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## Supporting Adolescents to Adhere (SATA): Lessons learned from an intervention to achieve medication adherence targets among youth living with HIV in Uganda

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### Abstract

**Introduction:** Youth in Uganda are disproportionately impacted by HIV and report significant barriers to ART adherence. We asked participants how fixed versus flexible adherence target setting for incentive interventions, in combination with other support systems, could help HIV-positive youth in Uganda reach medication adherence targets.

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#### SUBMISSION DECLARATION AND VERIFICATION

This manuscript has not been previously published or posted online and is not submitted elsewhere. It will not be submitted anywhere else while under consideration, and should it be published in *Children and Youth Services Review*, it will not be published elsewhere, verbatim or in similar form, without the permission of the editors. All authors are responsible for the reported research and have participated in all phases of research. All authors have approved this manuscript for submission.

#### RESEARCH DATA

Datasets generated and/or analyzed during the current study are not publicly available due the restrictions statement in our study consent forms.

#### ETHICS IN PUBLISHING

We obtained Institutional Review Board (IRB) approval for the study from the RAND Corporation, the ethics review board at the local participating HIV clinic, and the Uganda National Council for Science and Technology.

#### NEW GUIDELINES FOR RESEARCH DATA

Datasets generated and/or analyzed during the current study are not publicly available due the restrictions statement in our study consent forms.

#### COMPETING INTERESTS

The authors declare that they have no financial or competing interests.

**Methods:** Four focus groups conducted in Luganda were audiotaped, transcribed, and translated into English; the transcriptions were then coded using Dedoose software. Two members of the research team read the text and identified the basic topics covered. A codebook was developed that detailed inclusion and exclusion criteria for each topic area, as well as typical entries for each code. A directed content analysis was used to identify key themes.

**Results:** Several themes were common across groups. Participants consistently maintained that they preferred to set their own adherence targets. But regardless of how adherence targets were assigned, participants noted that missing their target was disappointing. They commented positively on the use of Medication Event Monitoring System (MEMS) caps, noting that knowing their adherence information was being tracked often encouraged them to take their medications. Participants reported that receiving text messages further motivated them to take their medications; however, on occasions when they reported not doing well, they wanted intensive follow-up by staff. Participants said that the prize drawing alone did not motivate their ART adherence and that receiving ‘zero’ in the drawing was disheartening.

**Conclusion:** We found that participants preferred to set their own adherence targets and that doing so increased a sense of ownership in achieving them. All participants enjoyed using MEMS caps and expressed disappointment at needing to return the device at the study’s completion. Participants noted that text message reminders may be a useful way to help patients stay motivated between clinic visits; however, ongoing engagement and support are needed from providers and counselors. Finally, our participants stressed the importance of including incentives with a small, positive value rather than 0 when designing the lowest prize.

### Keywords

Uganda; youth; HIV-positive; adherence; behavioral economics

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## 1. INTRODUCTION

In Uganda, youth comprise 33% of the population, but account for nearly 50% of the country’s HIV/AIDS cases (Mitchell, Bull, Kiwanuka, & Ybarra, 2011; The Alan Guttmacher Institute, 2005). Despite the clinical requirement that ART adherence exceed 90% to achieve viral suppression, a meta review looking at 50 studies from 53 countries reported a pooled adherence level of 62% among youth (Kim, Gerver, Fidler, & Ward, 2014). Our own research with youth in Uganda found electronically measured mean adherence of 61–64% (Linnemayr, Huang, et al., 2017). A 2018 systematic review of adherence interventions for youth in low- and middle-income countries (Ammon, Mason, & Corkery, 2018) concluded that current evidence on effective interventions is both “sparse and lacking.”

In an effort to improve adherence among this population, we developed the intervention SATA (Supporting Adolescents to Adhere) to investigate how flexible targets of their own choosing versus a fixed target impacted ART adherence among HIV-positive youth ages 17–24 in Uganda. Multiple barriers impacting ART adherence (e.g., sociodemographic, structural, economic, and psychosocial factors) have been identified among adolescents in sub-Saharan Africa (Adejumo, Malee, Ryscavage, Hunter, & Taiwo, 2015; Ammon et al.,

2018). In our intervention we focus on behavioral barriers. Our theoretical approach draws on behavioral economics, which suggests that “present bias” in decision-making (e.g., when people are heavily influenced by short-term considerations at the expense of long-term benefits) likely serves as a significant barrier to ART adherence (White & Dow, 2015).

The primary goal of SATA is to determine if types of target setting can help overcome present bias and enable improvements in ART adherence. The low average adherence among youth ages 17–24 poses important questions, including how high should the adherence targets be, and should everyone set the same target? SATA addresses these questions by using insights from behavioral economic theory to evaluate two approaches - flexible vs. fixed targets - to setting incentives. Preliminary analyses from the SATA pilot study showed that youth in the flexible target group had a statistically significant increase of 11% in mean adherence and a 12% increase in probability of adherence over 90%. The fixed target group showed only small increases in percentages, (4% and 1.6% respectively), which were not statistically significant.

To better understand the factors generating these significant differences, we conducted exit focus groups with SATA participants. Here, we report participant views on flexible and fixed target setting of ART adherence goals, and we describe their reactions to other intervention components including electronic monitoring of ART adherence through MEMS caps, as well as text messages and lottery incentives to address ART adherence.

## 2. MATERIALS & METHODS

### 2.1 Intervention Description

In SATA, we randomized study participants into one of two intervention groups. In Group 1 (Fixed Target), participants were eligible to win small mobile airtime incentives if they reached the adherence target of 90%, the clinically optimal target associated with viral suppression. During each clinic visit, study coordinators checked participants’ MEMS cap information to determine the last month’s adherence (defined as the use of ARTs at the prescribed dosing frequency). MEMS caps are electronic monitors that resemble ordinary bottle caps; they contain a tracker that counts openings and time of openings and sends that information to a central collection point at the clinic. Participants were given their medication in bottles with MEMS caps. If their MEMS record showed that they had reached or exceeded the 90% target, study coordinators entered those participants in a prize drawing to win up to \$2.60 USD in mobile phone airtime.

In Group 2 (Flexible Target), participants were eligible to win mobile airtime if they reached an adherence target of their own choosing within a given range—80, 85, 90, 95, or 100; they could revise the target at subsequent clinic visits. The control group did not receive any incentives/prize drawings during their clinic visits. All three groups (2 intervention and 1 control group) received motivational messages every Sunday (e.g., “Stay strong!”, “Have courage!”, “Don’t give up!”) as well as an airtime top-up of \$2.60 USD if they responded to these messages. At the end of the study, participants returned their MEMS caps. The demographics of the three groups are described in Table 1 of the Supplementary Tables.

## 2.2 Focus Group Study Site

The focus groups were conducted at a non-profit organization that provides HIV care and other services free of charge to the population in and around Kampala, generally serving lower-income clientele. The clinic currently serves 12,475 pediatric and adult patients living with HIV and specializes in providing comprehensive HIV/AIDS prevention, care, and treatment services. Services include: HIV counseling and testing; sexual and reproductive health services; rehabilitative services (nutrition, physiotherapy, occupational therapy); safe male circumcision; and ophthalmic and dental care. The ART regimen available at the clinic includes a twice a day regimen, the standard in Uganda at the time the study was implemented.

## 2.3 Focus Group Eligibility, Identification and Consent

The eligibility criteria for SATA were age 17 to 24, daily access to a mobile phone, familiarity with text messaging, ability and willingness to use MEMS caps, and routine clinic visits every 1–2 months. Once SATA concluded, we identified FG participants for our study by purposely sampling the fixed target group (n=72 participants) and the flexible target group (n=73 participants). Study coordinators were given lists of participants who fell into each of the four categories of interest: fixed target with improvement (defined as whether their adherence increased by 5 percentage points or more; n=9); fixed target with no improvement (n=9); flexible target with improvement (n=9); flexible target with no improvement (n=7). Study coordinators contacted participants until 8–9 individuals agreed to participate in each FG. Verbal assent for all study components had already been obtained at the start of SATA for non-minors; written consent was obtained for minors.

## 2.4 Focus Group Structure and Guide

We chose to conduct focus groups because they can stimulate discussions that would not occur in individual interviews, and they allowed us to explore similarities and differences of opinion and experiences. Focus groups were also used to generate a range of responses in a group and the overall central tendency (Patton, 1987). Each focus group lasted approximately 45 minutes; groups were run by facilitators who had psychology or public health experience and training in qualitative methods.

To develop the focus group guide, we identified the areas about which we wanted more information to inform the future scale-up of the intervention. These included participant feedback on the main components of the intervention (target setting) in addition to other components (MEMS cap, text messaging, and prize drawings). We drafted a semi-structured interview guide and iterated with the Ugandan study team before submitting the guide for ethics approval.

## 2.5 Focus Group Participant Characteristics

Table 1 describes the characteristics of our focus group participants (n=34), as measured in the SATA baseline survey done from July 2016 to January 2017. The average age was 19 years, and most were female (62%). Almost all participants had completed primary education (97%) and a majority could read and write a sentence easily (56% and 63% respectively). Slightly more than half of participants described the quality of their houses as

“poor” (53%). A majority had some form of electricity (77%), such as from a main line, generator, or solar in their homes, but fewer than half had piped or tap water (47%). Most focus group participants had their own phone (65%). Average adherence measured through MEMS caps one month before SATA started (77%) was lower than self-reported adherence (83%).

Further, focus group participants had been participating in a preceding text-messaging based intervention for two years, so none were treatment naïve, and the majority of participants were perinatally infected. Of note, 14 participants were missing endline data including: n= 6 control group, 2 from the fixed target group, and 6 from the flexible target group.

## 2.6 Focus Group Analysis

The four focus groups were conducted in Luganda, audiotaped, and transcribed into Luganda, and then translated to English. A directed content analysis, or deductive approach, guided our analysis (Assarroudi, Heshmati Nabavi, Armat, Ebadi, & Vaismoradi, 2018). We uploaded the transcripts to Dedoose. A senior qualitative researcher (SM) and a junior researcher (AMG) jointly read each transcript together and identified the basic topics covered. SM and AMG developed a codebook, reflecting the main areas of the FG interview script, and detailed the inclusion and exclusion criteria for each topic area, as well as exemplars for each topic or theme (Ryan & Bernard, 2003). All focus groups were then jointly coded using the themes included in Table 2. Data that did not appear to fit into existing categories were discussed, and either new themes were created, or existing themes were adapted. SM and AMG discussed the themes emerging, then sought additional feedback from the research team (SL and CH). The final quotes selected for inclusion in the text were reviewed collectively by the research team to ensure that they were representative of each theme. Through our analysis, we found the themes were consistent across the different study groups.

We obtained Institutional Review Board approval for the study from the RAND Corporation, the ethics review board at the local participating HIV clinic, and the Uganda National Council for Science and Technology.

## 3. THEORY

Rather than rely on prevailing adherence theories, we introduced a new framework based on behavioral economics. We built on prior work that applies Prospect Theory to goal setting. Prospect Theory is a descriptive model of decision-making that has been empirically validated across multiple cultural contexts. It posits that individuals make decisions about consumption following an S-shaped value-function curve; their choices and utility are based on perceived losses or gains relative to a reference point, rather than based on their absolute consumption level. Heath, Larrick and Wu adapt this theory to goal-setting, arguing that the way people set and respond to goals also follow properties of the value function in prospect theory (Heath, Larrick, & Wu, 1999; Wu, Heath, & Larrick, 2008). Specifically, goals function as *reference points*. They motivate people by creating a discrepancy between a person’s desired state and their actual state, and people then exert effort to close the gap (Heath et al., 1999). Further, the *diminishing sensitivity* around a goal suggests that as they

approach it, efforts to reach the goal increase. (Latham, Winters, & Locke, 1994). This assumption implies that those performing far below a difficult goal level actually lose motivation because they view the goal as unattainable. Prospect theory predicts that individuals are motivated to reach their goals when the goals are flexible and closer to the individuals' baseline performance. Further, the flexible target implies that a second mechanism is at play—allowing participants to choose a goal engenders a heightened sense of ownership. The ownership effect further motivates progress towards the goal and motivates individuals to reach for even higher goals once they met their original target.

To test these hypotheses, we varied the adherence targets needed to qualify individuals to participate in a prize drawing. Our goal was to determine whether participants are more responsive to a high, fixed adherence target (90%) or see greater improvements when they can set flexible adherence targets that take into consideration their initial performance. Consequently, a primary aim of the focus groups was to understand how study participants viewed fixed versus flexible targets as a motivation to improve adherence.

#### 4. RESULTS

Several themes were common across groups. Participants consistently maintained that they preferred to set their own adherence targets. But regardless of how adherence targets were assigned, participants noted that missing their target was disappointing. They commented positively on the use of Medication Event Monitoring System (MEMS) caps, noting that knowing their adherence information was being tracked often encouraged them to take their medications. Participants reported that receiving text messages further motivated them to take their medications; however, on occasions when they reported not doing well, they wanted intensive follow-up by staff. Participants said that the prize drawing alone did not motivate their ART adherence and that receiving 'zero' in the drawing was disheartening.

##### Target Setting Component.

Participants consistently declared that they preferred to set their own targets— regardless of their group assignment: “*So you find that when you set your own goal you find that you get a way to swallow your own medicine. But you might set me a goal and I may not be able to fulfil it. So, to me it's more comfortable if you set your own goal.*” (Participant with flexible target, improved ART adherence) A handful of participants in the fixed target group felt it was helpful to have someone set the target for them, and they thought that small incremental improvements would better support them in achieving their adherence target.

Whether the adherence target was fixed or flexible, participants felt bad when they missed it. One participant noted: “*I would feel so bad when my percentage is not very high... I know it hurt [other study participants] in some way.*” (Participant with fixed target, no change in ART adherence). Another participant stated, “*... When I get like 50 I feel really bad. So that feeling would help me improve my adherence*” (Participant with flexible target, improved ART adherence).



### **MEMS Cap Component.**

Most participants reported positive perceptions of MEMS caps and noted that knowing their adherence was being tracked often encouraged them to take their medications: "... personally, I was motivated by that cap that they put on our drugs. There are times when you would get caught up with time for taking your drugs you would still remember that you have to open your tin to take your drugs so that the next time you go to the clinic they find there are spaces with that MEMS cap and get to know that you are not taking your drugs. So that kept me motivated." (Participant with fixed target, improved ART adherence). Many participants expressed concerns that they were not able to keep the device that they viewed as critical to their successful ART adherence: "All of those people who have MEMS caps now ... [if] you take them away, they might not take [their] drugs." (Participant with fixed target, no change in ART adherence).

### **Text Messaging Component.**

Participants across groups reported being encouraged by the weekly messages: "Those messages encouraged me whenever I got it on my phone. Before I was always miserable because of being HIV positive, but every time I would see that message, I would feel so encouraged and loved that there are people who care about me. This even encouraged me to take my drugs more than fearing them... It is even no longer a problem for me to take my drugs because I am now used to it. (Participant with fixed target, improved ART adherence) However; some participants did note a desire for more follow up when their response to messages indicated that they were not well: "... when you are not okay, you send "2", and in those times when you are okay you send "1". But what I want to emphasize is that if someone is not okay, which is number "2", then you people [should] have tried to reply like 'how are you?' or 'what is the problem as to why you are not okay?'" (Participant with fixed target, improved ART adherence).

### **Prize Drawing Component.**

Participants from both intervention groups said they wanted to win something, and drawing 'zero' significantly demotivated them: "So even if you get something small it's better than a zero which will demotivate you and you feel like your aim has not been accomplished." (Participant with fixed target, improved ART adherence). On the other hand, there were some participants who felt that the game was generally fair and were not bothered by the zero option: "To me, it didn't hurt me because I came here not knowing that game is here. They just told me about it. I was expecting to win 10,000 [Ugandan Shillings] but I picked 0. It didn't hurt me because it was the first time, but as I continue playing it, am hopeful that I might win some airtime" (Participant with flexible target, no change in ART adherence).

## **5. DISCUSSION**

We report key themes from the exit focus groups regarding setting targets, electronic monitoring of ART adherence through MEMS caps, text messaging, and determining the prize drawing incentives.

Prospect Theory suggests that setting goals far above a person's current performance level can reduce an individual's motivation to meet the target (Wu et al., 2008). Our study provides empirical evidence that participants prefer incremental targets, which make reaching the goal more achievable. Participants in both groups welcomed the possibility of setting their own goals-doing so generated a sense of ownership. Future studies should consider how engaging participants in creating a shared action plan for success may ultimately facilitate achieving the desired behavior. This approach can be incorporated into the design of incentive studies, particularly when the target behavior is a continuous outcome such as adherence.

Several studies have included the use of electronic monitoring devices for ART adherence in both high- (Blashill et al., 2017; Koss et al., 2017; Pellowski, Kalichman, Kalichman, & Cherry, 2016) and low-income settings (Bionghi et al., 2018; Haberer et al., 2010; Sabin et al., 2015), and a study in Uganda found that patients thought the device convenient and easy to use (Haberer et al., 2010). A study we completed in collaboration with our research team in Uganda (MacCarthy, Mendoza-Graf, et al., 2018; MacCarthy, Saya, et al., 2018) suggested that although the monitoring device was generally effective, ongoing data checks to confirm its accuracy are still needed. In addition, participants needed strategies to describe the device when asked about it without having to disclose their HIV status.

Our FG findings reaffirmed that MEMS cap is a feasible and acceptable way to measure ART adherence and suggested that the mere presence of the device may encourage individuals to take their medication knowing that their adherence is being tracked. However, participants were frustrated that they could not keep the device when the study was over because they felt the MEMS caps had helped them improve their adherence. This emphasizes the need for the consent process to clearly explain that the reason MEMS caps are taken away at the end of the study is because they work only in combination with the MEMS software tracking the adherence used over the course of the study.

Text message-based interventions have been reported as acceptable and feasible to implement in a range of settings (Daher et al., 2017; Lester et al., 2010; Pop-Eleches et al., 2011). Ownership of mobile phones in low-income countries has continued to increase, spurring hopes that mobile health could provide a low-cost, scalable approach to reaching populations in these settings (DeKoekoek et al., 2015; Horvath, Azman, Kennedy, & Rutherford, 2012; Qiang, Yamamichi, Hausman, Altman, & Unit, 2011). However, more recent evidence regarding the effectiveness of text message-based interventions is mixed. For example, researchers tried to build on the success of the text message-based Wel-tel study, which reported a 12-percentage-point increase in the likelihood of self-reported adherence among HIV-positive adults in three clinics, as well as a 9-percentage-point increase in rates of viral suppression (Lester et al., 2010). But subsequent studies following a similar study design have reported no difference between the intervention and control groups (Fox & Kaufman, 2018; Mbuagbaw et al., 2012; van der Kop et al., 2018). Most recently, our own RCT from Uganda using a text message-based intervention also found no statistically significant difference in outcomes between the intervention and control groups over the 48-week study period (Linnemayr, Huang, et al., 2017). This body of work suggests that simple text message-based interventions may not achieve the desired behavior change.



They are likely only one component of a multi-pronged approach needed to improve adherence among youth in Uganda and elsewhere (Kagee et al., 2011; Scanlon & Vreeman, 2013; Seeley et al., 2012).

Traditional incentives have been used to address HIV prevention and treatment in the United States and internationally. This type of incentive often involves a relatively large amount of money, intended to help overcome structural barriers to adherence such as poverty. Studies suggest that these incentives produce limited results (Cooper, 2003; Grusky, Roberts, & Swanson, 2007; Haukoos, Witt, Coil, & Lewis, 2005; Jochelson, 2007; Kane, Johnson, Town, & Butler, 2004; Marteau, Ashcroft, & Oliver, 2009; Rosen et al., 2007; Sorensen et al., 2007; Sutherland, Christianson, & Leatherman, 2008; Thornton, 2008). More recent studies have focused on different types of cash transfers as incentives to prevent HIV (Baird, Garfein, McIntosh, & Özler, 2012; De Walque et al., 2012; Kennedy et al., 2014), improve HIV related outcomes (Mills et al., 2018), or link individuals to HIV care (Gamble et al., 2017; HIV Prevention Trials Network). Because these studies tended to use substantial monetary incentives, they are a costly way to motivate long-term behavior change.

In contrast, smaller incentives informed by insights from behavioral economics and targeting behavioral rather than structural/income barriers have been shown to improve health behaviors in low-income settings (Banerjee, Duflo, Glennerster, & Kothari, 2010; Linnemayr, Stecher, & Mukasa, 2017; Thornton, 2008). Feedback from our FG suggests that the prize drawings as implemented in the current study provided a useful mechanism to engage participants, but that some aspects of the prize drawing structure can be improved. For example, participants who met their adherence target but drew a 0-card reported being upset, despite being aware that this could happen. One way to mitigate disappointment without increasing the intervention's cost is to make the lowest prize value small but not zero. This ensures that the incentive design meets participants' expectation of receiving something for achieving the desired behavior.

