisions.

The remainder of this document is organized as follows. Sections 2 and 3 describe the intervention and research questions. Section 4 discusses the experimental design. Section 5 describes the different data collected and sample selection. Finally, Section 6 outlines the main empirical specifications.

[2]Glennerster, R., & Kremer, M. (2011). Small changes, big results: behavioral economics at work in poor countries. Boston Review: A Political and Literary Forum.

[3]ibid.

[4]Bénabou, Roland, and Jean Tirole. 2006. "Incentives and Prosocial Behavior." American Economic Review 96 (5): 1652-78.

[5]Bénabou, Roland, and Jean Tirole. 2011. "Laws and norms." No. w17579. National Bureau of Economic Research.

2 Intervention

Working with the Government of Kenya we offered free deworming treatment to adults in 3 counties in Western Kenya: Busia, Kakamega and Siaya County. Community Health Volunteers (CHVs) provided the treatment at central locations and sensitized households about the upcoming deworming treatment. CHVs informed all study communities one week prior to the start of the deworming treatment about the social benefits of deworming, when and where free deworming treatment will be available and if applicable what type of incentive will be given to adults when coming for treatment. Deworming treatment was subsequently offered at central locations for a period of 12 days.

We identified 144 central locations in the 3 selected counties. Central locations and their catchment areas were randomly assigned, in equal numbers, into one of four intervention arms: 1) CHVs mark adults' fingers with ink; 2) CHVs give adults a green wrist bracelet; 3) CHVs give adults a one-page calendar for 2017; 4) Only deworming treatment is provided and no incentive.

We mapped communities that fall within a 2.5 km catchment radius of the central location and randomly selected one community per catchment area. We conducted a census of all adults in those 150 communities and randomly selected 15 individuals in each control arm community to receive reminder text messages, and 15 (for control arm) or 25 (for ink/bracelet/calendar arms) individuals to receive reminder text messages that also contain information about deworming take-up in their community. Adults that signed up for the free text message service received a text message on the day before deworming started and on the 2nd, 4th, 6th, 8th and 10th day of deworming treatment. The text message service was free and individuals could unsubscribe at any time at no cost. The reminder messages contained the following content:

> Free deworming now at [Central Location]. Reply ___ to _____ stop texts. All texts are free.

The reminder and peer information about deworming take-up messages contained the following content:

> Free deworming now at [Central Location]. [No/few/almost half/half/more than half/almost all/all] of your village came, that is X in 10 adults. Reply ___ to _____ stop texts. All texts are free.

To verify that adults were reading the text messages, we offered an airtime reward of 50 Kenyan Shillings (50 US Cents) to a random subset of subscribers conditional on texting back and confirming the receipt of the text message.[6] The following reward text message was sent to adults on day 2 and 6 of deworming treatment:

> Thank you for signing up for this text message from Evidence Action. To receive your 50Ksh

[6] We only implemented the reward scheme during the second wave of deworming treatment. The reason being, we only decided to add the treatment shortly before we started deworming in wave one communities and had to wait for ethical approval for this added component before we could implement it.

airtime reward, message ___ to _____. The text is free.

We sent a reminder text messsage to adults that had not taken up the reward two days after the original reward text was sent:

> Thank you for signing up for text messages from Evidence Action. Don't forget to reclaim your 50Ksh airtime. Message ___ to _____ to receive the reward. The text is free.

The reminder messages were sent on day 4 (for reward messages sent on day 2) and on day 8 (for reward messages sent on day 6).

We split deworming treatment into two waves: wave one of deworming was implementedOctober 3rd to 14th in Busia and Siaya County, and wave two was implemented October 24th to November 4th in Kakamega County.

3 Research Questions

Our main questions are:

(I) Can social signaling incentivize adults to take up deworming treatment? That is, are adults more likely to seek deworming treatment if they can show to others that they did so?

(II) Are individuals' decision to deworm influenced by other people's deworming choices? That is, are adults more likely to seek deworming treatment if they can observe others come for treatment?

The experiment contains 9 treatment arms to separately identify these mechanisms, as shown in the below table.

Table 1: Cluster-level Treatment Arms

	Control	Ink	Calendar	Bracelet
No SMS	1	4	6	8
Reminder SMS	2	—	—	—
Reminder + Peer Info SMS	3	5	7	9

Below are the hypotheses we will investigate based on the cells in Table 1. A formal description of these hypotheses can be found in the Section 6.

1. *Incentive vs. no incentive treatment.*

   (i) The cluster randomization into different incentive arms allows us to identify the effect that social or private incentives have on deworming take-up, comparing 1 vs. 4, 6 or 8.

