

GOALS for Adherence with Low-cost Incentives (GOALS): Findings From Year 1 of a Randomized Controlled Trial Evaluating the Impact of Small Airtime Incentives on ART Adherence Among Young People Living With HIV in Kampala, Uganda

Sebastian Linnemayr

RAND Corporation

Haijing Crystal Huang

crystal.huang@idinsight.org

IDinsight

Faith Kemunto Onkundi

IDinsight

Barbara Mukasa

Mildmay Uganda

Mary Odiit

Mildmay Uganda

Research Article

Keywords: HIV/AIDS, Behavioral Economics, Incentives, Goals, Uganda, Global Health, Randomized Controlled Trial

Posted Date: October 14th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10776574/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: Competing interest reported. SL reports grants from the National Institute of Child Health and Human Development (R01) 5R01HD104555-02 for the conduct of this study, including manuscript preparation and article processing charges. All other authors declare that they have no competing interests.

Abstract

Background.

Low adherence to antiretroviral therapy among HIV-positive youth threatens treatment outcomes, particularly in sub-Saharan Africa. Traditional incentives typically target uniformly high adherence levels and may demotivate individuals with initially low adherence. This study aims to compare subgoal incentives with individual-specific interim targets versus fixed-goal incentives with a uniform high target for improving antiretroviral therapy adherence among youth living with HIV.

Methods.

This parallel-group randomized controlled trial enrolled 630 participants aged 15 to 30 at Mildmay Hospital, Kampala, Uganda, between July 2022 and February 2024. Participants were randomized 1:1:1:1 to assigned subgoals, participatory subgoals, fixed goal, or usual care. Treatment arms received small airtime incentives for reaching quarterly adherence goals tracked via electronic pill boxes.

Results.

Mean control-group adherence was 65.3%. Compared to control, mean adherence increased by 5.9 percentage points for participatory subgoals ($p = 0.04$) and 6.0 for fixed goals ($p = 0.03$). The fixed-goal group showed a 7 percentage point increase in achieving 90% or greater adherence ($p = 0.04$). Subgoal groups were more likely to reach interim targets but did not show superior attainment of the ultimate adherence goal.

Conclusions.

Small airtime incentives improved ART adherence, but subgoaling did not outperform fixed goals in ultimate target attainment. Small airtime incentives are a low-cost way to improve ART adherence among youth living with HIV, and programs can adopt a simple fixed high-adherence target as the default.

Name of trial registry:

ClinicalTrials.gov

Trial registration number:

NCT05378607

Date of registration:

May 18, 2022, retrospectively registered

URL of trial registry record:

<https://clinicaltrials.gov/ct2/show/NCT05378607>

Background

Africa accounts for 64.5% of the 26.3 million people living with HIV globally.¹ Sustained high adherence to antiretroviral therapy (ART) is essential for long-term health and transmission reduction, yet adherence remains critically low among youth. Only 12% of U.S. youth achieve viral suppression,² while South African adolescents aged 11–19 are 50% less likely than adults to maintain optimal ART adherence and 70–75% less likely to be virologically suppressed.³ Among Ugandan youth aged 15–22, mean ART adherence was 64%, with fewer than 30% achieving the clinically recommended $\geq 90\%$ threshold.⁴

Evidence for effective interventions to improve adherence and clinical outcomes for the youth in sub-Saharan Africa is sparse. A 2018 systematic review found “current evidence is both sparse and lacking in quality” for adolescents,⁵ while another review identified only seven intervention studies targeting youth living with HIV, mostly small-scale U.S. pilots.⁶

Research^{7,8} shows that incentives hold promise for improving complex health behaviors including cardiovascular prevention,⁹ sexual behavior,¹⁰ and HIV-related behaviors.^{11–13} They provide short-term rewards for actions with delayed benefits, offsetting present-bias (the tendency to prioritize immediate gratification).¹⁴ Adolescents may be particularly responsive as they discount the future more heavily than adults¹⁵ and are more reward-sensitive.¹⁶ Their socio-emotional system develops faster than cognitive control, creating self-regulation challenges,¹⁷ and consequently allow them to derive greater satisfaction from incentives.¹⁸

However, traditional incentives typically reward uniform high thresholds (like 90% adherence¹¹ or viral suppression¹⁹), potentially demotivating those far from such goals. Individuals with low baseline performance must exert substantial unrewarded effort for marginal improvements. In Linnemayr, Stecher, and Musaka (2017), adherence improvements were driven by those with 60–80% baseline adherence; those below 90% reported demotivation from failing to win incentives.¹¹ Adolescents and young adults have the lowest self-esteem of any age group,²⁰ increasing susceptibility to demotivation. Redesigning incentives to enable those with low baseline adherence (and in particular youth) to reach their goals is thus of paramount importance.

Behavioral economics suggests breaking goals into smaller increments reconciles short-term behavior with long-term aspirations.²¹ Prospect Theory conceptualizes goals as reference points.^{22,23} proximity to goals enhances motivation, while distance causes demotivation and inaction.²⁴ Subgoaling creates interim goals towards the ultimate objectives, leveraging heightened effort when goals feel attainable,^{25,26} and boosting persistence.²⁷ This approach is most useful when individuals doubt reaching or perform far below distant goals.^{28,29}

Allowing participants to set their own subgoals increases agency,³⁰ heightening self-efficacy, goal commitment, and performance.^{31–33} This avoids crowding out intrinsic motivation³⁴ and leverages participants' private information about their capabilities.

The Goals for Adherence with Low-cost Incentives (GOALS) trial tested two subgoaling approaches to evaluate relative contributions of subgoaling and ownership. While goals mediate incentive effects on performance,³⁵ evidence on optimal goal-setting in incentive interventions is lacking. GOALS compared externally assigned subgoals (T1) and participatory subgoals (T2) targeting $\geq 90\%$ adherence at 12 months, versus fixed goals (T3). Year 1 focused on improvement; Year 2 will address maintenance (requiring sustained 90% adherence with viral suppression incentives); Year 3 will assess persistence after incentive withdrawal. Most incentive studies measure short-term change (< 6 months);⁶ GOALS provides needed evidence on sustaining adherence over time.

This paper reports Year 1 findings on comparative effectiveness of incentive designs for improving ART adherence among youth.

Methods

Study Design

The study was a parallel group randomized controlled trial, designed as a superiority trial and was conducted at Mildmay hospital in Kampala, Uganda where free HIV services are provided to about 15,000 patients. The study received institutional review board approvals. The full study protocol is published.³⁶ We appointed a single independent clinical psychologist as a monitor instead of a Data Monitoring Committee, given the low risk of harm. Patients and members of the public were not involved in the design, conduct, or reporting of this research.

