Thrive with Me: Results of a Randomized Controlled Study of a Web-based ART Adherence Intervention in a Community-Recruited Sample of Sexual Minority Men Living with HIV

Keith Horvath, Sara Lammert, Darin Erickson, K. Rivet Amico, Ali Talan, Ore Shalhav, Christina J. Sun, H. Jonathon Rendina

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Keith Horvath[1] PhD; Sara Lammert[2] PhD; Darin Erickson[2] PhD; K. Rivet Amico[3] PhD; Ali Talan[4] DrPH; Ore Shalhav[5] MPH; Christina J. Sun[6] PhD; H. Jonathon Rendina[7] PhD

[1]Department of Psychology San Diego State University San Deigo US
[2]Division of Epidemiology and Community Health School of Public Health University of Minnesota Minneapolis US
[3]Health Behavior and Health Education School of Public Health University of Michigan Ann Arbor US
[4]Whitman Walker Health Washington DC US
[5]Guttmacher Institute New York City US
[6]College of Nursing University of Colorado Anschutz Medical Campus, Aurora US
[7]Department of Epidemiology Milken Institute School of Public Health George Washington University Washington D.C. US

Corresponding Author:
Keith Horvath PhD
Department of Psychology
San Diego State University
6363 Alvarado Court
Suite 250
San Deigo
US

Abstract

Background: The majority of new HIV infections are attributed to male-to-male sexual contact in the United States (US). However only two-thirds of sexual minority men (SMM) living with HIV achieve an undetectable viral load (VL), which is important to both optimize individual health and to substantially reduce onward HIV transmission. We tested a web-based antiretroviral therapy (ART) adherence intervention, called Thrive with Me (TWM), with core features that included medication self-monitoring and feedback, HIV and ART information, and a peer-to-peer exchange.

Objective: We assessed the efficacy of TWM on undetectable VL among adult (18+ years) SMM. As a secondary analysis, we assessed the impact of overall engagement and engagement with specific intervention features on undetectable VL.

Methods: 401 SMM (Mean = 39 years old; 72% racial/ethnic minority) in New York City were recruited between October 2016 and December 2019 and randomized to receive TWM (intervention) or a weekly email newsletter (control). Assessments occurred at baseline and months 5, 11, and 17. The primary outcome was a dichotomous measure of undetectable VL (<20 copies). Generalized Estimating Equations with robust standard errors were used to assess the effect of the TWM intervention on undetectable VL over follow-up in an unadjusted model, a model adjusted for baseline differences, and then stratified by baseline urinalysis (i.e., positive vs negative drug use). In secondary analyses, Generalized Linear Models were utilized to estimate risk differences of the association of overall engagement with TWM and engagement with specific TWM components on VL throughout the 17-month intervention period.

Results: Retention at each time point was: 88% (month 5), 82% (month 11), and 78% (month 17). No difference in DVL was found between those randomized to receive TWM or the control, or when stratified by baseline recent drug use. However, those TWM-assigned participants with high levels of engagement (in the 25th percentile) were more likely to have an undetectable VL at the end of the 5-month active intervention period compared to those with low engagement (below the 75th percentile) or no engagement in the intervention. Moreover, high engagement with the peer-to-peer exchange was associated with undetectable VL over time in unadjusted models.

Conclusions: TWM did not have overall impacts on viral suppression, however it may be beneficial to SMM who engage at high levels with this web-based intervention. Clinical Trial: ClinicalTrials.gov NCT02704208

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Keith J. Horvath[1], PhD; Sara Lammert[2], PhD; Darin Erickson[2], PhD; K. Rivet Amico[3], PhD; Ali Talan[4], DrPH; Ore Shalhav[5], MPH; Christina J Sun[6], PhD; H. Jonathon Rendina[7], PhD

1. Department of Psychology, San Diego State University, San Deigo, CA, United States
2. Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis, MN, United States
3. Health Behavior and Health Education, School of Public Health, University of Michigan, Ann Arbor, MI, United States
4. Whitman Walker Health, Washington DC, MD, United States
5. Guttmacher Institute, New York City, NY, United States
6. College of Nursing, University of Colorado Anschutz Medical Campus,, Aurora, CO, United States
7. Department of Epidemiology, Milken Institute School of Public Health, George Washington University, Washington D.C., MD, United States

Corresponding Author:
Keith Horvath, PhD
Department of Psychology
San Diego State University
6363 Alvarado Court
Suite 250
San Deigo, CA, 92120
United States
Phone: 1 6196943346
Email: khorvath@sdsu.edu

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ABSTRACT

Background

The majority of new human immunodeficiency virus (HIV) infections are attributed to male-to-male sexual contact in the United States (US). However, only two-thirds of sexual minority men (SMM) living with HIV achieve an undetectable viral load (UVL), which is important to both optimize individual health and to substantially reduce onward HIV transmission. We tested a web-based antiretroviral therapy (ART) adherence intervention, called Thrive with Me (*TWM*), with core features that included medication self-monitoring and feedback, HIV and ART information, and a peer-to-peer exchange.

Objective

We assessed the efficacy of *TWM* on HIV UVL among adult (18+ years) SMM. As a secondary analysis, we assessed the impact of overall engagement and engagement with specific intervention features on HIV UVL.

Methods

401 SMM (Mean age=39 years old; 72% racial/ethnic minority) in New York City were recruited between October 2016 and December 2019 and randomized to receive *TWM* (intervention) or a weekly email newsletter (control) for 5 months. Computerized assessments occurred at baseline and months 5, 11, and 17. The primary outcome was a dichotomous measure of HIV UVL ($\leq$20 copies). Generalized Estimating Equations with robust standard errors were used to assess the effect of the *TWM* intervention on HIV UVL over follow-up in an unadjusted model, a model adjusted for baseline differences, and then stratified by baseline urinalysis (i.e., positive vs negative drug use). In secondary analyses, Generalized Linear Models were utilized to estimate risk differences of the association of overall engagement with *TWM* (the sum of the number of days participants accessed 1 or more screens of the *TWM* intervention out of a possible 150 days) and engagement with specific *TWM* components on HIV UVL throughout the 17-month intervention period.

Results

Participant retention was: 88% (month 5), 82% (month 11), and 78% (month 17). No consistent differences in HIV UVL were found between those randomized to receive *TWM* or the control, or when stratified by baseline recent drug use at the 5- (differences in differences (DD) = -7.8 [-21.1, 5.5]), 11- (DD = -13.9 [-27.7, -0.04]), or 17-month (DD = -8.2 [-22.0, 5.7]) timepoint. However, those *TWM*-assigned participants with high overall levels of engagement (in the upper 25th percentile) were more likely to have an HIV UVL at the end of the 5-month active intervention period (Risk Difference (RD) = 19.4 [3.3, 35.5]) compared to those with low engagement (below the 75th percentile) (RD = 1.6 [-12.7, 16.0]) or no engagement (reference group) in the intervention. Moreover, high engagement with the peer-to-peer exchange was associated with HIV UVL over time in unadjusted models.

Conclusions

TWM did not have overall impacts on HIV UVL, however it may assist some SMM who are highly engaged with this web-based intervention to achieve HIV viral suppression.

Trial Registration: ClinicalTrials.gov NCT02704208, https://clinicaltrials.gov/study/NCT02704208

Key Words: HIV; ART; mHealth; Intervention; Men who Have Sex with Men

INTRODUCTION

Sexual minority men (SMM), especially Black and Latinx men, are at highest risk for acquiring human immunodeficiency virus (HIV) in the United States (US) [1]. It is estimated that 71% of all cases of HIV in the US (and 89% among males) in 2020 were attributed to male-to-male sexual contact, most of which occurred among Black (39%) and Hispanic/Latino (31%) SMM [1]. Disparities persist in HIV treatment outcomes. Among people living with HIV (PLWH), it is clear that greater efforts are needed to reach the Ending the HIV Epidemic Initiative goal that 90% of PLWH be virally suppressed by 2030 [2]. High proportions of PLWH who achieve an undetectable viral load (UVL) is important to both optimize individual health and to substantially reduce onward transmission [3-5]. However, among males living with HIV attributed to male-to-male sexual contact in 2020, 82% were linked to care within one month of their diagnosis, 76% received any HIV medical care, and 67% achieved virally suppressed in 2020 [6]. For these reasons, there is a continuing need for innovative ART adherence interventions for SMM living with HIV.