   (ii) Comparing 1 vs. 4 and 6 vs. 8 identifies the combined effect of social incentives (a) acting as reminders, (b) making observable others' deworming decision and thereby facilitating social learning and (c) allowing people to signal their decision.[7]

2. *Social incentives vs. no social incentives for text message treatment individuals.*

   Comparing individuals that received reminders and social information text messages in clusters without social incentives to individuals in clusters with social incentives, we identify the effect of social signaling on individuals' deworming decisions:

   (i) Comparing 3 vs. 4 we identify the effect of signaling using ink;

   (ii) Comparing 7 vs. 8 the effect of social signaling through bracelets.

3. *No text message treatment vs. text message reminders and social information.*

   Using the comparison from 1. where we identified the combined effect of reminders, social learning and social signaling and the comparison from 2. where we separately identified social signaling, we can identify the effect of reminders and social learning on deworming take-up:

   (i) Differencing 7 vs. 8 from 6 vs. 8 we identify reminder and social learning effects for ink;

   (ii) Differencing 3 vs. 4 from 1 vs. 4 we identify reminder and social learning effects for bracelets.

We will test for differences in reminder and social learning effects comparing (i) and (ii).

4. *Text message reminders and social information treatments vs. no text messages for no incentive individuals.*

   Comparing 1 vs. 2 and 2 vs. 3 allows us to identify the effect of reminders and information about others' treatment decisions on deworming take-up. The text message treatments within no incentive clusters allow us to identify the extent to which reminders or social learning are relevant for deworming take-up.

5. *Text message treatment with social information vs. no text messages for social incentive individuals.*

   Comparing 4 vs. 5 and 8 vs. 9 we identify the additional reminder and social learning effects of text messages in the presence of social incentives. The cross-treatments identify how "satiated" individuals are in terms of being reminded or informed about other people's decision through signals.

[7] We will first compare take-up for non-incentive vs. incentive clusters for the sample of phone and non-phone owners, excluding SMS treatment individuals. In a second step we will only focus on phone-owners to separate the different social incentive effects.

4 Experiment Design

4.1 Sampling and Identification Strategy

This study adopted a cluster randomized experiment to make causal inferences addressing our research questions. We selected three counties in western Kenya where soil transmitted helminths are endemic: Busia, Siaya and Kakamega. We then identified 158 clusters (communities) dispersed across the selected region. After various surveys identifying clusters where implementation would be infeasible, the study was reduced to 144 clusters. In each cluster, we conducted a census of all households and eligible adults (18 years or older).

All communities in the experiment were be provided with:

- Deworming treatment at a central location (point-of-treatment);
- An outreach campaign providing information on the location and duration of treatment, the incentives that would be offered, as well as framing the public good aspect of deworming.

We then randomly assigned treatment over cluster, stratified over counties and distance to the point-of-treatment.

From each cluster the following samples were selected (more details below):

- A baseline sample randomly selected from the entire cluster population;
- A sample of individuals to monitor the treatment of during the intervention including:
  - Text messaged individuals picked from the subpopulation of phone owners
    - Deworming reminders and
    - Information on peer deworming;
  - A stratified sample of phone and non-phone owners
    - Phone owners are used as controls for the text messaging treatment and
    - Non-phone owners selected to allow us to estimate impact of incentive treatment over the whole population.

  We used a stratified sample to make sure our text messaging control group has enough people.

  We split this sample into two groups:

  - Endline survey respondents (stratified between text message recipients and non-recipients);
  - Data use reconsent only individuals.

4.2 Clustered Design

The experiment was carried out in 18 subcounties in Western Kenya, randomized at the cluster level. A *cluster* was composed of

(i) a centralized *point-of-treatment (PoT)* at an easily identifiable location (e.g. near a church/mosque), and

(ii) a *targeted village* where we conducted an outreach campaign[8].

4.3 Experimental Manipulation

In the experiment there were two levels of randomized treatment assignment.

1. At the cluster level, there will be four groups:
   (i) a control group;
   (ii) a low/no private value, low visibility social incentive group: indelible ink mark on treatment compliers' hands;
   (iii) a private incentive group: wall calendars provided as gifts to treatment compliers;
   (iv) a high private value, high visibility social incentive group: colorful silicon bracelets will be provided as gifts to treatment compliers.
2. At the individual level, there will be three groups:
   (i) the control group, composed of a stratified sample of
      a. phone owners and
      b. non-phone owners;
   (ii) the text message reminder group: participants will receive regular messages on where and when treatment will be available;
   (iii) the text message and peer take-up information group: participants will receive regular messages on where and when treatment will be available, as well as the proportion of treatment take-up among others in their community.

4.4 Cluster Selection Algorithm

The selection of clusters (PoT and targeted villages) relied on geospatial data of primary schools in the targeted subcounties. While schools did not play a direct role in the study's implementation, they were used as proxies for the location of communities.