Participants

The study aimed to identify participants with low adherence to antiretroviral therapy (ART). To achieve this, we implemented a 3-month observation period. During this phase, we used electronic pill boxes called 'Wisepill' to monitor adherence. These Wisepills are digital adherence monitoring devices that

record each time the pill container is opened, providing real-time data on medication adherence and enabling remote monitoring without clinic visits.

Eligible participants were aged 15–30 years, had been receiving ART for more than three months, had mobile phone access at least five days per week, and had Wisepill adherence during the three-month observation window of less than 90%. Exclusion criteria included inability or unwillingness to use the Wisepill device, mental health problems requiring immediate treatment, cognitive impairment affecting consent, inadequate phone access, or participation in another study.

Between April 25, 2022, and August 22, 2023, 1,342 participants were enrolled in the observation phase. Of these, 630 participants meeting the adherence threshold (< 90%) in the month preceding the baseline visit were randomized between July 25, 2022, and February 12, 2024.

Written informed consent was obtained from participants aged 18 years and above, while those under 18 provided verbal assent alongside parental or caregiver consent. Consent materials were available in English and Luganda.

Randomization and Masking

We randomized participants after recruitment and completion of the baseline survey to avoid influencing responses. Participants were allocated in a 1:1:1:1 ratio to four arms: assigned subgoals (T1), participatory subgoals (T2), fixed goal (T3), and control. In the first arm (T1, assigned subgoals), goals were externally assigned and adapted to their initial adherence level. In the second arm (T2, participatory subgoals), participants set their own interim goals. In the third arm (T3, fixed goal), all participants had to reach the fixed target goal of 90 percent adherence. All treatment groups were required to reach 90% adherence by Month 12 to participate in a larger prize drawing. The control group received the usual standard of care.

Randomization was done using sequential assignment while stratifying by baseline adherence to ensure balance between treatment groups and increase statistical power and precision in the estimated treatment effects. Baseline adherence was measured during the observation period as the percentage of prescribed doses taken over the 30 days prior to the baseline visit. Participants were grouped into four adherence strata: 0–54%, 55–71%, 72–82%, 83–89%. Adherence was calculated daily as 100% if the participant took all prescribed doses that day (e.g., one dose for a once-daily regimen, or two doses for a twice-daily regimen), 50% if only one of two doses was taken (for a twice-daily regimen), and 0% if no doses were taken. A randomization schedule was established ex-ante and sequential participants within a stratum were randomized accordingly. The randomization schedule contained blocks of four possible randomizations to the three treatment arms or the control group, with the order of the four possibilities randomized each time a new block begins. We used the ralloc function in Stata 17 to generate the randomization lists, which were uploaded to SurveyCTO and programmed to randomize participants on

the spot. The study coordinators were responsible for enrolling the participants and assigning them to the groups, whereas the research associate was responsible for generating the randomization sequence.

Participants were not blinded to their treatment status, and neither were the study coordinators who interfaced with the participants. The data analyst who conducted the impact analysis was however blinded to treatment assignment.

Procedures

Recruitment procedure

Participants typically had a clinic visit scheduled for a return clinic visit approximately three months after recruitment into the observation phase. Whenever possible, this visit coincided with a routine clinic appointment to minimize travel for study purposes only. Participants whose next scheduled visit was beyond three months were contacted by phone and invited back. Eligibility for the intervention phase was based on Wisepill-measured adherence. Eligible participants provided informed consent, completed a baseline survey, and were then informed of their treatment assignment (control or one of the three intervention groups).

Wisepill procedures

All participants were given a Wisepill device upon recruitment into the observation period of the study. At the time of distribution, they were instructed on how to refill the pill box and asked to use the device continuously throughout the study. Participants were advised to remove only one dose at the time of ingestion and to notify the study coordinator if their ART regimen changed during the study period. They were also informed that adherence data recorded by the device would not be shared with their clinicians.

Quarterly Prize Drawings

Participants in the three treatment arms were eligible to enter an in-person or remote prize drawing to win small amounts of mobile airtime of either 500, 5,000, or 10,000 Ugandan Shillings (approximately \$0.15, \$1.50, and \$3, respectively) if they reached the adherence goal required in a given treatment arm. In-person prize drawings were done if the date of the drawing coincided with the participants' regularly scheduled clinic visits; otherwise, they were done remotely. Wisepills record adherence remotely, so the study team was able to monitor adherence without an in-person visit. Remote prize drawings were conducted automatically by the computer, and the results and airtime reward texted to the participant over the phone.

Each treatment arm followed a distinct eligibility rule for quarterly incentives:

Assigned sub-goals eligibility: Participants in the assigned subgoals arm were eligible for the quarterly prize drawing if they reached their assigned goal in the respective quarter. The goal assigned was based

on the distance of observed baseline adherence from 90%, and divided by four to get at 4 equal, relatively small, increasing steps. For example, for someone with 50% baseline adherence, the study coordinator would calculate $(90\% - 50\% = 40\%; 40\% / 4 = 10\%)$, and set the adherence targets at the four study visits equal to 60% at month 3, 70% at month 6, 80% at month 9, and 90% at month 12. All participants were required to reach 90% at month 12.

Participatory sub-goals eligibility: Participants in the participatory subgoals arm were eligible for the quarterly prize drawing if they reached the goal they chose for themselves in the respective quarter. The only restriction was that each subsequent goal had to be equal to or higher than the previous one, and that at month 12 90% adherence is reached. For example, someone selected their adherence target in three months to be 70%, but they actually achieved 75%. The next target they chose then had to be 75% or higher. If a given target was not achieved, the participant could then choose one equal or higher to the one chosen previously.

Fixed-goal eligibility: Participants in the fixed-goal arm were eligible for the quarterly prize drawing if they reached 90% adherence in the respective quarter. This arm corresponded to how existing adherence interventions typically are implemented.

Participants completing in-person drawings were also asked to fill out a short prize drawing survey capturing their motivation, perceived goal attainability, and feedback on the incentive process.

Annual prize drawing

Participants in all three treatment arms were eligible to enter a larger prize drawing at the end of the first year if they reached 90% adherence over the course of 12 months.

Weekly motivational messages

The three treatment groups received weekly motivational messages and a reminder of their upcoming prize drawing. Weekly SMS messages helped maintain contact with study participants and enabled them to become accustomed to receiving messages from the study, including information about potential remote prize drawings. The control group only received the motivational portion of the text messages (without the reminders of the possibility of winning prizes) as an attention control due to the potential beneficial effects of text messages on adherence.

Follow-up surveys

Follow-up surveys were conducted at month 6 and 12 post baseline. These assessments allowed us to collect several data points for each participant on mediators or moderators that we believed may be influenced by the intervention (e.g., cognitive and motivational factors). Participants were compensated 30,000 UGX (about 8.4 USD) for their time every time they completed a survey questionnaire.

Concomitant care

All participants continued to receive standard HIV care at Mildmay Hospital throughout the trial, including routine ART dispensing, clinical review, and viral load monitoring. No arm-specific concomitant interventions were provided.

Outcomes

We tracked ART adherence continuously on the Wisepill server remotely over a 12-months period by monitoring the date and time of all Wisepill device openings. Mean adherence was coded as the number of ART doses taken / number of doses prescribed, with adherence capped at 100% each day to avoid multiple openings on a given day artificially inflating mean adherence.

The primary outcomes, prespecified in the trial registry, were mean ART adherence over 12 months and the proportion of participants achieving $\geq 90\%$ adherence. Secondary outcomes included the proportion with treatment interruptions > 48 hours, and retention in care (abstracted from clinic data). We also included a post hoc outcome that measured the probability of participants in the respective treatment groups reaching their adherence targets every 3 months.

Statistical Analysis

The full sample size calculation (which indicated 140 participants/arm for 80% power to detect an 8 percentage points difference) was prespecified.³⁶

The analyses of primary outcomes were by intention to treat. We compared overall differences across the 3 groups by using an ordinary least squares Linear Probability Model and F-tests. We estimated mean ART adherence (day-level) and the proportion of participants with $\geq 90\%$ adherence (week-level) using both unadjusted and adjusted models. The adjusted models controlled for prespecified baseline covariates: age, education, sex, strata fixed effects, baseline World Health Organization (WHO) disease stage, baseline viral suppression, duration on ART, socio-economic status (measured by the Poverty Probability Index for Uganda), and HIV disclosure status. Age was defined in years and was measured as an integer, and education was defined as a binary, with 1 representing participants with some education and 0, no education at all. Both our primary and secondary analyses were based on those completing the full year of the intervention. As a robustness check, we tested differences in outcomes for treatment heterogeneity on subgroup variables based on our conceptual model, such as high vs. low baseline adherence, intrinsic motivation to take treatment, and self-efficacy. Intrinsic motivation to take treatment was measured at baseline using items adapted from the Perceived Competence, Effort/Importance, and Value/Usefulness subscales of the Intrinsic Motivation Inventory (IMI), rated on a 1–7 Likert scale.³⁷ Self-efficacy was measured at baseline using the 12-item HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES), rated on a 0–10 scale.³⁸ The full baseline instrument in English and Luganda is provided as online supplemental appendix 5 and 6, respectively.

We accounted for the panel data structure which results in multiple observations from each individual by clustering standard errors by individual using Huber-White cluster-robust standard errors. P-values were adjusted for multiple hypothesis testing for all secondary outcomes by applying a false discovery rate

adjustment (FDR) following Benjamini et al. (2006). We present both p-values and sharpened q-values discussed in Anderson (2008). We performed all statistical analyses with Stata version 18.0 (StataCorp LP, College Station, TX). Analyses used all available observations, with person-days as the unit for mean adherence and person-weeks for the $\geq 90\%$ outcome. No imputation was performed for missing Wisepill data.

Results

Between April 25, 2022, and August 22, 2023, we approached and recruited 1,342 participants on a rolling basis for the observation phase of the study. This phase lasted approximately three months per participant, after which adherence-based eligibility was determined for the intervention phase. Between July 26, 2022, and February 12, 2024, we randomized 630 participants who met the eligibility threshold into the intervention phase (46.9%; Fig. 1). The remaining 712 participants were not enrolled because they showed adherence $\geq 90\%$ during the observation phase and hence were ineligible ($n = 623$), refused participation ($n = 68$), were lost to follow-up ($n = 9$), or voluntarily withdrew ($n = 3$). In the months following enrollment, 35 people left the study (voluntarily, lost to follow-up, or died) prior to completing the full year of the intervention. Attrition rates were similar across study arms, suggesting that differential loss to follow-up is unlikely to have biased comparisons between intervention groups.

Baseline demographic and clinical characteristics were generally well balanced across study arms (Table 1). The mean age of participants was 23.5 years (range across groups: 23.3–23.7), and 69.6% of participants were female, with slightly higher proportions in the assigned (75.5%) and participatory (72.6%) groups than in the fixed goal group (61.3%). Most participants (70.1%) reported being single at enrolment. Educational attainment was high, with 50.8% having completed secondary school and 22.2% primary school. Employment status was similar across groups, with 64.8% of participants reporting being employed. The average income earned in the past month was UGX 319,072.7 (about \$90 USD).

Table 1
Baseline Characteristics of Participants

Age, mean (SD), years	Control n = 158	Assigned n = 156	Participatory n = 158	Fixed n = 158	Total N = 630
	23.4 (0.31)	23.6 (0.32)	23.7 (0.31)	23.3 (0.35)	23.5 (0.16)
Female sex, No. (%)	107 (68)	117 (72)	114 (73)	95 (60)	433 (69)
Time on ART, mean (SD), years	8.5 (0.47)	9.5 (0.45)	9.4 (0.47)	9.8 (0.44)	9.3 (0.23)
Baseline adherence, mean (SD), %	60.3 (2.00)	61.4 (1.92)	60.1 (2.00)	60.9 (1.92)	60.7 (0.98)
Baseline stratum, No. (%)					
0–54%	51 (33)	51 (33)	52 (33)	51 (33)	205 (33)
55–71%	34 (22)	34 (22)	35 (22)	34 (21)	137 (22)
72–82%	36 (23)	35 (23)	37 (24)	36 (23)	144 (23)
83–89%	34 (22)	35 (23)	33 (21)	34 (22)	136 (22)
Education level, No. (%)					
Primary	32 (21)	34 (22)	31 (20)	41 (27)	138 (22)
Secondary	78 (50)	81 (52)	86 (55)	71 (46)	316 (51)
Single, No. (%)	107 (69)	106 (69)	114 (73)	109 (70)	436 (70)
Disclosed HIV status, No. (%)	141 (91)	139 (90)	145 (92)	142 (91)	567 (91)
Travel time to clinic, mean (SD), hrs	1.5 (0.10)	1.6 (0.10)	2.1 (0.30)	1.6 (0.08)	1.7 (0.09)
Difficulty meeting basic needs, No. (%)	114 (74)	102 (67)	105 (67)	98 (63)	419 (67)
Self-efficacy, mean (SD)	8.7 (0.08)	8.7 (0.08)	8.7 (0.09)	8.7 (0.08)	8.7 (0.04)
Notes: Figures are presented as n (%) for categorical variables and as means for continuous variables. Abbreviations: ART, antiretroviral therapy; UGX, Ugandan shillings.					

Household-level economic vulnerability was common: 67.3% reported difficulty meeting basic needs in the past month, 50.0% had skipped a meal in the past month, and 22.5% had skipped ART due to lack of food over the past month. Mean clinic visit cost was UGX 19,058, and average travel time to the clinic ranged from 1.5 to 2.1 hours, and was slightly longer in the participatory group.