SMM living with HIV must navigate unique individual, social, and structural challenges – including intersectional stigma, racism, economic and legal hardships – throughout the HIV continuum of care [7]. Drug use, particularly stimulant use, [8] has been consistently associated with HIV seroconvesion [9, 10], as well as poorer antiretroviral therapy (ART) adherence that leads to sub-optimal rates of viral suppression [11-14]. Stimulant-using SMM have greater difficulties achieving and sustaining viral suppression, which could unnecessarily quicken clinical HIV progression [15-17] and increase risk for onward HIV transmission [18-20].

Efforts to develop and test electronic health (or eHealth), and more narrowly mobile health (or mHealth), interventions to address the HIV prevention and care continuum have expanded in recent years [21-23]. Reviews of eHealth and mHealth-based ART adherence interventions find that most are pilot or quasi-experimental designs and the results of these studies suggest a high potential of eHealth/mHealth approaches to improve ART adherence [21, 22]. However, the results of larger

randomized controlled trials of technology-based ART adherence interventions are mixed. One study showed significant reductions in plasma HIV VL for the treatment arm compared to the control arm [24]. Other studies show impacts on electronic dose monitoring or self-reported adherence outcomes but not plasma HIV VL [25-27], or only on plasma HIV VL for a sub-set of participants [28], or no impacts on plasma HIV VL or adherence [29]. For these reasons, further efforts are needed to understand how eHealth/mHealth interventions can be optimized to have impacts on clinically meaningful outcomes.

In addition to assessing overall intervention outcomes, it is critical that we have a better understanding of the effects that engagement in digital interventions is associated with treatment outcomes [30]. Intervention engagement metrics (e.g., the amount, frequency, duration, and depth of engagement in the entire or parts of a digital intervention) through the collection of "paradata" (i.e., data collected on users' actual activity in a digital intervention) may provide a more nuanced understanding of what features work for whom to advance digital intervention science [30-32]. A recent review of the use and findings from digital HIV prevention and treatment interventions for sexual and gender minority persons from 2017-2023 showed that, among the 33 digital HIV interventions published in those years, 19 reported paradata engagement metrics. However, only six studies reported the associations between intervention engagement and intermediate or primary study outcomes [30], of which four showed a positive association between intervention engagement (defined in a variety of ways) and health promotion behaviors [30]. Although these findings are encouraging, more information across a broad spectrum of digital HIV prevention and treatment interventions is needed to guide further investments into these approaches.

Here we report the results of the Thrive with Me (*TWM*) web-based intervention [33] in a large community sample of SMM living with HIV. We hypothesized that a higher proportion of participants in the *TWM* intervention than control participants will have HIV UVL post-intervention, and that participants in the *TWM* intervention who recently used illicit drugs will demonstrate

greatest improvements in HIV UVL post-intervention compared to participants who did not recently use illicit drugs. As a secondary aim, we examined the effect of level of engagement with the *TWM* intervention and its unique components on HIV UVL among those assigned to the *TWM* study arm. Such an analysis, although infrequently done [30,31], is critical to increase understanding of the degree to which exposure to eHealth/mHealth interventions and their individual components may be associated with HIV outcomes.

METHODS

Participants and Procedures.

SMM residing in the New York City metropolitan area were recruited between October 2016 and April 2018 by staff at an LGBTQ health research center at Hunter College, City University of New York. Interested persons completed an online screening survey that assessed for eligibility across multiple studies; next, persons who met basic criteria (e.g., living with HIV) for *TWM* were contacted to complete a second screener specific to the *TWM* study to determine eligibility. Eligibility included: 1) identified current gender as male; 2) reported having sex with a man in the past year; 3) HIV-positive serostatus; 4) self-report of a detectable VL in the past year or ART adherence <90% in the past 30 days; 5) English proficiency; 6) the ability to send / receive short message service messages; and 7) internet access over the course of the active intervention (5-months). Recruitment included a 50% target of self-reported street drug use (i.e., powder cocaine, crack cocaine, painkillers, methamphetamine, heroin, hallucinogens, recreationally used prescriptions drugs, ketamine, MDMA, and poppers). Participants meeting inclusion criteria were invited to attend an in-person enrollment visit that included completing a consent process with online documentation of consent, a computerized survey, urine-based drug use test, and a blood draw to assess HIV VL at the research offices at baseline, and months 5 (immediate post-intervention), 11, and 17.

Randomization and Blinding.

Following consent and completion of the enrollment activities described above, research staff used a computer algorithm used to randomize participants to either the *TWM* arm or control arm (1:1) using blocks of 20 (10 intervention and 10 control). The same computer algorithm stratified enrollment by recent drug use (i.e., reporting use of powder cocaine, crack cocaine, painkillers, methamphetamine, heroin, hallucinogens, prescription drugs used recreationally, ketamine, MDMA, and/or poppers in the past 30 days) and non-recent drug use based on their self-reported substance use in the baseline survey. Study arms were described to participants as "Group 1" or "Group 2", however study staff were not blinded as to which arm the participant was assigned.

The *Thrive With Me* (*TWM*) and Control Intervention.

Participants were onboarded to either the *TWM* or control condition as the final step during the enrollment visit. For participants randomized to the *TWM* study arm, they created a username and password that would give them free access to the intervention, and study staff provided information about each part of the intervention described below. Participants randomized to the control condition were told that they should receive the first email with the newsletter that week.

TWM is a 5-month (150 days) mobile-optimized web-based intervention to improve ART adherence among adult (18+ years of age) HIV-positive SMM residing in New York City with detectable VL and/or problematic ART adherence at baseline. An earlier pilot trial of *TWM* demonstrated feasibility, acceptability and preliminary impact [34]. *TWM* is grounded in the Information, Motivation, and Behavioral Skills (IMB) model [35, 36] and has the following core components: 1) a peer exchange (similar to Facebook) that allowed participants to post and comment on text, pictures, and videos in an unstructured format; 2) brief, tailored HIV and ART adherence informational articles (called "*Thrive Tips*", 300 were created in total) that were delivered daily, with the ability to search past content; 3) daily text message-based ART reminders that also provided an option for participants to report (through texting back) their ART adherence and overall mood for that day; and 4) weekly reflection on adherence, mood, and substance use. In addition, the *TWM* site

had a profile page to update settings and view points and badges earned, an “about us” page, and pages to explain how to use the site. Participants randomized to the *TWM* intervention were encouraged during the enrollment visit to use the intervention regularly, however, they were not required to meet a minimum engagement standard. A weekly drawing of a $25 gift card for those who used the site 5 or more times in the past 10 days was held during the active study period.

Participants randomized to the control condition receive a weekly email for 21 consecutive weeks that contained a link that, when clicked on, opened a webpage with information on a specific topic related to living with HIV and improving general wellbeing (e.g., HIV disclosure, managing stress), but not specifically about ways to improve ART adherence. An example weekly newsletter on the topic of managing stress is shown in Multimedia Appendix 1. More information about the *TWM* intervention and control arms is available elsewhere [33].

Measures.