Our study has both limitations and strengths. The number of focus groups was not sufficiently large to detect nuanced differences between groups. Furthermore, our study was conducted with youth in Kampala, a capital city where youth may have more reliable access to phones and networks; such mobile technology-based interventions may be more difficult in rural settings. However, there has been an increasing number of mobile phone-based studies in rural areas in Africa, as well as continuing improvements to mobile phone connectivity in rural areas of Uganda in the last several years (Bärnighausen et al., 2011; Pop-Eleches et al., 2011). It should also be noted that the demographics of the focus group participants is slightly different from the broader parent study population (e.g., there is a higher percentage of women and self-rated "poor" individuals and a lower percentage of individuals who own a phone, are married, and are literate) and could affect the generalizability of our findings. There was no clinical guidance to justify a specific percentage point difference in adherence improvement, however; we selected a difference that we felt reflected meaningful change over the course of the study period. Finally, we did not have specific adherence information for each separate focus group category (e.g., flexible target with improved ART adherence or fixed target with no difference in ART

adherence), but instead ensured that participants fell into the general requirements of each group.

To our knowledge this is the first study to explore how fixed vs flexible targets affect adherence outcomes. The study also provides detailed insights regarding the use of innovative technology (e.g., MEMS caps and text message-based reminders) and the use of a prize drawing to improve adherence among youth.

## 6. CONCLUSION

Our results highlight several lessons for future efforts to address ART adherence among youth in resource-poor settings. First, participants preferred to set their own targets; their preference is consistent with Prospect Theory, which suggests that creating more manageable and attainable goals may be more effective than setting a uniform, relatively distant goal. Further, allowing patient participation in goal setting increases a sense of ownership. Second, while enthusiasm for MEMS caps was high, loss of the device at the study conclusion was upsetting for many participants. While it was not feasible to extend the use of MEMS caps without the study infrastructure, including lower cost feedback mechanisms (e.g. texting viral load results from the lab) should be explored as a potential way to motivate participants. Third, text messaging may be a useful way to remind patients to keep motivated between clinic visits, although ongoing engagement and support are needed from providers and counselors. Finally, our participants stressed the importance of including incentives with a small, positive value rather than zero when specifying the lowest prize.

Our results also highlight important points related to the future implementation of our study. There is increased emphasis on interventions that require minimal investment of provider time, but still achieve measurable impact on HIV outcomes (e.g., viral load suppression) (Creese, Floyd, Alban, & Guinness, 2002; Meyer-Rath, 2016; Siapka et al., 2014). Our results provide growing evidence that insights from behavioral economics, such as the value to participants of setting goals, can overcome existing behavioral barriers to ART adherence. The results also reinforce how technology, enhanced by other features such as small prize incentives, can help improve health behaviors. Such ‘light touch’ interventions – with respect to the time required from an already over-extended workforce as well as from participants themselves – have the potential to measurably enhance ART adherence.

It is important to consider the total cost of new interventions (Masters, Anwar, Collins, Cookson, & Capewell, 2017; Meyer-Rath, 2016), and to find alternatives when it may not be feasible to integrate specific components (e.g., MEMS cap) into the standard of care. Specifically, Uganda’s national guidelines (Uganda Ministry of Health, 2018) for ART adherence promise a continuous supply of ART, programs for psychosocial support and adherence, as well as disclosure of HIV status by caregivers with support of counselors when children are over 10 years old. While these broad guidelines likely have the flexibility to integrate aspects of this study (e.g., incorporate target setting in adherence counseling), integrating other aspects (e.g., MEMS caps) is not financially feasible at this time.

Nevertheless, insights from this study can be incorporated into future interventions to improve their effectiveness, enhancing the wellbeing of Ugandan youth living with HIV.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## REFERENCES

- Adejumo OA, Malee KM, Ryscavage P, Hunter SJ, & Taiwo BO (2015). Contemporary issues on the epidemiology and antiretroviral adherence of HIV-infected adolescents in sub-Saharan Africa: a narrative review. *Journal of the International AIDS Society*, 18(1), 20049. [PubMed: 26385853]
- Ammon N, Mason S, & Corkery J (2018). Factors impacting antiretroviral therapy adherence among human immunodeficiency virus-positive adolescents in Sub-Saharan Africa: a systematic review. *Public Health*, 157, 20–31. [PubMed: 29501984]
- Assarroudi A, Heshmati Nabavi F, Armat MR, Ebadi A, & Vaismoradi M (2018). Directed qualitative content analysis: the description and elaboration of its underpinning methods and data analysis process. *Journal of Research in Nursing*, 23(1), 42–55.
- Baird SJ, Garfein RS, McIntosh CT, & Özler B (2012). Effect of a cash transfer programme for schooling on prevalence of HIV and herpes simplex type 2 in Malawi: a cluster randomised trial. *The Lancet*, 379(9823), 1320–1329.
- Banerjee AV, Duflo E, Glennerster R, & Kothari D (2010). Improving immunisation coverage in rural India: clustered randomised controlled evaluation of immunisation campaigns with and without incentives. *British Medical Journal*, 340, c2220. [PubMed: 20478960]
- Bärnighausen T, Chaiyachati K, Chimbindi N, Peoples A, Haberer J, & Newell M-L (2011). Interventions to increase antiretroviral adherence in sub-Saharan Africa: a systematic review of evaluation studies. *The Lancet Infectious Diseases*, 11(12), 942–951. [PubMed: 22030332]
- Bionghi N, Daftary A, Maharaj B, Msibi Z, Amico K, Friedland G, ... O'Donnell M (2018). Pilot evaluation of a second-generation electronic pill box for adherence to Bedaquiline and antiretroviral therapy in drug-resistant TB/HIV co-infected patients in KwaZulu-Natal, South Africa. *BMC infectious diseases*, 18(1), 171. [PubMed: 29642874]
- Blashill AJ, Safren SA, Wilhelm S, Jampel J, Taylor SW, O'Cleirigh C, & Mayer KH (2017). Cognitive behavioral therapy for body image and self-care (CBT-BISC) in sexual minority men living with HIV: A randomized controlled trial. *Health Psychology*, 36(10), 937. [PubMed: 28541068]
- Cooper S (2003). Counseling and Testing Programs Stive Through the Use of Incentives. Paper presented at the National HIV Prevention Conference, Atlanta, GA; .
- Creese A, Floyd K, Alban A, & Guinness L (2002). Cost-effectiveness of HIV/AIDS interventions in Africa: a systematic review of the evidence. *The Lancet*, 359(9318), 1635–1642.

- Daher J, Vijn R, Linthwaite B, Dave S, Kim J, Dheda K, ... Pai NP (2017). Do digital innovations for HIV and sexually transmitted infections work? Results from a systematic review (1996–2017). *BMJ Open*, 7(11), e017604.
- De Walque D, Dow WH, Nathan R, Abdul R, Abilahi F, Gong E, ... Krishnan S (2012). Incentivising safe sex: a randomised trial of conditional cash transfers for HIV and sexually transmitted infection prevention in rural Tanzania. *BMJ Open*, 2(1), e000747.
- DeKoekkoek T, Given B, Given CW, Ridenour K, Schueller M, & Spoelstra SL (2015). mHealth SMS text messaging interventions and to promote medication adherence: an integrative review. *Journal of Clinical Nursing*, 24(19–20), 2722–2735. [PubMed: 26216256]
- Fox MP, & Kaufman JS (2018). The WeITel Trial in context and the importance of null findings. *The Lancet Public Health*, 3(3), e107. [PubMed: 29361434]
- Gamble T, Branson B, Donnell D, Hall HI, King G, Cutler B, ... Wood AF (2017). Design of the HPTN 065 (TLC-Plus) study: A study to evaluate the feasibility of an enhanced test, link-to-care, plus treat approach for HIV prevention in the United States. *Clinical Trials*, 14(4), 322–332. [PubMed: 28627929]
- Grusky O, Roberts KJ, & Swanson A-N (2007). Failure to return for HIV test results: a pilot study of three community testing sites. *Journal of the International Association of Physicians in AIDS Care*, 6(1), 47–55.
- Haberer JE, Kahane J, Kigozi I, Emenyonu N, Hunt P, Martin J, & Bangsberg DR (2010). Real-time adherence monitoring for HIV antiretroviral therapy. *AIDS and Behavior*, 14(6), 1340–1346. [PubMed: 20809380]
- Haukoos JS, Witt MD, Coil CJ, & Lewis RJ (2005). The effect of financial incentives on adherence with outpatient human immunodeficiency virus testing referrals from the emergency department. *Academic Emergency Medicine*, 12(7), 617–621. [PubMed: 15995093]
- Heath C, Larrick RP, & Wu G (1999). Goals as reference points. *Cognitive Psychology*, 38(1), 79–109. [PubMed: 10090799]
- HIV Prevention Trials Network. HPTN 065 Results at CROI 2015. Retrieved from <https://www.hptn.org/research/studies/hptn065>
- Horvath T, Azman H, Kennedy GE, & Rutherford GW (2012). Mobile phone text messaging for promoting adherence to antiretroviral therapy in patients with HIV infection. *The Cochrane Library*.
- Jochelson K (2007). *Paying the patient: Improving health using financial incentives*. London: King's Fund 22.
- Kagee A, Remien R, Berkman A, Hoffman S, Campos L, & Swartz L (2011). Structural barriers to ART adherence in Southern Africa: challenges and potential ways forward. *Global public health*, 6(1), 83–97. [PubMed: 20509066]
- Kane RL, Johnson PE, Town RJ, & Butler M (2004). A structured review of the effect of economic incentives on consumers' preventive behavior. *American Journal of Preventive Medicine*, 27(4), 327–352.
- Kennedy CE, Brahmabhatt H, Likindikoki S, Beckham SW, Mbwambo JK, & Kerrigan D (2014). Exploring the potential of a conditional cash transfer intervention to reduce HIV risk among young women in Iringa, Tanzania. *AIDS Care*, 26(3), 275–281. [PubMed: 23926908]
- Kim S-H, Gerver SM, Fidler S, & Ward H (2014). Adherence to antiretroviral therapy in adolescents living with HIV: systematic review and meta-analysis. *AIDS (London, England)*, 28(13), 1945.
- Koss CA, Hosek SG, Bacchetti P, Anderson PL, Liu AY, Horng H, ... Saberi P (2017). Comparison of Measures of Adherence to Human Immunodeficiency Virus Preexposure Prophylaxis Among Adolescent and Young Men Who Have Sex With Men in the United States. *Clinical Infectious Diseases*, 66(2), 213–219.
- Latham GP, Winters DC, & Locke EA (1994). Cognitive and motivational effects of participation: A mediator study. *Journal of Organizational Behavior*, 15(1), 49–63.
- Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, ... Najafzadeh M (2010). Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WeITel Kenya1): a randomised trial. *The Lancet*, 376(9755), 1838–1845.

- Linnemayr S, Huang H, Luoto J, Kambugu A, Thirumurthy H, Haberer JE, ... Mukasa B (2017). Text messaging for improving antiretroviral therapy adherence: no effects after 1 Year in a randomized controlled trial among adolescents and young adults. *American Journal of Public Health*, 107(12), 1944–1950. [PubMed: 29048966]
- Linnemayr S, Stecher C, & Mukasa B (2017). Behavioral economic incentives to improve adherence to antiretroviral medication. *AIDS*, 31(5), 719–726. [PubMed: 28225450]
- MacCarthy S, Mendoza-Graf A, Saya U, Samba C, Birungi J, Okoboi S, & Linnemayr S (2018). Lessons learned from a mobile technology-based intervention informed by behavioral economics to improve ART adherence among youth in Uganda. Manuscript submitted for publication.
- MacCarthy S, Saya U, Samba C, Birungi J, Okoboi S, & Linnemayr S (2018). “How am I going to live?”: Exploring barriers to ART adherence among older adolescents living with HIV in Uganda. Manuscript submitted for publication.
- Marteau TM, Ashcroft RE, & Oliver A (2009). Using financial incentives to achieve healthy behaviour. *British Medical Journal*, 338.
- Masters R, Anwar E, Collins B, Cookson R, & Capewell S (2017). Return on investment of public health interventions: a systematic review. *Journal of Epidemiology and Community Health*, 71(8), 827–834. [PubMed: 28356325]
- Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester RT, Mills EJ, Smieja M, ... Kouanfack C (2012). The Cameroon Mobile Phone SMS (CAMPS) trial: a randomized trial of text messaging versus usual care for adherence to antiretroviral therapy. *PloS one*, 7(12), e46909. [PubMed: 23236345]
- Meyer-Rath G (2016). The economics of antiretroviral therapy in South Africa: The role of budget impact modelling in changing policy. *London School of Hygiene & Tropical Medicine*.
- Mills EJ, Adhvaryu A, Jakiela P, Birungi J, Okoboi S, Chimulwa T, ... Golchi S (2018). Unconditional cash transfers for clinical and economic outcomes among HIV-affected Ugandan households: a bayesian randomised trial. *AIDS (London, England)*.
- Mitchell KJ, Bull S, Kiwanuka J, & Ybarra ML (2011). Cell phone usage among adolescents in Uganda: acceptability for relaying health information. *Health education research*, 26(5), 770–781. [PubMed: 21536715]
- Pellowski JA, Kalichman SC, Kalichman MO, & Cherry C (2016). Alcohol-antiretroviral therapy interactive toxicity beliefs and daily medication adherence and alcohol use among people living with HIV. *AIDS Care*, 28(8), 963–970. [PubMed: 26964014]
- Pop-Eleches C, Thirumurthy H, Habyarimana JP, Zivin JG, Goldstein MP, De Walque D, ... Sidle J (2011). Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. *AIDS (London, England)*, 25(6), 825.
- Qiang CZ, Yamamichi M, Hausman V, Altman D, & Unit I (2011). *Mobile applications for the health sector*. Washington: World Bank, 2.
- Rosen MI, Dieckhaus K, McMahon TJ, Valdes B, Petry NM, Cramer J, & Rounsaville B (2007). Improved adherence with contingency management. *AIDS Patient Care STDs*, 21(1), 30–40. [PubMed: 17263651]
- Ryan GW, & Bernard HR (2003). Techniques to identify themes. *Field Methods*, 15(1), 85–109.
- Sabin LL, DeSilva MB, Gill CJ, Li Z, Vian T, Wubin X, ... Haberer JE (2015). Improving adherence to antiretroviral therapy with triggered real time text message reminders: the China through technology study (CATS). *Journal of Acquired Immune Deficiency Syndromes*, 69(5), 551.
- Scanlon ML, & Vreeman RC (2013). Current strategies for improving access and adherence to antiretroviral therapies in resource-limited settings. *HIV/AIDS (Auckland, NZ)*, 5, 1.
- Seeley J, Watts CH, Kippax S, Russell S, Heise L, & Whiteside A (2012). Addressing the structural drivers of HIV: a luxury or necessity for programmes? *Journal of the International AIDS Society*, 15, 17397.
- Siapka M, Remme M, Obure CD, Maier CB, Dehne KL, & Vassall A (2014). Is there scope for cost savings and efficiency gains in HIV services? A systematic review of the evidence from low-and middle-income countries. *Bulletin of the World Health Organization*, 92, 499–511AD. [PubMed: 25110375]

- Sorensen JL, Haug NA, Delucchi KL, Gruber V, Kletter E, Batki SL, ... Hall S (2007). Voucher reinforcement improves medication adherence in HIV-positive methadone patients: a randomized trial. *Drug and Alcohol Dependence*, 88(1), 54–63. [PubMed: 17056206]
- Sutherland K, Christianson JB, & Leatherman S (2008). Impact of targeted financial incentives on personal health behavior. *Medical Care Research and Review*, 65(6\_suppl), 36S–78S. [PubMed: 19015378]
- The Alan Guttmacher Institute. (2005). Adolescent in Uganda: Sexual and reproductive health. Retrieved from New York, NY:
- Thornton RL (2008). The demand for, and impact of, learning HIV status. *American Economic Review*, 98(5), 1829–1863. [PubMed: 21687831]
- Uganda Ministry of Health. (2018). Consolidated Guidelines for the Prevention and Treatment of HIV and AIDS in Uganda. Retrieved from [https://elearning.idi.co.ug/pluginfile.php/5675/mod\\_page/content/19/Uganda%20HIV%20%20Guidelines%20-%20September%202018.pdf](https://elearning.idi.co.ug/pluginfile.php/5675/mod_page/content/19/Uganda%20HIV%20%20Guidelines%20-%20September%202018.pdf)
- van der Kop ML, Muhula S, Nagide PI, Thabane L, Gelmon L, Awiti PO, ... Marra C (2018). Effect of an interactive text-messaging service on patient retention during the first year of HIV care in Kenya (WeITel Retain): an open-label, randomised parallel-group study. *The Lancet Public Health*.
- White J, & Dow WH (2015). Intertemporal Choices for Health. *Behavioral Economics and Public Health*. In: Oxford University Press.
- Wu G, Heath C, & Larrick R (2008). A prospect theory model of goal behavior. Unpublished manuscript.



**HIGHLIGHTS**

- Almost all participants maintained that they preferred to set their own targets.
- Participants appreciated MEMS caps and noted that knowing their adherence information was being tracked often encouraged them to take their medications.
- Participants reported that text messages motivated them to take their medications and requested more intensive follow up by project staff when they reported not doing well.
- Participants said that the prize drawing alone did not motivate their ART adherence and that receiving ‘zero’ in the drawing was disheartening.

**Table 1.**

Sociodemographic Characteristics of FG Participants (n= 34) Compared to All Intervention Participants (n=215)

	Focus Group Participants (subgroup of all intervention participants)				All Intervention Participants		
	Mean	n/(SD)	Min	Max	Control (Mean)	Fixed Target (Mean)	Flexible Target (Mean)
<b>Socio-demographic information</b>							
Female (%)	61.8	21	0	1	50.7	53.52	57.97
Age (years)	19.4	-2.9	17	24	19.04	19.55	19.25
Married (%)	20.6	7	0	1	25.35	29.58	40.58
Literacy (%)							
read easily	56.3	19.1	0	1	69.01	69.01	63.77
write easily	62.5	21.3	0	1	77.46	77.46	65.22
Education (%)							
Completed primary	97.1	33	0	1	100	100	98.55
Completed secondary	55.9	19	0	1	77.46	77.46	65.22
Housing (%)							
Self-rated house as "poor"	52.9	18	0	1	43.66	49.3	37.68
Has electricity	76.5	28	0	1	78.87	88.73	81.16
Has piped water	47.1	16	0	1	53.52	59.15	50.72
<b>Text-related information</b>							
Owns Phone (%)	64.7	22	0	1	71	73	71
Text messages sent in past 24 hours	4	-8.3	0	30			
Text messages received in past 24 hours	6.6	-14.8	0	66			
<b>Adherence (%)</b>							
Self-reported	82.5	-19.9	30	100	83.85	80.21	85.77
Measured using MEMS cap	76.7	-33.9	0	100			
<b>Percentage of participants from each intervention group</b>							
Flexible Target	52.9	18	0	1			
Fixed Target	47.1	16	0	1			

NOTE: Self-reported adherence is the share of doses taken as prescribed in the past month, as reported by the participant also during the baseline survey. Adherence at randomization refers to the average electronically-measured adherence taken one month before SATA started.

**Table 2.**

## Themes from Focus Groups

Primary Theme	Secondary Theme	Description
<b>Fixed Target Setting</b>	General feedback	How participants felt about having their adherence target set for them, whether they thought this was a good idea or not
	Missing your fixed target	Comments about how participants felt when they missed their fixed target
	Gradual vs ambitious target setting	Opinions about whether participants think that gradual steps are better for helping to reach a high fixed target, or whether it is not necessary
	Level of difficulty	Feedback about how easy or difficult it was to reach their fixed target
<b>Flexible Target Setting</b>	General feedback	How participants felt about their ability to set their own target, whether they thought it was a good or bad idea
	Missing your flexible target	Comments about how participants felt when they missed their flexible target
	Gradual vs ambitious target setting	Opinions about whether participants think that gradual steps are better for helping to reach a high flexible target, or whether it is not necessary
	Level of difficulty	Feedback about how easy or difficult it was to reach their flexible target
<b>MEMS Cap Component</b>		Feedback about the MEMS caps, whether they helped to improve adherence, general comments on use of the MEMS cap in the intervention
<b>Text Messaging Component</b>		How text messaging can motivate ART adherence between prize drawings; other comments about the text-based component, including feelings and emotions in response to text messages
<b>Prize Drawing Component</b>	General impressions	Thoughts about whether the prize drawing encouraged them to increase their ART adherence
	Chances of winning	Thoughts about whether the prize drawings were fair, whether the airtime amounts were appropriate, other opinions about chances of winning