At baseline, mean adherence over the 3-month observation period was 60.7%, with minimal variation across groups as is expected from stratifying randomization on adherence quartiles. Most participants (91.0%) had disclosed their HIV status to someone in their household or a friend. Reported psychosocial readiness was high overall, with mean self-efficacy scores of 8.7 (10-point scale) and average intrinsic motivation scores of 6.3 (competence), 6.6 (effort), and 6.9 (value), all measured on a 7-point scale. These measures were consistently high across arms.

Table 2 presents the primary outcome results. In the full sample of 51,817 person-days observed between intervention months 10 and 12, the mean adherence in the control group was 65.3%. We focused on the three months preceding month 12, as each participant in the participatory and assigned subgoals groups had a different subgoal path, and the only shared goal was to reach 90% adherence by month 12. A person-day was defined as any day with a valid Wisepill reading recorded for a participant, indicating non-missing adherence measurement on that day. Participants in all three treatment arms displayed higher average adherence than those in the control arm. Among these, only the participatory and fixed goal groups achieved statistically significant improvements. Compared to control, mean adherence increased by 5.87 pp (95% CI 0.2 to 11.6; $p = 0.04$) in the participatory goal group and 5.97 pp (95% CI 0.38 to 11.6; $p = 0.03$) in the fixed goal group. The assigned goal group saw a smaller, non-significant increase of 4.3 pp (95% CI - 1.5 to 10.1; $p = 0.15$). Results were consistent in unadjusted models, with slightly higher point estimates and significance retained for both participatory and fixed goal group (online supplemental appendix table 1).

Table 2
Effects of Intervention on ART Adherence (Adjusted Estimates)

Outcome	Obs	Control (n = 146)	Assigned subgoals (n = 149)	P	Participatory subgoals (n = 150)	P	Fixed goal (n = 150)	P
		Mean	Diff (95% CI)		Diff (95% CI)		Diff (95% CI)	
Mean adherence (%)	51,817	65.26	4.28 (-1.56 to 10.13)	0.15	5.87 (0.19 to 11.56)	0.04	5.97 (0.36 to 11.58)	0.03
Proportion $\geq 90\%$	7,027	0.26	0.01 (-0.05 to 0.08)	0.70	0.02 (-0.04 to 0.08)	0.60	0.07 (0.00 to 0.13)	0.04
Treatment effects are from adjusted models controlling for age, education, sex, baseline WHO disease stage, baseline viral suppression, duration on ART, socioeconomic status, and HIV disclosure status, with stratum fixed effects. Control group means are from unadjusted models. All estimates use robust standard errors clustered at the individual level. Differences are reported as percentage points compared to the control group.								

Subgroup analyses (adjusted for multiple-hypothesis testing) in the online supplemental appendix table 3 showed among participants with low self-efficacy, participatory subgoals increased adherence by 9.28pp (95% CI, 0.11–18.44; $q = 0.07$). The strongest effects occurred among youth with low intrinsic motivation, defined by below-median scores on intrinsic effort. In this group, participatory subgoals led to a statistically significant increase in mean adherence of 9.93 pp (95% CI: 2.40 to 17.6; $p = 0.04$).

Table 3
Secondary Outcomes (Adjusted Estimates)

Outcome	Obs	Control (n = 146)	Assigned subgoals (n = 149)	P	Participatory subgoals (n = 150)	P	Fixed goal (n = 150)	P
		Mean	Diff (95% CI)		Diff (95% CI)		Diff (95% CI)	
Treatment interruption ≥ 48 hrs	7,164	0.49	−0.05 (−0.12 to 0.02)	0.16	−0.04 (−0.11 to 0.03)	0.26	−0.08 (−0.15 to 0.00)	0.03
Clinic visit on time	2,299	0.83	0.04 (−0.01 to 0.08)	0.15	0.01 (−0.04 to 0.06)	0.67	0.02 (−0.02 to 0.07)	0.30
Mean clinic visits, year 1	590	3.91	−0.29 (−0.77 to 0.20)	0.24	−0.07 (−0.55 to 0.41)	0.77	0.24 (−0.24 to 0.71)	0.33
<i>Treatment effects are from adjusted models controlling for age, education, sex, baseline WHO disease stage, baseline viral suppression, duration on ART, socioeconomic status, and HIV disclosure status, with stratum fixed effects. Control group means are from unadjusted models. All estimates use robust standard errors clustered at the individual level. Differences are reported as percentage points compared to the control group.</i>								
[Figure 1: Randomization Flowchart]								
[Figure 2: Probability of Reaching Adherence Target by Treatment Arm and Round]								

In terms of achieving $\geq 90\%$ adherence during the final quarter of year 1 (calculated on a weekly basis), 26% of control participants met this threshold ($n = 7,027$ person-weeks). In comparison, participants in the fixed goal group experienced a 7 pp increase in this outcome (95% CI 0.0 to 13.0; $p = 0.041$). Improvements in the assigned and participatory groups were smaller (1 and 2 pp respectively) and not statistically significant ($p = 0.70$ and $p = 0.60$). Subgroup patterns were broadly similar, with the largest estimated increase observed among participants with low intrinsic motivation (competence) in the fixed goal group (8 pp; 95% CI −0.01 to 17.0; q -value = 0.40).

Table 3 below presents the results for secondary outcomes. For treatment interruptions, defined as any 48-hour gap in adherence, 7,164 person-weeks of Wisepill data were analyzed. Participants in the fixed goal group were less likely to experience a treatment interruption, with an 8-percentage point reduction compared to the control group (95% CI - 0.15 to 0.00; $p = 0.039$). Subgroup analyses indicated that the effects were similar across groups, with no statistically significant differences (online supplemental appendix table 4). Timeliness of clinic attendance likewise showed no overall effect; however, in subgroup analyses, participants with low intrinsic motivation (effort) who received assigned subgoals were 10 pp more likely to arrive on time (95% CI 0.03 to 0.17; q -value = 0.02). No significant differences in clinic-visit frequency emerged in the full sample or in any subgroup.

We conducted post-hoc exploratory analyses to explore outcomes that were not pre-specified in the protocol but were suggested by engagement data and participant behaviors during the intervention. In particular, we examined how likely participants were to meet their participatory (self-set) or assigned goals in each round against the fixed goal. As shown in Fig. 2, participants in both the assigned and participatory subgoal groups were more likely to reach their interim targets compared to those in the fixed goal group. On average, those in the assigned group were 10.8 pp more likely to meet their goal than the fixed group (95% CI: 3.4 to 18.2; $p = 0.004$), while those in the participatory group were 8.0 pp more likely (95% CI: 1.1 to 14.9; $p = 0.023$).

To complement our analysis of goal attainment, we conducted post-hoc exploratory analyses of goal-setting behavior to better understand how participants in the participatory group approached target selection compared to the assigned subgoal group. Participants had three sub-goaling opportunities throughout the year, each aligned with a quarterly prize drawing round. Draws were scheduled to coincide with routine clinic visits (rounds 2 and 4 were held in person, while rounds 1 and 3 were conducted remotely if no visit was scheduled). In Rounds 1 to 3, assigned-group participants received pre-set adherence goals, while those in the participatory group selected their own targets. By Round 4, all participants were expected to meet a $\geq 90\%$ adherence threshold.

Online supplemental appendix Fig. 1 presents average subgoal targets by baseline adherence and goal-setting round. Across all rounds, targets set by participants in the participatory group were broadly similar to those in the assigned group within each baseline adherence stratum. In the lowest adherence group ($< 50\%$), participatory participants selected slightly lower targets in Round 1, but in subsequent rounds, targets closely matched those in the assigned arm. In higher adherence strata (e.g., 70–89%), target levels remained uniformly high and nearly identical between groups across rounds.

Adverse events

Ten adverse events were reported to the relevant ethical committees throughout the study period. Seven participant deaths occurred due to causes unrelated to study participation (kidney failure, pregnancy complications, natural causes, motorcycle accident). One case involved HIV status disclosure to a spouse resulting in psychological distress and domestic violence exposure. One event was deemed

potentially study-related: unintentional HIV status disclosure to neighbors due to Wisepill device use, leading to social isolation. All events were handled per established protocols.

Discussion

In this randomized controlled trial among youth living with HIV in Uganda, we found that three different incentive-based interventions, including two with subgoals based on behavioral economics theory, improved medication adherence compared to standard care. These findings contribute important insights to the literature on incentive interventions for HIV adherence, particularly for adolescent and young adult populations, while challenging some theoretical assumptions about the superiority of incremental goal-setting approaches. While participants in both subgoal groups were significantly more likely to achieve their interim targets compared to the fixed goal group (10.8 and 8.0 pp higher, respectively), this success with intermediate goals did not translate into superior performance on the fixed 90% adherence target. Specifically, participatory subgoals performed (+ 5.9pp) better than assigned subgoals (+ 4.3pp), but fixed goal incentives demonstrated similar statistically significant adherence improvements compared to the usual-care control group (+ 6.0 pp). The fixed goal group also showed the strongest effect for achieving $\geq 90\%$ adherence (+ 7.0 pp, $P = 0.04$), while subgoals groups showed smaller, non-significant improvements.

Our results contribute to the growing evidence base on financial incentives for HIV medication adherence. A recent systematic review found that monetary incentives significantly improved viral suppression and adherence among people living with HIV, with effects being stronger for long-term interventions (≥ 1 year).³⁹ Our findings are consistent with this literature, showing meaningful improvements in adherence across all treatment arms compared to control. However, we clearly did not see the subgoaling arms to outperform the fixed goal arm (that largely mirrors the approach used in existing incentive interventions) in reaching the ultimate goal of 90% adherence.

One explanation for this finding could be tension between goal attainability (reinforcing motivation) and complacency (that is motivation-reducing).⁴⁰ Smaller, interim targets on the path to a larger objective can make daunting goals feel more attainable, especially for individuals starting far from the end goal.^{41–43} However, the literature on subgoaling has also shown that achieving a subgoal can sometimes create a sense of premature accomplishment, leading individuals to relax their efforts before reaching the ultimate goal.⁴⁰ This phenomenon, sometimes called the “resting on laurels” effect,⁴¹ can interfere with sustained motivation and ultimate goal attainment. Huang et al. (2017) also found the impact of subgoaling appears to shift over the course of goal pursuit. Early on, subgoals enhance motivation by increasing perceived attainability. As individuals make significant progress, however, the motivational benefit of subgoals diminishes, and a focus on the overall goal becomes more effective for sustaining effort. This dynamic is supported by experimental evidence showing that subgoals are most helpful when progress is low, but can become less motivating, or even counterproductive, as the end goal nears.

The competing effects of complacency versus motivation driven by subgoal attainability is individual-specific: some individuals may benefit from a longer period of subgoaling (before ultimate goal) to reinforce goal attainability and motivation, whereas others who reach a subgoal may be ready to immediately shift to a higher goal. As our study had the same goal adjustment period across subgoaling participants, one explanation could be that participants on average might have been ready to transition more rapidly to a higher goal, and the period of 3 months in between goal adjustments may have contributed to complacency effects. Alternatively, the study's 12-month "improvement" timeframe may have been too short for participants with initially low adherence to fully benefit from the motivational boost of consistently adhering to their subgoals – and we may expect to see adherence increases from them as the study progresses.

Another potential explanation for the mixed subgoaling results relates to habit formation theory. Medication adherence is fundamentally a daily repetitive behavior that benefits from automaticity and consistent routine.⁴⁴ The repetition-cue-reward model suggests that habits form through behavioral repetition in stable contexts with consistent rewards. Participants working toward a single, unchanging goal of 90% adherence throughout the study may have found it easier to develop consistent daily routines and medication-taking habits. In contrast, subgoal participants may not have repeated the behavior as often in the early stages where lower adherence levels make them eligible for prizes, potentially disrupting the formation of automatic behaviors. This interpretation aligns with research showing that habit strength, measured as consistency in medication timing, is strongly correlated with adherence outcomes.^{44,45}

Lastly, study-specific reasons may have contributed to subgoaling not being more effective. For example, maybe attaining the 90% adherence threshold may not have been perceived as particularly challenging, explaining why fixed goals showed strong results. We also may not have chosen the right subgoals in the assigned subgoals group that overall showed the weakest performance. Further research into these and other study parameters is warranted to fully exploit the (conceptually suggested) potential of setting subgoals in incentive interventions in the HIV and other realms.

The potential scalability of our intervention is promising. While electronic pillboxes are currently relatively expensive, their reusable nature and decreasing costs over time suggest feasibility for broader implementation. Additionally, simpler adherence monitoring methods—such as participants sending photos of their medication intake—could substantially reduce costs and further enhance scalability, although these methods require testing in future studies. A cost effectiveness analysis conducted at the end of the full 3-year study will contribute further insights into this point.

Our study has some limitations. First, it included only 630 participants from one urban clinic in Uganda. Although this sample was sufficient to detect significant differences, results might differ in other settings or countries. Second, while adherence was carefully monitored using electronic pill boxes (Wisepill), we cannot completely rule out the possibility that some participants opened boxes without actually taking their medication, in an attempt to increase their likelihood of receiving incentives. Third,

the ideal magnitude and timing of incremental adherence targets remains unclear; additional research is needed to identify the most effective ways to set and pace these intermediate subgoals. Lastly, our subgroup analyses were potentially underpowered, particularly after adjusting for multiple hypothesis.

Conclusions

Overall, this trial contributes important evidence about structuring incentives effectively to improve medication adherence among youth, a critical issue in HIV care in Sub-Saharan Africa and beyond. If further testing confirms long-term effectiveness, these insights could inform incentive-based strategies for other chronic health conditions and behaviors requiring sustained effort, such as weight loss or diabetes management, where smaller, frequent targets might similarly encourage long-term behavior change. As this trial continues into its second and third years (the maintenance and persistence phases), we will better understand whether adherence improvements achieved during the first year are sustained over the long term, including after incentives are discontinued.

Abbreviations

ART
Antiretroviral Therapy
FDR
False Discovery Rate
GOALS
Goals for Adherence with Low-cost Incentives
HIV
Human Immunodeficiency Virus
HIV-ASES
HIV Treatment Adherence Self-Efficacy Scale
IMI
Intrinsic Motivation Inventory
IRB
Institutional Review Board
MUREC
Mildmay Uganda Research Ethics Committee
NIH
National Institutes of Health
pp
percentage points
SMS
Short Message Service
UGX
Ugandan Shillings

USD
US Dollars
WHO
World Health Organization

Declarations

Ethics approval and consent to participate

We obtained IRB approval from the Mildmay Uganda Research Ethics Committee IRB (# MUREC-2022-102), as well as the Uganda National Council for Science and Technology (# HS2207ES). The conduct of the study conformed to the principles and relevant ethical guidelines covering informed consent, confidentiality, and data storage. We obtained written informed consent to participate from all participants aged 18 years and older prior to enrolment. In accordance with Ugandan national guidelines, which define a minor as any individual under 18 years of age, we obtained written informed consent from the parents or legal guardians of all participants under 18, and additionally obtained written informed assent from the minor participants themselves. Study coordinators explained the study objectives, procedures, risks, and benefits to participants (and, where applicable, to their parents or legal guardians) before signed consent and assent forms were collected at the pre-baseline visit. Participation was voluntary, and participants (or their parents/legal guardians) were informed that they could withdraw from the study at any time without consequence. No separate and/or additional procedures were needed for auditing trial conduct.

Consent for publication

Not applicable. No identifying images or other personal or clinical details of participants are presented in this manuscript.

Competing Interests

SL reports grants from the National Institute of Child Health and Human Development (R01) 5R01HD104555-02 for the conduct of this study, including manuscript preparation and article processing charges. All other authors declare that they have no competing interests.

Funding

The study is funded by the National Institute of Child Health and Human Development (R01) 5R01HD104555-02 (mPIs Huang and Linnemayr). The funder played no role in the study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication.

Author Contribution

SL and HCH designed the study and led all aspects of the protocol development as the principal investigators. HCH and FKO did program management, monitored data collection, and performed the main analysis. BM and MO advised on the study design and intervention implementation. All authors contributed to the study design, refinement of the study protocol, and data interpretation, and approved the final article.

Acknowledgement

We would like to thank the Mildmay management for hosting the study, in particular Dr. Barbara Mukasa and Ms. Mary Odiit. We are grateful to the Mildmay clinic staff for allowing this study to take place at their clinic and for providing administrative support. We are particularly grateful to our excellent study team Peter Wabukala, Lillian Lunkuse, Philip Aroda, Pol Wasirwa, Pius Flower, and Williams Kizito. We also thank all study participants for their time and effort being part of this study.

Data Availability

External researchers interested in investigator data, survey instruments, and other research methodology and procedures will be able to obtain this information through collaborative agreements such as a data use agreement with the Principal Investigators and Co-Investigators, as required by NIH's data sharing policy. Requests for access should be directed to the corresponding author, Dr. Haijing Crystal Huang (crystal.huang@idinsight.org).

References

1. 2025. World Health Organization. HIV statistics, globally and by WHO region, Geneva. WHO; 2025. https://cdn.who.int/media/docs/default-source/hq-hiv-hepatitis-and-stis-library/who-ias-hiv-statistics_2025-new.pdf. Accessed 25 Aug 2025.
2. Kapogiannis BG, Koenig LJ, Xu J, et al. The HIV continuum of care for adolescents and young adults attending 13 urban US HIV care centers of the NICHD-ATN-CDC-HRSA SMILE Collaborative. *J Acquir Immune Defic Syndr*. 2020;84(1):92–100. 10.1097/QAI.0000000000002308.
3. Uganda AIDS. Commission. Uganda HIV and AIDS country progress report: July 2015-June 2016. Kampala: Uganda Ministry of Health; 2016. https://www.unaids.org/sites/default/files/country/documents/UGA_2017_countryreport.pdf. Accessed 25 Aug 2025.
4. Linnemayr S, Huang H, Luoto J, et al. Text messaging for improving antiretroviral therapy adherence: no effects after 1 year in a randomized controlled trial among adolescents and young adults. *Am J Public Health*. 2017;107(12):1944–50. 10.2105/AJPH.2017.304089.

5. Ridgeway K, Dulli LS, Murray KR, et al. Interventions to improve antiretroviral therapy adherence among adolescents in low- and middle-income countries: a systematic review of the literature. *PLoS ONE*. 2018;13(1):e0189770. 10.1371/journal.pone.0189770.
6. Lall P, Lim SH, Khairuddin N, Kamarulzaman A. An urgent need for research on factors impacting adherence to and retention in care among HIV-positive youth and adolescents from key populations. *J Int AIDS Soc*. 2015;18(2 Suppl 1):19393. 10.7448/IAS.18.2.19393.
7. Giles EL, Robalino S, McColl E, Sniehotta FF, Adams J. The effectiveness of financial incentives for health behaviour change: systematic review and meta-analysis. *PLoS ONE*. 2014;9(3):e90347. 10.1371/journal.pone.0090347.
8. Vlaev I, King D, Darzi A, Dolan P. Changing health behaviors using financial incentives: a review from behavioral economics. *BMC Public Health*. 2019;19(1):1059. 10.1186/s12889-019-7407-8.
9. Kane RL, Johnson PE, Town RJ, Butler M. A structured review of the effect of economic incentives on consumers' preventive behavior. *Am J Prev Med*. 2004;27(4):327–52. 10.1016/j.amepre.2004.07.002.
10. Nyqvist MB, Corno L, de Walque D, Svensson J. Using lotteries to incentivize safer sexual behavior: evidence from a randomized controlled trial on HIV prevention. *World Bank Policy Research Working Paper No. 7215*. Washington, DC: World Bank; 2015. 10.1596/1813-9450-7215
11. Linnemayr S, Stecher C, Mukasa B. Behavioral economic incentives to improve adherence to antiretroviral medication. *AIDS*. 2017;31(5):719–26. 10.1097/QAD.0000000000001387.
12. Thornton RL. The demand for, and impact of, learning HIV status. *Am Econ Rev*. 2008;98(5):1829–63. 10.1257/aer.98.5.1829.
13. Lee R, Cui RR, Muessig KE, Thirumurthy H, Tucker JD. Incentivizing HIV/STI testing: a systematic review of the literature. *AIDS Behav*. 2014;18(5):905–12. 10.1007/s10461-013-0588-8.
14. White JS, Dow WH. Intertemporal choices for health. In: Roberto CA, Kawachi I, editors. *Behavioral economics and public health*. New York: Oxford University Press; 2015. pp. 27–68. 10.1093/med/9780199398331.003.0002.
15. Steinberg L. A social neuroscience perspective on adolescent risk-taking. *Dev Rev*. 2008;28(1):78–106. 10.1016/j.dr.2007.08.002.
16. Galván A. The teenage brain: sensitivity to rewards. *Curr Dir Psychol Sci*. 2013;22(2):88–93. 10.1177/0963721413480859.
17. Kray J, Schmitt H, Lorenz C, Ferdinand NK. The influence of different kinds of incentives on decision-making and cognitive control in adolescent development: a review of behavioral and neuroscientific studies. *Front Psychol*. 2018;9:768. 10.3389/fpsyg.2018.00768.
18. Trzesniewski KH, Donnellan MB, Robins RW. Stability of self-esteem across the life span. *J Pers Soc Psychol*. 2003;84(1):205–20. 10.1037/0022-3514.84.1.205.
19. Thirumurthy H, Ndyabakira A, Marson K, et al. Financial incentives for achieving and maintaining viral suppression among HIV-positive adults in Uganda: a randomised controlled trial. *Lancet HIV*. 2019;6(3):e155–63. 10.1016/S2352-3018(18)30330-8.

20. UNICEF. Statistical tables: HIV/AIDS global and regional trends. New York: UNICEF; 2017. <https://data.unicef.org/topic/hiv/aids/global-regional-trends/>. Accessed 25 Aug 2025.
21. Fennell LA. Slices and lumps: division and aggregation in law and life. Chicago: University of Chicago Press; 2019. 10.7208/chicago/9780226650432.001.0001.
22. Heath C, Larrick RP, Wu G. Goals as reference points. *Cogn Psychol*. 1999;38(1):79–109. 10.1006/cogp.1998.0708.
23. Wu G, Heath C, Larrick R. A prospect theory model of goal behavior. Working paper. Chicago: University of Chicago Booth School of Business; 2008.
24. Koo M, Fishbach A. Dynamics of self-regulation: how (un)accomplished goal actions affect motivation. *J Pers Soc Psychol*. 2008;94(2):183–95. 10.1037/0022-3514.94.2.183.
25. Bandura A, Schunk DH. Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *J Pers Soc Psychol*. 1981;41(3):586–98. 10.1037/0022-3514.41.3.586.
26. Louro MJ, Pieters R, Zeelenberg M. Dynamics of multiple-goal pursuit. *J Pers Soc Psychol*. 2007;93(2):174–93. 10.1037/0022-3514.93.2.174.
27. Stock J, Cervone D. Proximal goal-setting and self-regulatory processes. *Cogn Ther Res*. 1990;14(5):483–98. 10.1007/BF01172969.
28. Brunstein JC. Personal goals and subjective well-being: a longitudinal study. *J Pers Soc Psychol*. 1993;65(5):1061–70. 10.1037/0022-3514.65.5.1061.
29. Soman D, Shi M. Virtual progress: the effect of path characteristics on perceptions of progress and choice. *Manage Sci*. 2003;49(9):1229–50. 10.1287/mnsc.49.9.1229.16574.
30. Sue-Chan C, Ong M. Goal assignment and performance: assessing the mediating roles of goal commitment and self-efficacy and the moderating role of power distance. *Organ Behav Hum Decis Process*. 2002;89(2):1140–61. 10.1016/S0749-5978(02)00017-1.
31. Latham GP, Winters DC, Locke EA. Cognitive and motivational effects of participation: a mediator study. *J Organ Behav*. 1994;15(1):49–63. 10.1002/job.4030150106.
32. Latham GP, Yukl GA. Assigned versus participative goal setting with educated and uneducated woods workers. *J Appl Psychol*. 1975;60(3):299–302. 10.1037/h0076753.
33. Erez M, Arad R. Participative goal-setting: social, motivational, and cognitive factors. *J Appl Psychol*. 1986;71(4):591–7. 10.1037/0021-9010.71.4.591.
34. Gneezy U, Meier S, Rey-Biel P. When and why incentives (don't) work to modify behavior. *J Econ Perspect*. 2011;25(4):191–210. 10.1257/jep.25.4.191.
35. Locke EA, Latham GP. A theory of goal setting and task performance. Englewood Cliffs, NJ: Prentice-Hall; 1990.
36. Linnemayr S, Huang HC, Wagner Z, et al. Goals for Adherence with Low-cost Incentives (GOALS): a protocol for a randomized controlled trial evaluating the impact of small airtime incentives on ART adherence among young people living with HIV in Kampala, Uganda. *Trials*. 2023;24(1):511. 10.1186/s13063-023-07449-z.

37. Ryan RM. Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *J Pers Soc Psychol.* 1982;43(3):450–61.
38. Johnson MO, Neilands TB, Dilworth SE, Morin SF, Remien RH, Chesney MA. The role of self-efficacy in HIV treatment adherence: validation of the HIV Treatment Adherence Self-Efficacy Scale (HIV-ASES). *J Behav Med.* 2007;30(5):359–70.
39. Zhu Z, Guo L, Yang M, Cheng J. The effectiveness of monetary incentives in improving viral suppression, treatment adherence, and retention in care among the general population of people living with HIV: a systematic review and meta-analysis. *AIDS Res Ther.* 2025;22(1):57. 10.1186/s12981-025-00748-2.
40. Huang S, Jin L, Zhang Y. Step by step: sub-goals as a source of motivation. *Organ Behav Hum Decis Process.* 2017;141:1–16. 10.1016/j.obhdp.2017.05.001.
41. Amir O, Ariely D. Resting on laurels: the effects of discrete progress markers as subgoals on task performance and preferences. *J Exp Psychol Learn Mem Cogn.* 2008;34(5):1158–71. 10.1037/a0012857.
42. Soman D, Shi M. Virtual progress: the effect of path characteristics on perceptions of progress and choice. *Manage Sci.* 2003;49(9):1229–50. 10.1287/mnsc.49.9.1229.16574.
43. Heath C, Larrick RP, Wu G. Goals as reference points. *Cogn Psychol.* 1999;38(1):79–109. 10.1006/cogp.1998.0708.
44. Stecher C, Mukasa B, Linnemayr S. Uncovering a behavioral strategy for establishing new habits: evidence from incentives for medication adherence in Uganda. *J Health Econ.* 2021;77:102443. 10.1016/j.jhealeco.2021.102443.
45. Badawy SM, Shah R, Beg U, Heneghan MB. Habit strength, medication adherence, and habit-based mobile health interventions across chronic medical conditions: systematic review. *J Med Internet Res.* 2020;22(4):e17883. 10.2196/17883.

Figures

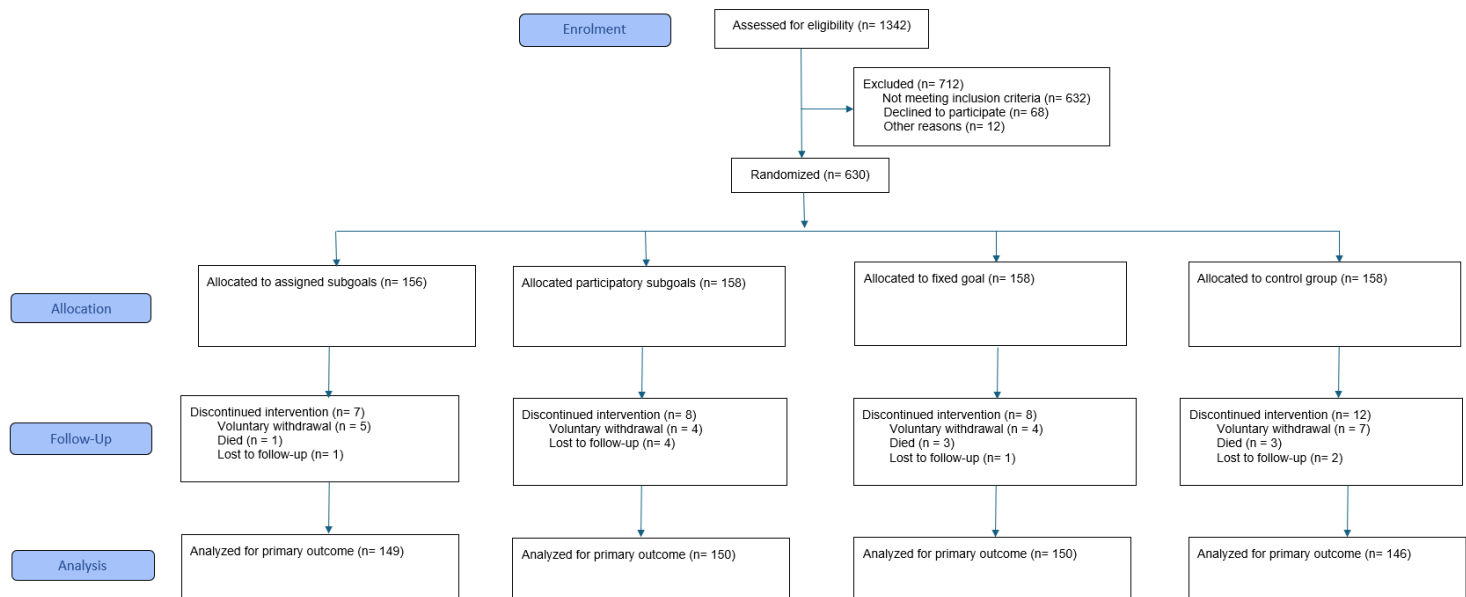
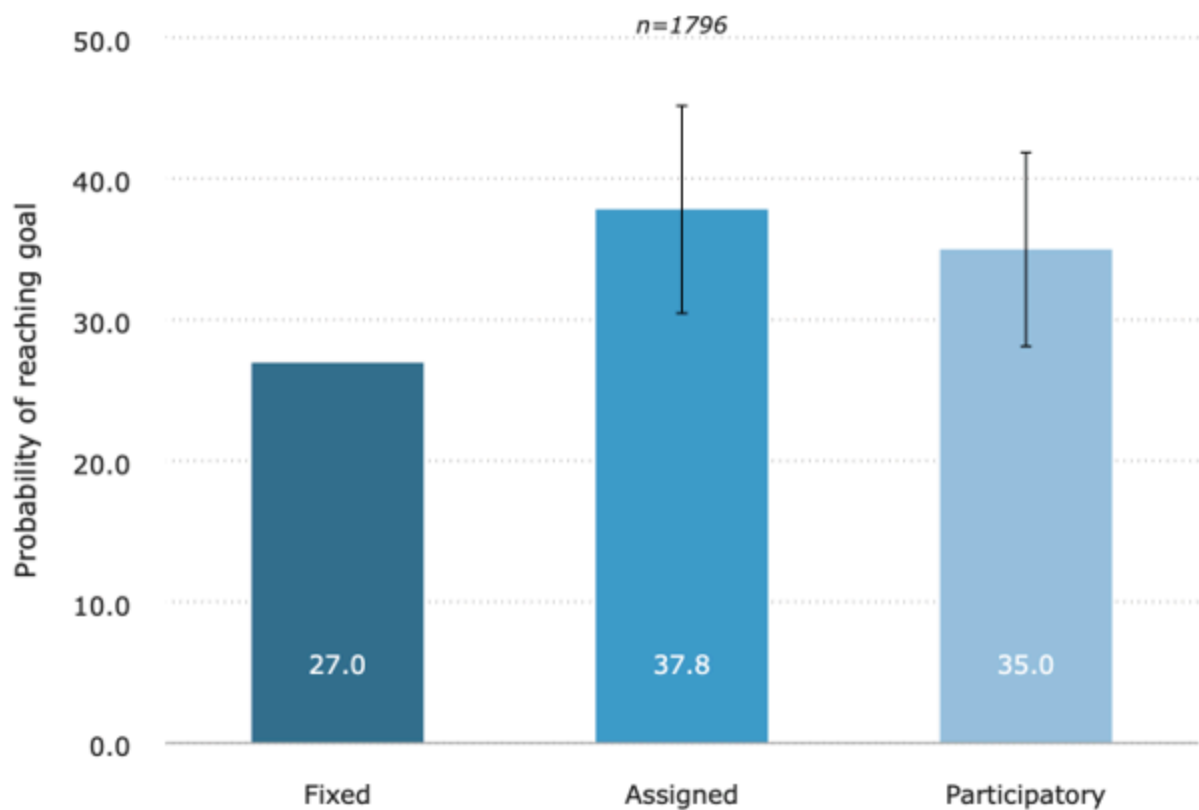


Figure 1

Randomization Flowchart

Flow of participants through the first year of the GOALS Trial



NOTE: Confidence intervals represent tests of equality between each treatment group and the fixed group.

Figure 2

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [CONSORT2025ChecklistGOALScompleted.docx](#)
- [Onlinesupplementalmaterial.docx](#)