[8]Other communities were not denied treatment, but our analysis is focused on targeted villages.

Below is the main body of the selection algorithm:

1. Let C be the set of all potential clusters, defined as 2.5 kilometer radius circle centered on a primary school in the study region. In this study the size of this set is $|C| = 1,451$.
2. Let $\mathcal{R} := \emptyset$ be the set of clusters selected for the experiment
3. While $C \neq \emptyset$:
   a) Randomly pick $i \in C$
   b) Set $C := C \setminus \{i\}$
   c) If $(ClusterSize(i, \mathcal{R}) < ThresholdClusterSize) \vee (\exists j \in \mathcal{R}, ClusterSize(j, \mathcal{R} \cup \{i\}) < ThresholdClusterSize)$:
      i. Repeat Loop

      Else:

      i. Set $\mathcal{R} := \mathcal{R} \bigcup \{i\}$
4. If $|\mathcal{R}| < NumRctClusters$: Goto 1

$ClusterSize(m, \mathcal{M})$ is a function that returns the size of cluster m, removing any overlaps with the clusters in $\mathcal{M}$. We defined the size of a cluster to be the number of primary schools available in the non-overlapped 2.5 km circle around the cluster center (as a proxy of the available communities to target). We set the cluster size threshold to be 1 primary school[9].

While we use a 2.5 km circle to define the boundary of the area we will target communities within for treatment, when considering overlaps we assume points-of-treatment would have larger catchment areas, thus providing buffers between clusters. In order to fit the study's geographic area we randomly split the PoT to have 3 and 4 km catchment areas. Thus a targeted village would always be at least 0.5 km closer to its own assigned point-of-treatment than any other cluster's.

This first step of cluster selection yielded 158 clusters. Figure 1 shows the geographic location of all clusters. The center of each cluster (the point-of-treatment) is represented by a cross, and the grey regions are the catchment areas of each cluster not within the buffers we placed between clusters. Targeted villages were chosen within these catchment areas.

While the cluster point-of-treatments and targeted villages were initially selected as described above, their exact locations varied slightly before the intervention started. Figures 2, and 3 show the actual distribution of (i) the distance between targeted villages and their home points-of-treatment, (ii) the distance between targeted villages and their the closest other point-of-treatment, and (iii) the difference between (i) and (ii).

[9] To be exact we defined the threshold to be 60% of a 1 km radius circle around a school.

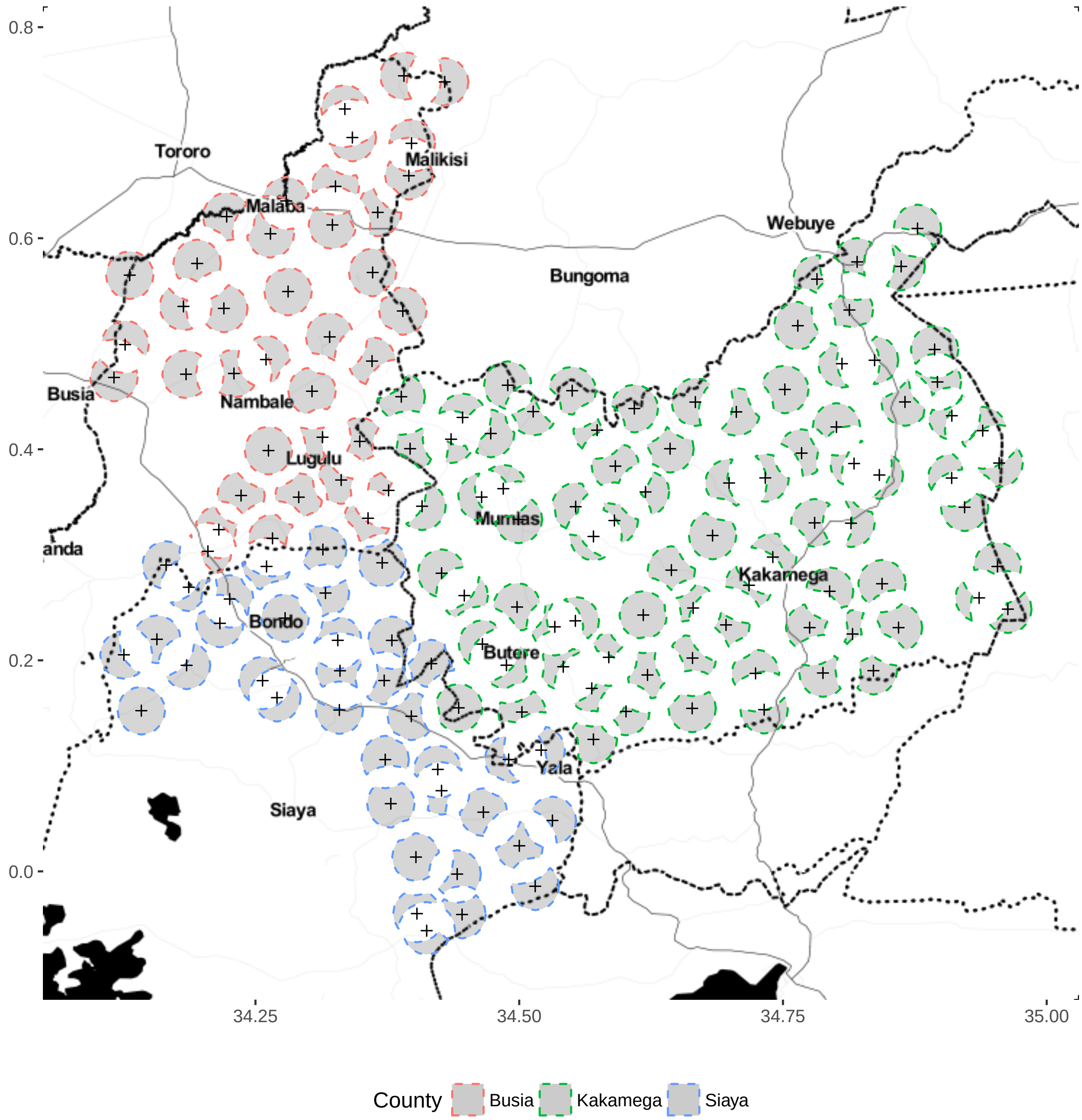

Figure 1: Map of Initial Cluster Selection

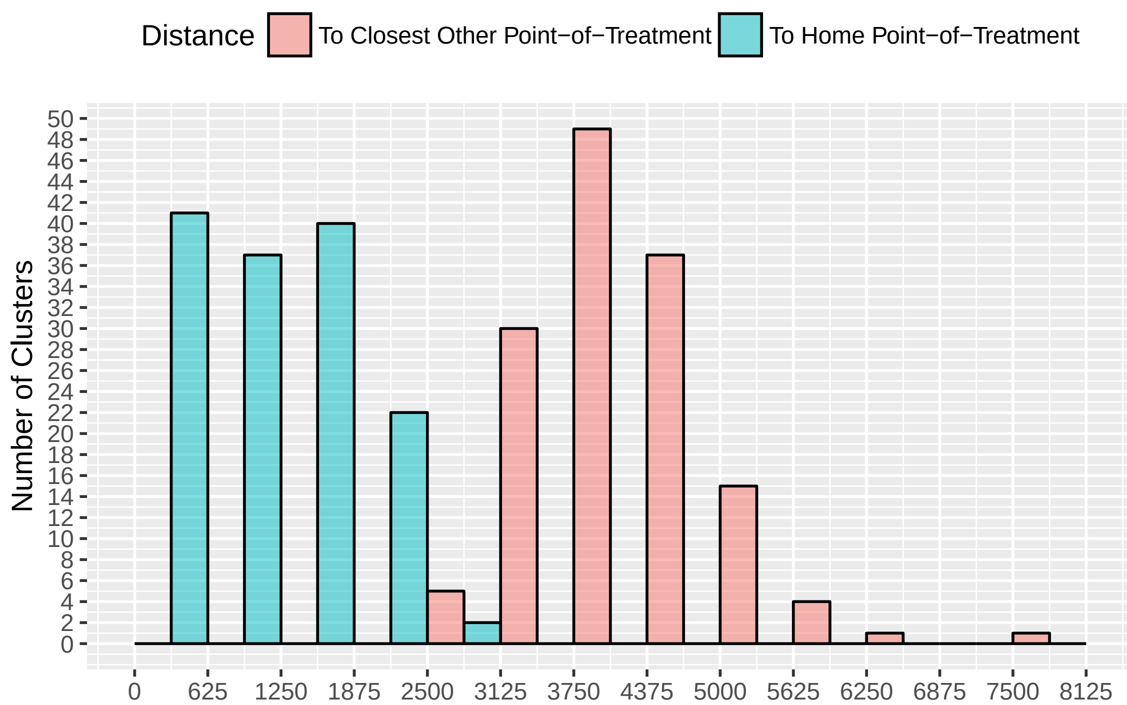

Figure 2: Distance to Points-of-Treatment

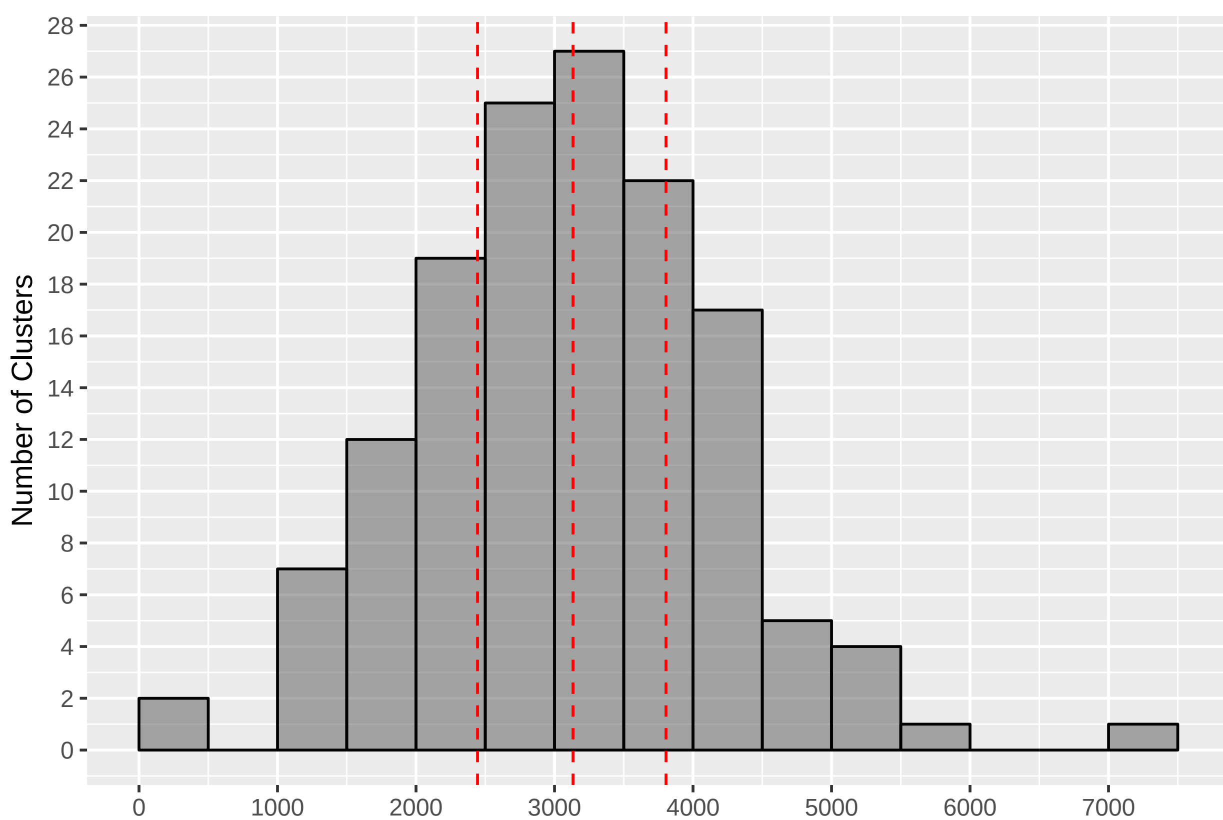

Figure 3: Marginal Distance to Closest Other Point-of-Treatment

4.5 Village and Point-of-Treatment Selection

Villages were randomly selected across clusters to give us an equal proportion of *close* and *far* village to point-of-treatment distances. Distances were categorized as *close* if less than 1250 meters and *far* otherwise. This split is half the upper range of the distance we observed people were generally willing to travel for deworming treatment. As explained above, these distances varied in response to implementation contraints, so after some clusters had to be dropped from the study, we ended up with approximately 46% of targeted villages being *far* from their point-of-treatment.

This random assignment of each cluster to the *close* or *far* group is considered orthogonal to any targeted village characteristics, since each village could have been assigned to either group with equal probability. In other words, we are exogenously varying the distance individuals in a targeted village would have to travel for treatment.

4.6 Treatment Assignment Mechanism

We used a stratified treatment assignment mechanism, whereby we stratified by (i) county and (ii) targeted village to point-of-treatment distance. Thus we had six strata within which we randomly assigned with equal probability one of four incentive treatments (control, indelible voting ink, calendars, and bracelets). For strata not divisible by four, we randomly assign, without replacement, one of the four treatments to the (stratum size % 4) remaining clusters (randomly picked)[10].

4.7 Power Calculation

Given an intracluster correlation (for the random effects logit latent model used in power analysis simulations) of 0.1 we will be able to detect a 10 percentage point difference in deworming take-up between any incentive treatment arm and the control group, and a 8 percentage point change between any two incentive treatment arms. We can further detect a 7 percentage point difference in deworming take-up within treatment arms between adults who received and did not receive a text message reminder/information about deworming take-up in their community, and a 9 percentage point change in demand between any two arms for adults that did receive the text messaging treatment.

[10] http://blogs.worldbank.org/impactevaluations/tools-of-the-trade-doing-stratified-randomization-with-uneven-numbers-in-some-strata

5 Data Collection and Sample Selection

5.1 Pre-Intervention

5.1.1 Census

A census of all households in *targeted villages* was conducted before the treatment intervention. It was used to randomly select households for surveying and further individual level interventions, as well as to monitor treatment take-up. Information was collected for all adults, 15 years of age or older (see Docs & Materials for census survey instrument).

5.1.2 Baseline Household Survey

From each cluster a random sample of 15 censused households were selected and from each household one adult eligible for deworming was randomly picked to respond to a baseline survey (see Docs & Material for baseline survey instrument).

5.2 Mid-Intervention

5.2.1 Treatment Take-up Monitoring

- The individuals to monitor are described in 4.1.
- Enumerator's data collection devices pre-loaded with identifying information.
- Identified individuals were tagged as dewormed, for others we collected some personal information to conduct a match with the group to monitor (in case enumerators miss any).

5.2.2 SMS Airtime Reward

As described in the Intervention section, a number of text message treatment recipients will receive a message offering a free one time reward. Two people per cluster were randomly picked for each of the reminders and social information text message groups. Thus in each control cluster four individuals were picked and in each incentive treatment cluster two people were picked.

Through the SMS airtime reward treatment we get a lower bound for information take-up for our SMS treatment. People may be hesitant to reply to the reward messages, inspite of reading the reminder and peer information text messages. We therefore further interviewed people in the endline about whether or not they received text messages, their knowledge about the content of the text messages and the number of text messages they have received.

5.3 Post-Intervention

5.3.1 Endline Household Survey

From each cluster we randomly picked 25 individuals for an endline survey

- For control clusters we randomly picked 15 individuals who did not receive any text messaging treatment, 5 individuals who received reminders and 5 individuals who received reminders and social information text messages.
- For incentive treatment clusters we randomly picked 20 individuals who did not receive any text messaging treatment and 5 individuals who received reminders and social information text messages.

(see Docs & Material for endline survey instrument).

We will use the endline data to generate descriptive statistics that allow us to verify (a) people's knowledge about the availability of treatment, (b) the proper implementation of treatment, (c) people's understanding and awareness of the incentives. Specifically we will look at:

- people's knowledge about the start and end date and duration of deworming treatment;
- whether people were visited by a CHV prior to deworming;
- whether people received a deworming flyer;
- whether deworming treatment was offered for free;
- whether people had seen the incentive;
- conditional on receiving an incentive, whether people retained/wore it;
- people's knowledge about the meaning of the incentive;
- whether other people in the household had also come for deworming/received the incentive.

We will further use the endline data to try and verify some of the assumptions made in the Section 6. We will compare the accuracy of beliefs about deworming take-up at the community level between social incentives and no social incentives individuals that received text messages.

5.3.2 Social Knowledge

Every endline respondent will be either asked about ten of their community members' deworming status, or ten pairs of individuals to allow them to provide information about their community members' deworming without identifying exact individuals' deworming status. The individuals respondents will be asked about are from either the endline survey sample or the reconsent-only sample, thus they are individuals whose deworming status will be known to us.

5.4 Data Quality

5.4.1 Backchecks

Following standard procedure, we performed backchecks consisting of 10% of the sample of baseline and endline survey respondents, as well as individuals that were recruited for the SMS treatment. Backcheck surveys focused on non-changing information.

5.4.2 Geographic and Time Monitoring

All data collection was done using electronic devices, providing us with (i) the geolocation and (ii) timestamp of surveys or deworming treatment. That way we were able to make sure enumerators were surveying the correct households based on geolocations collected during the census, and to make sure that all points-of-treatment were active at the correct times and in the expected locations.

6 Analysis

6.1 Causal Framework

This section describes the potential outcomes causal framework we will use in this study. Below are the exogenous variables of individuals and clusters (i indexes individuals and j indexes clusters):

- $Z_j \in \mathcal{Z} = \{control, ink, calendar, bracelet\}$ is the cluster level treatment
- $M_{ij} \in \mathcal{M} = \{none, reminders, socialinfo\}$ is the individual level text message treatment
- $\mathbf{X}_{ij}$ individual and cluster level pre-treatment characteristics. While we will omit this vector from most of our notation, we will sometimes need to refer to one variable in that vector

- $P_{ij} \in \{phone, nophone\}$, indicating phone ownership.

We describe the set of sampled and monitored individuals as $\mathcal{W}$ and the sub-sample based on phone ownerhship as $\mathcal{Q}(q) = \{i : P_{ij} = q\}$.

Below are the latent intermediate outcomes that influence the decision to get dewormed:

- $V^*_{ij}(z)$, represents the private utility of deworming in response to $z \in \mathcal{Z}$.
- $S^*_{ij}(z, m)$, represents the social influence (in utility terms) of treatment $z \in \mathcal{Z}$ and $m \in \mathcal{M}$ on deworming.

  This influence combines different mechanisms, thus we can further decompose it into:

  - $R^*_{ij}(z, m)$, a reminder effect
  - $L^*_{ij}(z, m)$, a social learning effect: the effect of receiving information on deworming by observing others' deworming choices
  - $G^*_{ij}(z)$, reputational returns from social signaling

  This should also make clear our assumption that text message treatment does not have an effect on V^*_{ij} and G^*_{ij}.

We represent the binary deworming choice, $Y_{ij} \in \{0, 1\}$, in different ways depending on context

$$Y_{ij}(z, m) \equiv Y_{ij}(V^*_{ij}(z), S^*_{ij}(z, m)) \equiv Y_{ij}(V^*_{ij}(z), R^*_{ij}(z, m), L^*_{ij}(z, m), G^*_{ij}(z))$$

We also represent the total number of individuals dewormed in cluster j in response to treatment z, irrespective of these individuals' origins, as $Y^{tot}_j(z)$.

Whenever we reference any of these potential outcomes using one input, this refers to having $m = none$ (e.g., $S^*_{ij}(z) \equiv S^*_{ij}(z, none)$).

6.2 Main Hypotheses

First we define the finite sample treatment effect estimators

$$\tau[(z, m), (z', m')] = \sum_{i \in \mathcal{W}} \frac{Y_{ij}(z, m) - Y_{ij}(z', m')}{|\mathcal{W}|}$$
$$\tau[(z, m), (z', m'); q] = \sum_{i \in \mathcal{Q}(q)} \frac{Y_{ij}(z, m) - Y_{ij}(z', m')}{|\mathcal{Q}(q)|}$$

We can also use the simplified notation $\tau[z, z'; q] \equiv \tau[(z, none), (z', none); q]$ and $\tau[z, z'] \equiv \tau[(z, none), (z', none)]$.

Unless otherwise stated, all estimates will be tested for significance using two-sided hypothesis tests where the null hypothesis is a zero treatment effect.

$$H_0 : \tau(\cdot, \cdot) = 0$$

6.2.1 Incentive vs. no incentive treatment

The cluster randomization into different incentive arms allows us to identify the effect that social or private incentives have on deworming take-up, comparing 1 vs. 4, 6 or 8. We will estimate

$$\tau[ink, control] \equiv \tau[(V^*(ink), S^*(ink)), (V^*(control), S^*(control))] \tag{1}$$

If we assume that $V*(control) = V^*(ink)$, this is an estimate of the impact ink's social influence $S^*(ink) - S^*(control)$ on deworming take-up. We will also estimate

$$\tau[bracelet, calendar] \equiv \tau[(V^*(bracelet), S^*(bracelet)), (V^*(calendar), S^*(calendar))] \tag{2}$$

If we assume that $V^*(calendar) = V^*(bracelet)$, this is an estimate of the impact bracelets' social influence $S^*(bracelet) - S^*(calendar)$ on deworming take-up.

Both these estimates would identify the combined effect of social incentives, $S^*(\cdot)$:

(a) Acting as reminders, $R^*(\cdot)$,

(b) Making observable others' deworming decision, $L^*(\cdot)$, and

(c) Allowing people to signal their decision, $G^*(\cdot)$.

We will also conduct the joint hypothesis test

$$H_0 : \tau[ink, control] = 0 \wedge \tau[bracelet, control] = 0 \wedge \tau[calendar, control] = 0$$

6.2.2 Social vs. no social incentives treatment for text message treatment individuals

Comparing individuals that received reminders and social information text messages in clusters without social incentives to individuals in clusters with social incentives, we identify the effect of social signaling on individuals' deworming decisions. We will estimate

$$\tau[(ink, none), (control, socialinfo)] \equiv \tau[(V^*(ink, none), S^*(ink, none)), (V^*(control, socialinfo), S^*(control, socialinfo))] \quad (3)$$

If we assume that $R^*(ink, none) = R^*(control, socialinfo)$ and $L^*(ink, none) = L^*(control, socialinfo)$, this is an estimate of the impact of $G^*(ink) - G^*(control)$ on deworming take-up. We will also estimate

$$\tau[(bracelet, none), (calendar, socialinfo)] \equiv \tau[(V^*(bracelet, none), S^*(bracelet, none)), (V^*(calendar, socialinfo), S^*(calendar, socialinfo))] \quad (4)$$

If we assume that $R^*(bracelet, none) = R^*(calendar, socialinfo)$, $L^*(bracelet, none) = L^*(calendar, socialinfo)$, and $V^*(calendar) = V^*(bracelet)$ this is an estimate of the impact of $G^*(bracelet) - G^*(calendar)$ on deworming take-up.

6.2.3 No text message treatment vs. text message reminders and social information

Using estimates from 6.2.1 where we identified the combined effect of reminders, social learning and social signaling and the comparison from 6.2.2 where we separately identified social signaling, we can identify the effect of reminders and social learning on deworming take-up. We will estimate

$$\tau[(ink, none),(control, socialinfo)] - \tau[(ink, none), (control, none)] \equiv \tau[control, socialinfo), (control, none)] \quad (5)$$

to identify the combined effect of $R^*(ink)$ and $L^*(ink)$ on deworming take-up; and we will estimate

$$\tau[(bracelet, none),(calendar, socialinfo)] - \tau[(bracelet, none), (calendar, none)] \equiv \tau[(calendar, socialinfo), (calendar, none)] \quad (6)$$

to identify the combined effect of $R^*(bracelet)$ and $L^*(bracelet)$ on deworming take-up.

6.2.4 Text message reminder plus social information treatment vs. no text messages for no incentive individuals

We will estimate

$$\tau[(control, reminders), (control, none)] \tag{7}$$

and

$$\tau[(control, socialinfo), (control, reminders)] \tag{8}$$

to identify the effect of reminders and information about others' treatment decisions on deworming take-up. The text message treatments within no incentive clusters allow us to identify the extent to which reminders or social learning are relevant for deworming take-up.

6.2.5 Text message treatment with social information vs. no text messages for social incentive individuals

We will estimate

$$\tau[(ink, socialinfo), (ink, none)] \tag{9}$$

and

$$\tau[(bracelet, socialinfo), (bracelet, none)] \tag{10}$$

to identify the additional reminder and social learning effects of text messages in the presence of social incentives. The cross-treatments identify how "satiated" individuals are in terms of being reminded or informed about other people's decision through signals.

6.2.6 Calendar/Bracelet Preference Survey

During the endline survey, respondents were asked to choose between a calendar or bracelet as a gift for their participation. We will use this to identify the distribution of preference over these two incentives.

First, we define their choice to be

$$H_{ij} = \mathbb{1}\{D^*_{ij} > 0\},$$

where

$$D^*_{ij} = V^*_{ij}(\mathit{calendar}) - V^*_{ij}(\mathit{bracelet}),$$

the latent difference in utility between calendars and bracelets. We will estimate this difference from the survey observational data.

6.3 Social Information

As secondary outcome, in addition to deworming take-up, we will look at individuals' beliefs/knowledge about others' deworming decision. Using the information collected in the beliefs section of the endline survey, we will look at whether people know or do not know about others' deworming take-up, whether they are more/less correct about their decisions, whether they are are more/less correct for yes/no answers and make a comparison between social incentive and control individuals.

6.4 Heterogeneity

We will be investigating heterogeneity of impact on deworming take-up (as described in the main hypotheses section above) based on the following:

1. The village to point-of-treatment distance binary characteristic (discussed in the Village and Point-of-Treatment Selection section above).
2. The household to household distance within clusters, creating a density measure per cluster that allows us to investigate if proximity affects the effectiveness of social incentives.

We will further investigate heterogeneity of impact on individuals' beliefs and knowledge about others' deworming take-up based on the geographic proximity between the individual and others in her village.

6.5 Temporal Dynamics

Deworming treatment was offered over a period of 12 days. We will look at the distribution of take-up over time comparing social incentive to control clusters.

6.6 Sample Selection

As described in Section 4.1 our sampling will be stratified based on individuals' phone ownership (collected in the census). A random sample of 25 individuals per clusters were selected in the group without text messaging treatment, $M_{ij} = none$: 17 individuals were selected to be phone owners and 8 were selected to be non phone owners. While this distribution is similar to that observed in the population, we will still need to correct our estimation.

6.7 Inter-cluster Spillover

We will test for the possibility of spillovers or contamination due to cluster proximity. As mentioned in Section 4.4 clusters were selected with a geographic buffer between them. However, this is not sufficient guarantee that people would travel farther than we anticipated. Thus we need to test the hypothesis that individuals in our monitored sample have received deworming outside their cluster, and should we fail to reject this hypothesis is sufficient precision we will need to model this spillover in our econometric models.

6.8 Multiple Hypotheses Testing

While we only have a small set of outcomes that we would be analyzing (mainly deworming take-up), there is significant number of treatments (cluster level and individual) we will use to investigate the various behavioral mechanism driving observed behavior. Therefore, we will we correct our inference to account for this.