Laboratory Measures

Plasma HIV-1 VL. Blood draws were collected at baseline and the 5-month, 11-month, and 17-month follow-ups at the Hunter research offices by a trained phlebotomist and assayed by Quest Diagnostics for the presence of plasma HIV-1 RNA. To assess primary outcome, we used anything below the lower limit of detection of 20 copies per microliter to define HIV UVL.

Drug Use. Participants completed urine screens at each assessment timepoint to detect for the following substances using the Integrated E-Z Split Key Cupp II-5 panel (Innovacon Laboratories): THC (marijuana), methamphetamine, amphetamine, cocaine, and opioids. This test can detect methamphetamine, amphetamine, cocaine, and opioids from 1 to 4 days after use and THC (marijuana) for up to 30 days after use. For this analysis, a positive baseline urinalysis was defined as any detectable measure of methamphetamine, amphetamine, cocaine, or opioids.

Survey Measures.

Sociodemographic Characteristics. At baseline, participants were asked common

sociodemographics factors including age (in years), race and ethnicity, highest level of education, and current employment status. Additional HIV history data was collected including 30-day ART adherence.

Psychosocial Characteristics. The following psychosocial characteristics were assessed using a computerized survey at each assessment, of which baseline measures were used for the purpose of characterizing participants in the current study. Depressive symptoms were assessed using the 10-item Center for Epidemiological Studies-Depression Scale [37] and dichotomized into depressive symptoms (CESD-Score ≥ 10) and no depressive symptoms (CESD-Score < 10). ART related Information (9 items), personal and social motivation (10 items), and behavioral skills (14 items) were assess used using the Information-Motivation-Behavior-ART Adherence Questionnaire (IMB-AAQ) [38]. HIV stigma, including internalized (6 items), anticipated (9 items), and enacted (9 items) stigma was assessed using the HIV Stigma Scale [39]. Social Support, including emotional/information support (8 items), tangible support (4 items), affectionate support (3 items), positive social interaction (3 items), as well as an overall social support score was assessed using the Medical Outcomes Study (MOS) Social Support Survey [40]. Life chaos and perceived stress were assess using the 6-item Life Chaos Scale [41] and the 14-item Perceived Stress Scale [42], respectively. Finally, alcohol use was assessed using the Alcohol Use Disorders Identification Test (AUDIT) [43].

TWM Intervention Engagement Measures.

TWM engagement data were only collected from individuals randomized to receive the *TWM* intervention (n = 202) during the 5-month (150 days) active intervention period. Engagement data were collected via a customized back-end website accessible only to study staff and investigators that provide these data in comma separated value (CSV) files that were updated as participants engaged with the intervention. These CSV files were downloaded after study participants were no longer active in the *TWM* intervention arm and cleaned for analyses.

Overall TWM Engagement. To quantify overall engagement in the *TWM* intervention, we summed the number of days on which a participant accessed at least one screen of the *TWM* intervention out of a possible 150 days. Those who did not log onto the *TWM* intervention during the intervention period were categorized as non-engagers, while those who accessed at least one screen of the *TWM* intervention were considered engagers. Next, those who engaged in *TWM* were further categorized as having high and low engagement based on dichotomization at the 75th percentile. While there are not established thresholds for definitions of engagement in digital interventions, we chose this level of engagement (as opposed to other possible options, such as 50th percentile) to represent participants who were more obviously active in the *TWM* intervention than, for example, a participant who was above the 50th percentile but not by much (e.g., 55th percentile). Using this cut-off, engagement to *TWM* was categorized as follows: Non-Engagers (0 days active); Low Engagement with *TWM* (1 – 33 days active); and High Engagement with *TWM* (34+ active days).

Engagement with Individual TWM Components. We calculated engagement with three individual *TWM* components: (1) peer exchanges; (2) *Thrive Tips* (i.e., brief informational pieces of content); (3) and ART adherence self-monitoring. Engagement with the asynchronous peer exchanges was measured using the sum of the number of unique wall posts and comments made by a user during the *TWM* intervention period (i.e., up to 150 days). Engagement with the *Thrive Tips* was calculated as the number of unique Thrive Tips participants viewed (possible range 0-300). Engagement with the ART adherence self-monitoring feature was the number of days participants reported their ART adherence (possible range 0-150). Participants were categorized as having high or low engagement with the individual *TWM* components based on dichotomization of each component at the 75th percentile.

Statistical Analyses.

Descriptive statistics (means [sd], frequencies [%]) were generated to describe the participants in the *TWM* study. Appropriate statistical tests were used to compare numeric (t-test) and

categorical variables (chi-square test) between the *TWM* intervention and control arms at baseline. All analyses were conducted using STATA v14 [44] and significance was established at $p < 0.05$.

To account for missing data during follow-up, we used multiple imputation. Demographic, psychosocial, and substance use factors that were associated with having an HIV UVL (<20 copies / mL) at baseline were used to impute missing variables at subsequent time points and HIV UVLs at month-5, month-11, and month-17 follow-ups.

We used Generalized Estimating Equations with robust standard errors to assess the effect of the *TWM* intervention on HIV UVL over follow-up in an unadjusted model, a model adjusted for baseline differences, and then stratified by baseline urinalysis (i.e., positive vs negative drug use). The main effects of interest are the condition-by-time interaction terms at Month-5, Month-11, and Month-17. The STATA xtgee command was used to calculate the differences-in-differences estimate as the proportion of those with an HIV UVL between participants in the *TWM* intervention arm and those in the control arm. Described in more detail elsewhere [45], a difference-in-difference estimation, first, calculates the difference between each follow-up timepoint and baseline estimates within each study arm; using those within arm difference estimates, the difference-in-difference estimate (and the associated confidence interval) is arrived at by finding the difference between study arms for each assessment timepoint.

To assess the impact of engagement with the *TWM* intervention on viral suppression, we modelled overall engagement with the *TWM* intervention, as well as engagement with the three *TWM* components described above, on HIV UVL (<20 copies / mL) throughout the 17-months for participants assigned to the *TWM* intervention (n=202). Generalized Linear Models with robust standard errors were utilized to estimate risk differences and 95% confidence intervals of the association of overall engagement with *TWM* and engagement with specific *TWM* components on viral suppression throughout the 17-month intervention period including unadjusted models and models adjusted for differences between *TWM* users and non-users of the *TWM* intervention.

Ethical Considerations

All study procedures were approved by the University of Minnesota Internal Review Board and Hunter College City University of New York Internal Review Board. Additionally, a Data Safety and Monitoring Board was established to provide regular oversight of research practices and activities to protect human subjects and the integrity of the data in the study. Written informed consent was provided by all study participants, and data were de-identified prior to analyses for the current study. Participants were paid $50 in cash at the baseline and 5-month, 11-month, 17-month assessments. Participants in the intervention group were also eligible to win a weekly prize drawing of a $25 electronic gift card if they were active on the *TWM* website for five out of 10 preceding days. The study was registered on the national registry of clinical trials at clinicaltrials.gov; trial number NCT02704208.

Results

A total of 401 men who have sex with men living with HIV were recruited to participate in the *TWM* study. Following a 1:1 randomization, 202 participants were randomized to receive the *TWM* intervention (50.4%) while 199 were randomized to receive the control condition (49.6%) (**Figure 1**).

Baseline Characteristics

Table 1 shows participant characteristics for the full sample and by study arm. The average age of participants was 39.1 years old. More than half of participants identified as African American /Black (57%), 28% as White, and almost 8% as more than one race. Additionally, more than a quarter (27%) identified as Hispanic/Latino. More than 40% were employed full-time or part-time and an additional 39% were unemployed. Overall, approximately three-quarters of participants had some college or a college degree, with a higher proportion of participants in the control than the *TWM* arm holding a college degree (42.2% vs 25.7%, respectively). Nearly half of participants self-reported depressive symptoms at baseline (48.4%). No group differences were found for perceived

stress, HIV stigma, social support, or life chaos.

Table 1. Baseline Characteristics of the Thrive With Me (*TWM*) Intervention and Control Conditions

	Total (n = 401)	***TWM* Study Arm** (n = 202)	**Control Study Arm** (n = 199)
Demographics			
Age, *mean (sd)*	39.1 (10.8)	40.1 (10.8)	38.1 (10.6)
Race, *n (%)*[a]			
African American or Black	230 (57.4)	123 (60.9)	107 (53.8)
American Indian / Alaska Native	5 (1.2)	1 (0.5)	4 (2.0)
Asian	3 (0.7)	1 (0.5)	2 (1.0)
Native Hawaiian or Pacific Islander	2 (0.5)	2 (1.0)	0 (0)
White	113 (28.2)	54 (26.7)	59 (29.6)
More than one race	31 (7.7)	12 (5.9)	19 (9.6)
Hispanic, *n (%)*	108 (26.9)	62 (30.7)	46 (23.1)
Education, *n (%)*[b]			
High School or Less	97 (24.2)	59 (29.2)	38 (19.1)
Some college / Associates / Technical Degree	167 (41.6)	90 (44.6)	77 (38.7)
College / Post Graduate / Professional Degree	136 (33.9)	52 (25.7)	84 (42.2)
Employment Status, *n (%)*[c]			
Full-Time	87 (21.7)	41 (20.3)	46 (23.1)
Part-Time	88 (21.9)	45 (22.3)	43 (21.6)
Unemployed	156 (38.9)	77 (38.1)	79 (39.7)
Disabled	63 (15.7)	35 (17.3)	28 (14.1)
Retired	3 (0.7)	2 (1.0)	1 (0.5)
Viral Load & ART Adherence Measures			
Viral Load (VL) (≤ 20), *n (%)*[d]			
Detectable VL	154 (38.4)	74 (36.6)	80 (40.2)
Undetectable VL	246 (61.3)	127 (62.9)	119 (59.8)
30-Day Adherence, mean (sd)	87.6 (17.6)	87.2 (18.6)	88.0 (16.6)
IMB Scale for ART Adherence, *mean (sd)*			
Information	36.7 (5.8)	37.0 (5.8)	36.4 (5.9)
Motivation	34.0 (8.4)	34.8 (8.1)	33.2 (8.5)
Behavior	48.2 (8.5)	48.8 (8.3)	47.6 (8.8)
Drug Use & Alcohol Measures			
Positive Urinalysis, *n (%)*	113 (28.2)	65 (32.2)	48 (24.1)
Marijuana Use, *n (%)*	165 (41.1)	88 (43.6)	77 (38.7)
Methamphetamine Use, *n (%)*	58 (14.5)	31 (15.3)	27 (13.6)
Amphetamine Use, *n (%)*	45 (11.2)	25 (12.4)	20 (10.1)
Cocaine Use, *n (%)*	52 (13.0)	33 (16.3)	19 (9.6)
Opioid Use, *n (%)*	5 (1.2)	2 (1.0)	3 (1.5)
Hazardous or Harmful Alcohol Use, *n (%)*	116 (28.9)	61 (30.2)	55 (27.6)
Additional Sociodemographics			
Depressive Symptoms, *n (%)*	194 (48.4)	100 (49.5)	94 (47.2)
Perceived Stress, *mean (sd)*	16.8 (7.3)	17.0 (7.3)	16.6 (7.4)
HIV Stigma Scale, *mean (sd)*			
Internalized Stigma	2.2 (1.1)	2.2 (1.1)	2.2 (1.1)
Anticipated Stigma	2.0 (0.9)	2.0 (0.9)	2.0 (0.8)
Enacted Stigma	1.5 (0.7)	1.5 (0.7)	1.6 (0.7)

Social Support Scale, *mean (sd)*			
Emotional Support	3.5 (1.2)	3.6 (1.2)	3.5 (1.2)
Affectionate Support	3.5 (1.3)	3.5 (1.3)	3.4 (1.4)
Tangible Support	3.1 (1.4)	3.1 (1.4)	3.1 (1.4)
Social Interaction Support	3.6 (1.3)	3.6 (1.2)	3.5 (1.3)
Overall Social Support	3.4 (1.1)	3.5 (1.1)	3.4 (1.2)
HIV Life Chaos, *mean (sd)*	15.9 (4.8)	15.8 (4.7)	15.9 (4.8)

a. 17 participants did not report Race
b. 1 participant did not report Education
c. 4 participants did not report Employment
d. 1 participant did not receive VL testing

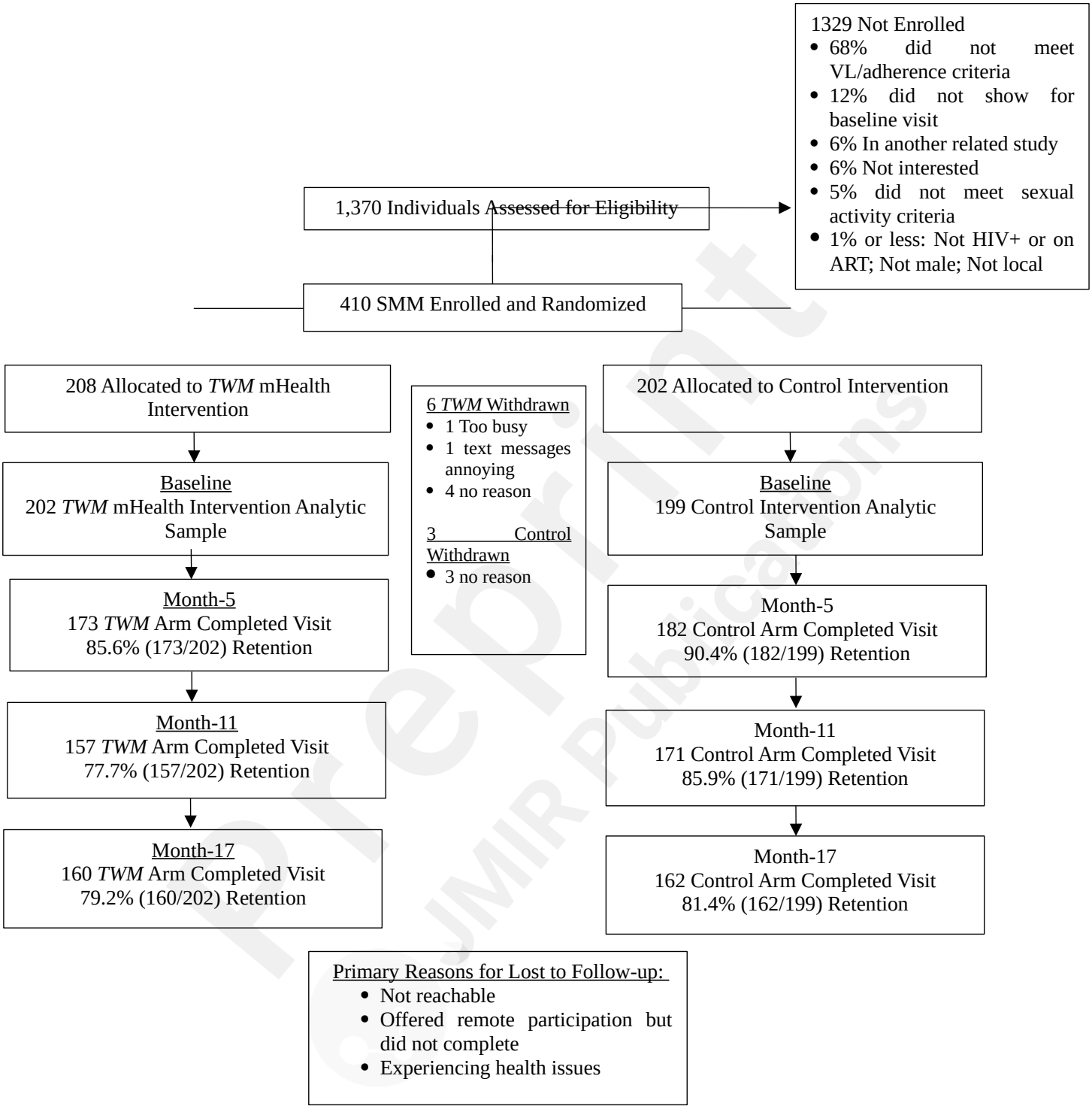
Excluding marijuana, approximately one-quarter of participants at baseline had detectable levels of substance use from urinalysis and 11% were positive for two or more substances. Over 10% of the sample reported baseline levels of methamphetamine (14.5%), cocaine (13.0%), and amphetamine use (11.2%); however only 1% of participants tested positive for opioids. Approximately 41% of participants tested positive for THC at baseline. More than one-quarter of participants (28.9%) self-reported hazardous, harmful alcohol use or alcohol dependence.

At baseline, participants reported an average percent ART adherence in the past 30 days of 87.6%, with no group differences found in this or IMB-AAQ ART-related information, motivation, or behavioral skills variables.

Study Retention.

Overall, nearly 90% were retained at Month-5 (88.5%), while 328 (81.8%) and 322 (80.3%) were retained at Month-11 and Month-17, respectively. Differences in retention were found at Month-11 (Intervention: 157 [77.7%] vs 171 [85.9%]). On average, those who were retained across both study arms at Month-11 had lower affectionate support (M=3.4) compared to those who were not retained (M=3.8). No other sociodemographic differences by study arm were found. Retention by treatment and control group can be found in the CONSORT [46] flow diagram in Figure **1.**

Figure 1. Thrive with Me (*TWM*) intervention trial CONSORT diagram.



The Effect of TWM on HIV VL for the Overall Sample and Stratified by Baseline Drug Use

Approximately two-thirds of participants had an HIV UVL at baseline (66.3% in the adjusted model), as shown in **Table 2**. The proportion of all participants with an HIV UVL remained relatively consistent over the follow-up period (Month-5: 59.6%; Month-11: 55.9%; Month-17: 54.5%).

Overall, the proportion of participants with HIV UVL decreased from baseline to month-17 across both study arms. In unadjusted models, there was no difference in HIV UVL between those randomized to receive the *TWM* intervention and those randomized to the control at any of the follow-up time points. Similarly, adjusting for baseline education, there was no difference in HIV UVL between those randomized to receive the *TWM* intervention and the control arm for the month-5 and month-17 assessments. However, in the month-11 assessment, participants randomized to the *TWM* intervention were less likely to have an HIV UVL compared to those randomized to the control in the adjusted model (Difference in Difference: -13.9 [-27.7, -0.04]).

Table 2. The Effect of *TWM* on HIV-1 Undetectable Viral Load (UVL) for the full sample and by study arm.

	***TWM* Intervention (n = 202)**			
	Baseline % UVL[a]	Month 5 % UVL	Month 11 % UVL	Month 17 % UVL
Full Sample				
Unadjusted	63.1 (56.4, 59.7)	57.9 (50.7, 65.0)	54.2 (46.9, 61.6)	52.9 (45.2, 60.6)
Adjusted	66.3 (59.8, 72.7)	59.6 (52.4, 66.8)	55.9 (48.5, 63.3)	54.5 (46.8, 62.2)
Positive Drug Urinalysis				
Unadjusted	48.5 (36.2, 60.7)	42.1 (29.3, 54.8)	30.5 (17.5, 43.5)	34.2 (21.0, 47.3)
Adjusted	51.1 (39.0, 63.2)	44.8 (31.6, 58.1)	31.0 (17.5, 44.6)	35.4 (21.6, 49.2)
Negative Drug Urinalysis				
Unadjusted	70.1 (62.4, 77.7)	66.4 (58.2, 74.6)	65.0 (56.2, 73.8)	61.6 (52.8, 70.5)
Adjusted	73.1 (65.7, 80.4)	67.4 (59.4, 75.5)	66.8 (58.2, 75.3)	62.7 (54.0, 71.5)
	Control (n = 199)			
	Baseline % UVL	Month 5 % UVL	Month 11 % UVL	Month 17 % UVL
Full Sample				
Unadjusted	59.8 (53.0, 66.6)	60.9 (53.9, 67.9)	63.9 (56.5, 71.2)	56.8 (49.2, 64.5)
Adjusted	58.1 (51.6, 64.7)	59.3 (52.6, 65.9)	61.6 (54.6, 68.7)	54.5 (47.1, 62.0)
Positive Drug Urinalysis				

Unadjusted	47.9 (33.8, 62.0)	54.1 (38.9, 69.3)	56.7 (42.2, 71.1)	46.7 (30.5, 62.8)
Adjusted	46.0 (32.9, 59.1)	51.5 (37.8, 65.2)	53.1 (39.8, 66.4)	42.2 (27.4, 57.0)
Negative Drug Urinalysis Unadjusted	63.6 (55.9, 71.3)	62.6 (54.7, 70.6)	66.6 (58.3, 74.8)	60.4 (51.6, 69.2)
Adjusted	62.1 (54.6, 69.6)	61.6 (53.8, 69.3)	64.9 (56.9, 72.9)	58.9 (50.3, 67.6)
		Difference-in-Difference Estimates[a]		
		Baseline to Month 5	Baseline to Month 11	Baseline to Month 17
Full Sample Unadjusted		-6.4 (-20.1, 7.4)	-12.9 (-27.1, 1.4)	-7.2 (-21.5, 7.0)
Adjusted		-7.8 (-21.1, 5.5)	-13.9 (-27.7, -0.04)	-8.2 (-22.0, 5.7)
Positive Drug Urinalysis Unadjusted		-12.5 (-34.7, 9.6)	-26.8 (-49.9, -3.6)	-13.1 (-38.5, 12.4)
Adjusted		-11.7 (-37.8, 14.3)	-27.2 (-52.5, -1.9)	-11.9 (-39.0, 15.2)
Negative Drug Urinalysis Unadjusted		-2.8 (-18.5, 13.0)	-8.1 (24.4, 8.3)	-5.3 (-21.6, 11.1)
Adjusted		-5.1 (-20.4, 10.2)	-9.1 (-24.9, 6.8)	-7.1 (-23.1, 8.8)

a. UVL = Undetectable Viral Load
b. Difference-in-Difference = The between study arm difference calculated from the difference between each follow-up assessment and baseline within study arm.

When stratified by baseline drug use, the proportion of participants with HIV UVL was higher among those with a negative urinalysis compared to those with positive urinalysis at baseline. Among those with a positive urinalysis at baseline, individuals randomized to the *TWM* intervention were less likely at only the month-11 assessment to have an HIV UVL compared to those randomized to the control in both unadjusted (Difference in Difference: -26.8 [-49.9, -3.6]) and adjusted models (Difference in Difference: -27.2 [-52.5, -1.9]). However, this difference was not found at any other timepoint for those with a positive urinalysis, nor at any timepoint for participants with a negative baseline urinalysis.

The Effect of Engagement in TWM on HIV VL for Participants Randomized to the TWM Intervention

Among the 202 participants who were randomized to receive the *TWM* intervention, 110 participants (54.5%) accessed the *TWM* intervention at least once during the 5-month intervention (i.e., engagers) while 92 participants (45.5%) did not use any of the *TWM* intervention components (i.e., non-engagers). There were no demographic differences between *TWM* engagers and non-

engagers. However, participants who used the *TWM* intervention were less likely to have a detectable VL (29.1%) at baseline compared to those who did not use the intervention (45.7%). *TWM* engagers were also less likely to have a positive urinalysis for methamphetamine (9.1% vs 22.8%) and amphetamines (5.5% vs 20.7%) compared to non-engagers.

Table 3 shows the median frequency and interquartile range [IQR] for overall engagement and each of the three individual components (frequency of asynchronous peer exchanges, number of unique *Thrive Tips* viewed, daily ART self-monitoring) by whether participants were considered to be low engagers (75th percentile) or high engagers (25th percentile) in each of the variables. With the exception of daily ART self-monitoring, substantial differences in engagement was found between low and high engagers. For example, low engagers had an average of only 7 active days in the intervention, while high engagers had an average of 78 active days. While differences in daily ART self-monitoring were evident among low and high engagers (100 days for low engagers vs. 144 for high engagers), it was not as stark as with other features.

Table 3. Frequency of *Thrive with Me* User Engagement Among Participants Randomized to and Accessed TWM At Least Once

TWM User Engagement	TWM Engaged Participants (n = 110) Median [IQR]	Low Engagers[a] Median [IQR]	High Engagers[a] Median [IQR]
Overall Engagement: Number of Active Days	16 [5 – 33]	(n = 84) 9 [4 – 20.5]	(n = 26) 77.5 [40 –115]
Number of Peer Exchanges[b] Wall Posts Comments	7 [2 – 34] 3 [1 – 13] 3 [0 – 12]	(n = 83) 4 [2 – 9] 2 [1 – 5] 1 [0 – 5]	(n = 27) 135 [58 – 195] 34.5 [20 – 68] 91 [29 – 142]
Number of Unique Thrive Tips Accessed	6 [2 – 32]	(n = 75) 4 [2 – 10]	(n = 25) 121 [78 – 168]
Number of ART Self-Monitoring Days	117 [51 – 137]	(n = 79) 100 [41 – 124]	(n = 26) 144.5 [142 – 147]

a. Engagement dichotomized at the 75th percentile for each user engagement variable
b. Excluding one individual.

Table 4 shows the effect of overall engagement in TWM on HIV UVL, as well as the effect of engagement in the individual components of TWM on HIV UVL, at each assessment timepoint. At month-5 (the end of the intervention period), 73.1% of *TWM* users with overall high engagement

(i.e., were in the 25th percentile of active intervention use days) were virally suppressed compared to 53.6% of those categorized as having low engagement and 40.2% of non-engagers. At month-5, high engagers were more likely to be virally suppressed compared to non-engagers in both the unadjusted (Risk Difference [RD] = 31.9; 95% CI: 12.6, 51.3) and adjusted (RD = 19.4; 95% CI: 3.3, 35.5) models. Similarly, high engagers were more likely to be virally suppressed compared to low engagers in the unadjusted (RD = 23.4; 95% CI: 4.3, 42.4) and adjusted (RD = 17.8; 95% CI: 2.5, 33.0) models (not shown in table). However, no differences were found between engagement categories and viral suppression at month-11 or month-17.

Table 4. TWM User Engagement on Undetectable Viral Load

Variable	TWM Intervention (n = 202) % (N)	Month – 5		
		UVL[a] % (n)	Risk Difference (95% CI)[b]	Risk Difference (95% CI)[c]
Overall Engagement[d]				
High Engagement	12.9 (26)	73.1 (19)	**31.9 (12.6, 51.3)**	**19.4 (3.3, 35.5)**
Low Engagement	41.6 (84)	53.6 (45)	8.5 (-7.4, 24.5)	1.6 (-12.7, 16.0)
Non-users (Ref)	45.5 (92)	40.2 (37)	*Ref*	*Ref*
Peer Exchanges				
High Engagement	13.4 (27)	70.4 (19)	**25.3 (4.9, 45.7)**	14.6 (-2.9, 32.2)
Low Engagement	41.1 (83)	54.2 (45)	10.1 (-5.9, 26.1)	2.7 (-11.6, 17.1)
Non-users (Ref)	45.5 (92)	40.2 (37)	*Ref*	*Ref*
Unique Thrive Tips[e]				
High Engagement	12.4 (25)	68.0 (17)	19.0 (-2.0, 40.0)	7.2 (-11.2, 25.7)
Low Engagement	37.1 (75)	52.0 (39)	3.3 (-12.7, 19.4)	-5.0 (-19.5, 9.5)
Non-users (Ref)	50.5 (102)	44.1 (45)	*Ref*	*Ref*
ART Adherence Self-Monitoring				
High Engagement	12.9 (26)	61.5 (16)	15.4 (-6.7, 37.4)	4.4 (-17.1, 25.8)
Low Engagement	39.1 (79)	58.2 (46)	12.6 (-3.3, 28.4)	4.5 (-9.5, 18.4)
Non-users (Ref)	48.0 (97)	40.2 (39)	*Ref*	*Ref*
Variable	**TWM Intervention (n = 202) % (N)**	**Month – 11**		
		UVL[a] % (n)	Risk Difference (95% CI)[b]	Risk Difference (95% CI)[c]
Overall Engagement[d]				
High Engagement	12.9 (26)	61.5 (16)	20.3 (-2.2, 45.8)	6.8 (-13.0, 26.7)
Low Engagement	41.6 (84)	48.8 (41)	4.5 (-12.5, 21.5)	-0.6 (-15.3, 14.0)
Non-users (Ref)	45.5 (92)	34.8 (32)	*Ref*	*Ref*
Peer Exchanges				
High Engagement	13.4 (27)	66.7 (18)	**22.5 (1.1, 44.0)**	7.7 (-11.8, 27.2)
Low Engagement	41.1 (83)	47.0 (39)	3.3 (-13.9, 20.4)	-1.0 (-15.7, 13.8)
Non-users (Ref)	45.5 (92)	34.8 (32)	*Ref*	*Ref*
Unique Thrive Tips[e]				
High Engagement	12.4 (25)	60.0 (15)	13.9 (-8.9, 36.7)	2.1 (-15.1, 19.4)
Low Engagement	37.1 (75)	48.0 (36)	2.9 (-14.1, 19.8)	-5.2 (-21.2, 10.8)
Non-users (Ref)	50.5 (102)	37.3 (38)	*Ref*	*Ref*
ART Adherence Self-Monitoring				
High Engagement	12.9 (26)	50.0 (13)	3.4 (-20.3, 27.1)	-6.7 (-29.8, 16.4)
Low Engagement	39.1 (79)	53.2 (42)	8.6 (-20.3, 27.1)	2.3 (-11.9, 16.5)
Non-users (Ref)	48.0 (97)	35.1 (34)	*Ref*	*Ref*
Variable	**TWM Intervention (n = 202) % (N)**	**Month – 17**		
		UVL[a] % (n)	UVL[a] % (n)	UVL[a] % (n)

Overall Engagement[d]				
High Engagement	12.9 (26)	61.5 (16)	61.5 (16)	61.5 (16)
Low Engagement	41.6 (84)	45.2 (38)	45.2 (38)	45.2 (38)
Non-users (Ref)	45.5 (92)	35.9 (33)	35.9 (33)	35.9 (33)
Peer Exchanges				
High Engagement	13.4 (27)	66.7 (18)	66.7 (18)	66.7 (18)
Low Engagement	41.1 (83)	43.4 (36)	43.4 (36)	43.4 (36)
Non-users (Ref)	45.5 (92)	35.9 (33)	35.9 (33)	35.9 (33)
Unique Thrive Tips[e]				
High Engagement	12.4 (25)	60.0 (15)	60.0 (15)	60.0 (15)
Low Engagement	37.1 (75)	42.7 (32)	42.7 (32)	42.7 (32)
Non-users (Ref)	50.5 (102)	39.2 (40)	39.2 (40)	39.2 (40)
ART Adherence Self-Monitoring				
High Engagement	12.9 (26)	50.0 (13)	50.0 (13)	50.0 (13)
Low Engagement	39.1 (79)	50.6 (40)	50.6 (40)	50.6 (40)
Non-users (Ref)	48.0 (97)	35.1 (34)	35.1 (34)	35.1 (34)

a. UVL = HIV Undetectable Viral Load
b. Unadjusted models
c. Models adjusted for baseline viral suppression and positive drug urinalysis
d. Active days in the TWM intervention
e. Brief informational content
Note: bolded estimates were statistically significant at p<.05

Notably, 70.4% of those categorized as having high engagement in peer exchanges (i.e., were in the 25th percentile) were virally suppressed at month-5, compared to 54.2% of those with low engagement and 40.2% of non-engagers. High engagers with the peer exchange component were more likely to be virally suppressed than participants who did not engage with the peer exchanges at all at month-5 (RD = 25.3; 95% CI: 4.9, 45.7), month-11 (RD = 22.5; 95% CI: 1.1, 44.0), and month-17 (RD = 23.4; 95% CI: 2.2, 44.7) in unadjusted models, although these effects were not found in adjusted models. We found no differences in viral suppression between engagement groups when examining the *Thrive Tips* or ART self-monitoring components at any assessment timepoint.

DISCUSSION

We did not find that the 5-month *TWM* web-based intervention delivered to a community-recruited sample of SMM living with HIV overall improved their VL outcomes over 17 months,

nor did we find that the intervention showed greater impact for participants who had recent drug use at study entry. However, overall high engagement with the intervention, compared to no engagement or low engagement, among participants assigned to the *TWM* intervention arm was associated with having an HIV UVL at month-5, which was the active intervention use period (after which access to the intervention ended).

Behavioral ART adherence interventions have had mixed success in modifying adherence behaviors and reducing VL. In a meta-analysis of interventions co-targeting one or more syndemic factors (e.g. mental health, substance use) and HIV prevention or treatment outcomes, significant effects were shown for sexual risk reduction interventions, but not for ART adherence interventions [47]. Text messaging and voice (e.g., telephone-based) interventions have shown some success for improving adherence or viral suppression in lower-income countries [48]. However, mobile apps and computerized interventions most commonly used in higher-income countries, with one exception of a computerized intervention by Kurth and colleagues [24], either lack sufficient power to be conclusive [48] or have not yet demonstrated effects on plasma HIV VL [25-29].

An important factor that may drive the degree to which digital ART adherence interventions are impactful is whether they are embedded in other aspects of HIV clinical care. *TWM* was designed and tested as a stand-alone ART adherence intervention that could supplement HIV clinical care of SMM living with HIV. In contrast, the computerized ART adherence intervention by Kurth and colleagues [24] was conducted in four sessions during regular HIV clinic appointments, and demonstrated positive impacts on HIV VL [24]. This arrangement may have provided a more successful context to engage participants with the intervention than mobile apps or computerized interventions that rely on participants to engage

with it outside the clinic context. However, providing technology-based interventions in the clinic may diminish the potential benefits of these types of interventions, including lower implementation costs (i.e., requiring less staff time), circumventing clinic-based stigma, and direct-to-consumer availability [21, 49, 50]. A better understanding of the trade-offs of the venues where technology-based interventions are deployed, and the accompanying staffing requirements is needed.

While results did not support that the overall sample benefited from the intervention, those *TWM*-assigned participants with high levels of engagement (in the 25th percentile) were more likely to have an HIV UVL at the end of the 5-month active intervention period compared to those with low engagement (below the 75th percentile) or no engagement at all in the intervention. This finding is consistent with those of an ART adherence gaming intervention to improve rates of viral suppression among 16-24 year old youth living with HIV, called *Epic Allies* [29]. In that study, participants were enrolled primarily in HIV clinics that served a large number of youth, but engagement with the app occurred outside the clinic over 26 weeks. While no intervention effects on HIV VL were shown in an intent-to-treat analysis, youth who used the mobile app four or more days a week were 56% more likely to achieve viral suppression compared to youth who used the app less often at the month-3 assessment; however, those effects dissipated in later follow-up assessments. These, and other studies showing impacts of mHealth interventions dissipate over time [51], suggest that optimizing technology-based ART interventions will require robust management of participants to get and keep them engaged in the intervention.

Little is known about the impact of individual components of eHealth/mHealth studies on HIV VL, even though having a better understanding of which components may be the most

impactful is needed [31]. A prior study by Bonett and colleagues [52] found that engagement (measured as total time spent) with different features of the mHealth intervention among HIV-negative youth was associated with sociodemographic and behavioral factors (e.g., participants who spent more time using the HIV/STI testing site locator were more likely to be single). In the *TWM* arm of the current study, we found high proportions of HIV UVL among users with high engagement in the peer exchange feature (both posting and commenting) in the unadjusted models at all follow-up timepoints, although not when adjusted for baseline viral suppression and positive drug urinalysis. Among high engagement participants, all of them posted at least one wall comment and 75% of them responded to another participant's post. Content of peer exchanges on social platforms focused on health promotion among PLWH may play a critical role. A prior qualitative analysis of the peer exchanges in *TWM* showed that social support was the most common theme from the analysis of peer exchanges, with half seeking social support and half providing social support [53]. Peer exchanges also included issues regarding HIV treatment and care, such as challenges taking ART, adherence strategies, discussing HIV treatment including labs or side effects, and participants' relationships with healthcare providers [53]. A recent study by Bauermeister et al found that young (18-30 years old) Black SMM who discussed experiences of stigma in a peer exchange forum during an mHealth intervention trial showed decreased anticipated stigma over time, while those whose discussions focused on sexuality-related stigma reported increased levels of internalized homophobia and sexual prejudice [54]. Together, the results of this study and the current *TWM* study suggest that a greater understanding of how peer exchanges may impact HIV care outcomes and other dimensions of wellbeing is warranted.

This study has important limitations that contextualize study findings. First,

approximately 30% of participants entered the study with detectable HIV VL which may have hindered our ability to demonstrate effects on VL as many participants started the study virally suppressed. As with many ART adherence studies, we balanced our ability to recruit our sample, who were required to self-report adherence problems, with more rigorous study inclusion (e.g., detectable VL). Nonetheless, our findings suggest potential positive impact among those using the TWM intervention. Second, participants were recruited in the New York City area, which may have better technology infrastructure, higher technology adoption rates, and other unique considerations that differ from other regions of the US. Therefore, results may not generalize to other areas of the US. Third, while our findings suggest a possible benefit of *TWM* for high-engaging participants, only approximately half of those randomized to the *TWM* intervention actually engaged with it. We only incentivized intervention use through gift card drawings, and therefore this approach may mimic "real-world" use of this type of computerized intervention in the context of deploying minimal staffing to engage participants. Finally, improvement in VL may be due to an exogenous factor unrelated to study participation for men who chose to access *TWM*. For this reason, caution should be used when interpreting study findings for this group of men.

Keeping limitations in mind, we believe the results fill a critical gap in eHealth/mHealth ART adherence intervention science by adding to evidence that these types of interventions may need to be developed alongside in-person or virtual support to have the greatest impacts on HIV VL. Using stepped-care models [55] to identify which participants need to more intensive support holds promise in this area. Aside from employing different intervention designs to meet the unique needs of users, processes for engaging users early and sustaining that engagement over time continues to be a high priority to fully realize the potential of technology-based ART

intervention studies. Finally, efforts should be made to expand our understanding of how peer exchange forum use may have positive impacts across a range of clinical and mental health domains.

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Author Contributions:
KJH: Conceptualization, funding acquisition, investigation, methodology, project administration, supervision, writing the original draft.
SL: Data curation; formal analysis; writing the original draft.
DE: Conceptualization, investigation, methodology, formal analysis, review and editing.
KRA: Conceptualization, investigation, methodology, review and editing.
AT: Project administration, resources, supervision, review and editing
OS: Project administration, resources, supervision, review and editing
CJS: Review and editing
HJR: Project administration, resources, supervision, review and editing

Abbreviations:

ART: antiretroviral therapy
AUDIT: Alcohol Use Disorders Identification Test
CSV: comma separated value
HIV: human immunodeficiency virus
IMB: information, motivation, and behavioral skills model
MOS: Medical Outcomes Study
RD: risk difference
SMM: sexual minority men
TWM: Thrive with Me
UVL: undetectable viral load
VL: viral load

Use of AI: Generative AI was not used in any portion of the manuscript writing.

References

1. Centers for Disease Control and Prevention, : HIV Surveillance Report, 2020. https://www.cdc.gov/hiv/library/reports/hiv-surveillance.html. In., vol. 33; 2022.
2. Key Strategies in the Plan [https://www.hiv.gov/federal-response/ending-the-hiv-epidemic/key-strategies]
3. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, Hakim JG, Kumwenda J, Grinsztejn B, Pilotto JH *et al*: Antiretroviral Therapy for the Prevention of HIV-1 Transmission. *N Engl J Med* 2016, 375(9):830-839.
4. Cohen MS, Chen YQ, McCauley M, Gamble T, Hosseinipour MC, Kumarasamy N, Hakim JG, Kumwenda J, Grinsztejn B, Pilotto JH *et al*: Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med* 2011, 365(6):493-505.
5. Rodger AJ, Cambiano V, Bruun T, Vernazza P, Collins S, van Lunzen J, Corbelli GM, Estrada V, Geretti AM, Beloukas A *et al*: Sexual Activity Without Condoms and Risk of HIV Transmission in Serodifferent Couples When the HIV-Positive Partner Is Using Suppressive Antiretroviral Therapy. *JAMA* 2016, 316(2):171-181.
6. Centers for Disease Control and Prevention: Monitoring selected national HIV prevention and care objectives by using HIV surveillance data—United States and 6 dependent areas, 2020. HIV Surveillance Supplemental Report 2022. Revised edition. http://www.cdc.gov/hiv/library/reports/hiv-surveillance.html. . In., vol. 27; 2022.
7. Mayer KH, Nelson L, Hightow-Weidman L, Mimiaga MJ, Mena L, Reisner S, Daskalakis D, Safren SA, Beyrer C, Sullivan PS: The persistent and evolving HIV epidemic in American men who have sex with men. *The Lancet* 2021, 397(10279):1116-1126.
8. Colfax G, Shoptaw S, Colfax G, Shoptaw S: The methamphetamine epidemic: implications for HIV prevention and treatment. *Current HIV/AIDS Reports* 2005, 2(4):194-199.
9. Plankey MW, Ostrow DG, Stall R, Cox C, Li X, Peck JA, Jacobson LP, Plankey MW, Ostrow DG, Stall R *et al*: The relationship between methamphetamine and popper use and risk of HIV seroconversion in the multicenter AIDS cohort study. *Journal of Acquired Immune Deficiency Syndromes: JAIDS* 2007, 45(1):85-92.
10. Carey JW, Mejia R, Bingham T, Ciesielski C, Gelaude D, Herbst JH, Sinunu M, Sey E, Prachand N, Jenkins RA *et al*: Drug use, high-risk sex behaviors, and increased risk for recent HIV infection among men who have sex with men in Chicago and Los Angeles. *AIDS & Behavior* 2009, 13(6):1084-1096.
11. Carrico AW, Hunt PW, Neilands TB, Dilworth SE, Martin JN, Deeks SG, Riley ED: Stimulant Use and Viral Suppression In the Era of Universal Antiretroviral Therapy. *J Acquir Immune Defic Syndr* in press.
12. Carrico AW, Riley ED, Johnson MO, Charlebois ED, Neilands TB, Remien RH, Lightfoot MA, Steward WT, Weinhardt LS, Kelly JA *et al*: Psychiatric risk factors for HIV disease progression: the role of inconsistent patterns of antiretroviral therapy utilization. *J Acquir Immune Defic Syndr* 2011, 56(2):146-150.
13. Ellis RJ, Childers ME, Cherner M, Lazzaretto D, Letendre S, Grant I, Group HIVNRC: Increased human immunodeficiency virus loads in active methamphetamine users are explained by reduced effectiveness of antiretroviral therapy. *J Infect Dis* 2003, 188(12):1820-1826.

14. Horvath KJ, Carrico AW, Simoni J, Boyer EW, Amico KR, Petroll AE: Engagement in HIV Medical Care and Technology Use among Stimulant-Using and Nonstimulant-Using Men who have Sex with Men. *AIDS Res Treat* 2013, 2013:121352.
15. Carrico AW: Substance use and HIV disease progression in the HAART era: implications for the primary prevention of HIV. *Life Sci* 2011, 88(21-22):940-947.
16. Carrico AW, Shoptaw S, Cox C, Stall R, Li X, Ostrow DG, Vlahov D, Plankey MW: Stimulant use and progression to AIDS or mortality after the initiation of highly active antiretroviral therapy. *J Acquir Immune Defic Syndr* 2014, 67(5):508-513.
17. Adams JW, Bryant KJ, Edelman JE, Fiellin DA, Gaither JR, Gordon AJ, Gordon KS, Kraemer KL, Mimiaga MJ, Operario D *et al*: Association of Cannabis, Stimulant, and Alcohol use with Mortality Prognosis Among HIV-Infected Men. *AIDS Behav* 2018, 22(4):1341-1351.
18. Mayer KH, Skeer MR, O'Cleirigh C, Goshe BM, Safren SA: Factors associated with amplified HIV transmission behavior among American men who have sex with men engaged in care: implications for clinical providers. *Ann Behav Med* 2014, 47(2):165-171.
19. Johnson MO, Carrico AW, Chesney MA, Morin SF: Internalized heterosexism among HIV-positive, gay-identified men: implications for HIV prevention and care. *J Consult Clin Psychol* 2008, 76(5):829-839.
20. Morin SF, Myers JJ, Shade SB, Koester K, Maiorana A, Rose CD: Predicting HIV transmission risk among HIV-infected patients seen in clinical settings. *AIDS Behav* 2007, 11(5 Suppl):S6-16.
21. Nelson KM, Perry NS, Horvath KJ, Smith LR: A systematic review of mHealth interventions for HIV prevention and treatment among gay, bisexual, and other men who have sex with men. *Transl Behav Med* 2020, 10(5):1211-1220.
22. Muessig KE, LeGrand S, Horvath KJ, Bauermeister JA, Hightow-Weidman LB: Recent mobile health interventions to support medication adherence among HIV-positive MSM. *Curr Opin HIV AIDS* 2017, 12(5):432-441.
23. Horvath KJ, Walker T, Mireles L, Bauermeister JA, Hightow-Weidman L, Stephenson R: A Systematic Review of Technology-Assisted HIV Testing Interventions. *Curr HIV/AIDS Rep* 2020, 17(4):269-280.
24. Kurth AE, Spielberg F, Cleland CM, Lambdin B, Bangsberg DR, Frick PA, Severynen AO, Clausen M, Norman RG, Lockhart D *et al*: Computerized counseling reduces HIV-1 viral load and sexual transmission risk: findings from a randomized controlled trial. *J Acquir Immune Defic Syndr* 2014, 65(5):611-620.
25. Schnall R, Sanabria G, Jia H, Cho H, Bushover B, Reynolds NR, Gradilla M, Mohr DC, Ganzhorn S, Olender S: Efficacy of an mHealth self-management intervention for persons living with HIV: the WiseApp randomized clinical trial. *J Am Med Inform Assoc* 2023, 30(3):418-426.
26. Amico KR, Lindsey JC, Hudgens M, Dallas R, Horvath KJ, