Improving household participation in a vector control campaign: A pragmatic randomized field trial of behavioral economic interventions

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ABSTRACT

Door-to-door health campaigns are a critical component of many health promotion, disease prevention, and surveillance efforts in a variety of contexts. Unfortunately, participation in these campaigns is often low, undermining the effectiveness of proven interventions. New approaches are needed to understand and influence household decisions to participate in door-to-door public health interventions. In this study, we apply novel insights from behavioral economics to increase participation in an ongoing Chagas disease vector control campaign in Arequipa, Peru, where we have collaborated with the Ministry of Health for a decade. Low participation currently threatens the success of the campaign; the greatest barriers to participation reported by households include lost work hours, concerns about insecticide, and allergies. The overarching hypothesis of our study is that low rates of participation in door-to-door vector control campaigns can be significantly improved through interventions that incorporate the realities of human decision-making and behavior change.
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INTRODUCTION

Door-to-door campaigns are a critical component of many health promotion, disease prevention, and surveillance efforts. Successful implementation of door-to-door public health initiatives is vital for several reasons: First, the door-to-door approach is indispensable for the assessment and control of health threats in and around the domestic environment, including disease vectors, toxic substances, and fire and injury risks. Second, the door-to-door approach is vital for studying the spread of infectious diseases, which is often driven by spatial factors operating at the scale of the household; understanding and controlling disease spread through a community therefore requires assessment of health threats at this scale. Third, door-to-door approaches reach community residents who do not seek care in clinical settings. In the US, recent door-to-door campaigns have been successful in promoting health screenings and HIV testing. In developing country settings, door-to-door campaigns remain important for health surveillance and product promotion. Unfortunately, participation in these campaigns is often low, undermining the effectiveness of proven interventions. The potential impact of door-to-door approaches is limited by a lack of evidence on how best to achieve adequate household participation. The purpose of this study is to contribute to that evidence base by evaluating three novel interventions that incorporate behavioral insights in order to increase participation in a Chagas disease vector control campaign in Arequipa, Peru.
Behavioral insights for health behavior change

To date, most health interventions have relied on classical economic models and conventional health behavior change frameworks\(^{13,14}\) which assume that individuals form behavioral intentions based on a rational assessment of costs and benefits and consistently act in their own best interests. With some exceptions,\(^{15}\) large-scale interventions that assume rational choices by participants have been disappointing.\(^{16,17}\) Recently, health researchers have looked to the field of behavioral economics for new approaches to achieve behavior change. These approaches recognize the common biases and mental shortcuts that influence our decisions. For example, present bias, the tendency to place more weight on costs and benefits realized today and less weight on those realized in the future, makes us prioritize immediate pleasure over actions that are in our long-term interest.\(^{18,19}\) The power of social norms and peer pressure leads us to mimic behaviors we observe in others around us.\(^{20-22}\) Attention and cognitive processing power constraints\(^{23-25}\) make us highly responsive to salient, framed messages that simplify decisions.\(^{26-28}\) Using these principles and others, researchers have designed strategies and interventions that work with, rather than against, mental biases and shortcuts to achieve desired behavior change.\(^{22,29}\) For example, advance commitments, which help counter present bias because a future action seems less costly than a present one, have improved weight-loss and healthy eating programs.\(^{30-32}\) Planning prompts, which encourage people to form a plan for a desired behavior, such as “When situation X arises, I will implement response Y,” counter present bias, address attention constraints and have been shown to improve voting,\(^{33}\) influenza vaccination,\(^{34}\) oral hygiene behaviors,\(^{35}\) and weight loss.\(^{36}\) Using peer opinion leaders to promote behavior change leverages the importance of social norms, and has been successful in HIV prevention and influenza vaccination.\(^{37,38}\)
Behavioral insights have also generated considerable interest how best to structure financial incentives to motivate behavior change.\textsuperscript{31,32,39-42} Lotteries counter present bias by providing an immediate and tangible reward for future-oriented behavior, and have been shown to be effective for promoting medication adherence,\textsuperscript{40} weight loss,\textsuperscript{31} cholesterol reduction,\textsuperscript{43} and immunization.\textsuperscript{44} Group-based lotteries, where a group is eligible for a prize only if all group members participate in the target behavior, additionally take advantage of social norms and peer pressure.\textsuperscript{45,46} While behavioral economic approaches have achieved compelling results for individual behaviors in controlled settings,\textsuperscript{31,32,39-41,47,48} few studies have been conducted of large-scale community health interventions\textsuperscript{49-51}, and none related to vector control campaigns.

**Chagas Disease vector control in Arequipa, Peru**

Household insects are an important cause of both infectious and chronic health conditions.\textsuperscript{52-58} Chagas disease, the focus of this study, is a devastating insect-borne disease, and one of the principal infectious causes of morbidity and mortality in the Americas. More than 8 million people are currently infected with *Trypanosoma cruzi*, the etiologic agent of the disease.\textsuperscript{59-61} *T. cruzi* is transmitted by contact with the feces of triatomine insects, which harbor the parasite in their guts. Acute infections have a 20-30% probability of eventually progressing to cardiac or digestive forms of chronic Chagas disease, which are difficult to treat and often fatal.\textsuperscript{62} Since 1991, *Triatoma infestans*, the principal insect vector of *T. cruzi* in South America, has been the target of an elimination program known as the Southern Cone Initiative. As a result of the initiative, three countries, Chile,\textsuperscript{63} Brazil,\textsuperscript{64} and Uruguay,\textsuperscript{65} have been declared free of *T. cruzi* transmission by *T. infestans*. Two factors make current elimination programs in the remaining infested countries in the Americas, including Peru, more challenging: First, previous elimination programs,
particularly those conducted in Chile during the military dictatorship of General Pinochet, succeeded in part due to overt or implied coercion to participate. Democratic societies cannot employ such strategies. Second, the vector has become an urban problem. The dense environment of cities facilitates the spread of insects, hindering control efforts and putting large numbers of individuals at risk for disease.\textsuperscript{66-68} Vector-borne \textit{T. cruzi} transmission cycles are now well established in cities throughout the region including Arequipa, Peru, a city of nearly one million inhabitants.\textsuperscript{67} In poorer communities of this city, 5.3\% of children are infected.\textsuperscript{68} Current low household participation rates in the Chagas vector control program in Arequipa threaten the control of Chagas disease in Peru and ultimately the success of the Southern Cone Initiative. For Chagas and other vector-borne disease, simple and inexpensive household hygiene behaviors coupled with indoor residual spraying can drastically decrease or eliminate the presence of insect vectors from the home, protecting household members from illness. However, households cannot undertake vector control individually or in isolation; it must implemented in a coordinated fashion across a community to prevent rapid reinfestation.  

Based on formative research\textsuperscript{69}, and using a behavioral design framework\textsuperscript{70}, we developed three interventions designed to increase participation in Arequipa’s vector control campaign. In this study we evaluate the effectiveness of each of the interventions in a pragmatic cluster-randomized controlled field trial of over 5,000 households. Results will contribute to the evidence base on increasing household participation in vector control and other important door-to-door community health campaigns through behavioral economic strategies to maximize the effectiveness of these important public health investments.

\textbf{METHODS}
Interventions

**Current practice (control).** The control arm consists of the current Ministry of Health (MOH) campaign as described in Figure 1 which employs a conventional health education and promotion approach. Printed campaign materials motivate households to participate, while discussions with health promoters are intended to alleviate uncertainty about allowing strangers or government workers into the home, and concerns about potential negative consequences of insecticide application, such as allergic reactions and staining of walls.

**Advance commitment responsive scheduling.** Households are approached 2-4 weeks prior to the spray date and asked to commit, in advance, to participate. Households that agree to participate are offered convenient 2-hour appointment windows on a future spray date. Planning prompts, which encourage households to make a specific plan to prepare the home for spraying, are also be offered. Households have the opportunity to request a paper or text message reminder prior to their scheduled appointment. This intervention is motivated by prior work on the effectiveness of planning prompts for implementing desired behavior.\(^{33,34,36}\) Present bias also leads households to more heavily discount the time burden of participating 2-4 weeks in the future vs. the next day. Self-consistency bias\(^ {71}\) suggests that once a household head has committed to the spray in advance, he/she will be more likely to follow up on that commitment in order to maintain a consistent self-image.

**Neighbor recruitment.** Two to four weeks prior to spray dates, study staff approach formal community leaders (MOH-trained health promoters, block captains, and elected community officials) and informal neighborhood opinion leaders (corner store owners, day care coordinators), explain the campaign in depth, and recruit leaders to serve as neighbor recruiters. Leaders are given promotional t-shirts with gain-framed messages, a clipboard, a phone card with minutes,
and the same educational materials used by campaign staff. Recruiters are asked to promote the campaign to 10-12 nearby households and wear the campaign t-shirts regularly. Prior work on norms and peer pressure suggests that households will be more likely to participate if they are recruited by a neighborhood opinion leader. Campaign t-shirts increase the salience of the campaign and gain-framed messages highlight the benefits of participation for child health.

**Contingent group lotteries.** Contiguous households are assigned to lottery groups of 5-7 households. We set average group size at 6 households for two reasons: First, it is the average size of a block face (row of houses along one side of a block facing the street) in the intervention district. Second, our preliminary studies show that, while 5-house runs of participation occur occasionally, 6-house runs are rare; achieving runs of 6 will therefore require the person-to-person recruitment we hope the lottery prizes will motivate. Lottery groups are randomly assigned a lottery number (1-45) and a specific date for the twice-weekly Peruvian Tinka Megabol™ lottery drawing. Households whose lottery group number is selected and who participated in spraying win a 50 soles (approximately $15) voucher to a local hardware store. If 100% of households in the selected group participated in the spray campaign, the voucher for each household doubles in value to 100 soles (approximately $31). A lottery leverages present bias by making the future, intangible benefits of spraying more immediate and tangible.

Our lottery procedures ensure that households know if their number was drawn (as Tinka Megabol™ results are widely broadcast and published), thus invoking anticipated regret as a motivator to participate. The lottery may also mitigate any stigma associated with participation by providing a salient, external stimulus that publically validates the behavior.

**Field trial**
A pragmatic clustered-randomized controlled field trial was conducted in the Alto Selve Alegre district of Arequipa during the second spray of the attack phase of the campaign (March-October 2015). We divided the spray area into 56 clusters of approximately 80-100 households. Clusters were randomly assigned to the control arm or one of the three interventions, with assignment balanced by prior vector infestation and participation in a preliminary entomological survey. The sample size in each arm is approximately 1,400 household. All households in sampled sectors are included in the trial. Non-participation in the preliminary survey does not remove the households from the sampling frame.

**Data collection.** We systematically record participation as the spray campaign proceeds through the study site. The current campaign protocols include careful documentation of the order in which households are approached, the number of times each household is approached, the outcome of each approach, and the date and time that treatment was scheduled and then completed. For households refusing treatment, reasons for refusal are captured on a standardized instrument. We merge participation data, including temporal and spatial components, with the household data collected during the preliminary survey into a single geo-referenced database.

**Analysis.** The campaign database will be used to estimate participation rates by intervention arm, and to compare the relative effectiveness of each intervention to the control (current campaign) and to each of the other interventions. We will use a mixed effects logistic regression model to estimate participation and 95% confidence intervals. We include sampling tract as a random effect, and intervention arm, household baseline infestation, and household sociodemographic covariates, as fixed effects. The mixed effects model and confidence intervals will account for clustering by study tract.
Following the trial we will also evaluate 3 hypotheses informed by prior work on correlates of participation/refusal and by behavioral economic theory:

**H1. Spatial patterns of participation** will be more ‘clumpy’ in the lottery and neighbor recruitment arms compared to the control and scheduling arms, due to the social aspects of those interventions.

**H2. Refusing households** in the advance-commitment responsive scheduling arm will be less likely to report time and schedule constraints and landlord/tenant issues as reasons for refusal than refusing households in the other arms, due to more convenient scheduling and greater time to prepare for spray.

**H3. Refusing households** in the lottery and the neighbor recruitment arms will be less likely to report allergy concerns and lack of bugs as reasons for refusal than other arms, due to greater perceived benefits and reduced costs of spray and peer pressure.

We will evaluate H1 by comparing the “spatial clumpiness” of participation in the lottery and neighbor recruitment arms to that of the control and scheduling arms using a new method developed by our team. We will test H2 and H3 using multinomial logistic regressions, including reasons given for non-participation as outcomes and assessing the effect of study arms, which will be included as covariates. The results of our analyses will provide the needed estimates of participation achieved under alternative interventions to inform cost-effectiveness analyses, as well as elucidate how each intervention alters patterns of and barriers to participation in door-to-door health campaigns.

**PRELIMINARY RESULTS**
The field trial will be completed in October 2015 and analysis of participation outcomes by treatment arm will begin shortly thereafter. In Figure 2 we show the progress of the campaign and the trial as of mid-September. Fidelity assessments have been conducted continuously to assure that the interventions have been delivered as designed. Given the pragmatic nature of the trial, we have also recorded in detail any deviations from normal campaign operations. For example, the treatment area has experienced weather delays, special campaign promotional events, and a canine rabies outbreak during the field trial period. While we do not expect that any of these events had a differential effect on participation by study arm, we will be able to control for their impact in our analysis. We also have extensive survey data from households on the knowledge and awareness of household insect vectors (both Chagas vectors and other insects of medical importance), their social networks in the neighborhood, perceived time costs to participate in the campaign, and their perceptions about the campaign following household spraying. Neighborhood leaders are debriefed about their experiences recruiting households. Redemption data for the hardware store vouchers are also available. These process and attitudes data will allow us to pinpoint the mechanisms underlying intervention effectiveness and inform future campaign operations in Arequipa and elsewhere.

REFERENCES


15


FIGURES

Figure 1—Phases of the *T. infestans* Control Campaign, Arequipa, Peru

**I. PRELIMINARY SURVEY PHASE**
- All houses are surveyed for *T. infestans* by trained inspectors.
- Inspectors record household social and demographic characteristics, including education of household head, household building materials, asset ownership, animal ownership, and employment.

**II. ATTACK PHASE**
- District-wide education campaign: including radio, billboard and megaphone messages.
- Community meetings: Health promoters describe Chagas disease, the role of the insect in transmission, and the control activities.
- Health promoters visit houses sequentially to schedule insecticide application for the following day.
- Residents prepare homes for insecticide application by moving furniture and stowing kitchenware.
- An exterminator spends 1-2 hours applying insecticide.
- Residents stay out of house 2 hours following treatment.
- The process is repeated six months later (round 2 of attack phase).

**III. SURVEILLANCE PHASE**
- Community-based surveillance effort to identify residual vector populations
- Begins six months after attack phase
- Surveillance continues until the vector is eliminated from the region.
- Residents asked to notify health posts of vector presence in homes.
- MOH personnel search houses for insects every two years.
Figure 2: Progress of the Pragmatic Field Trial as of September 17, 2015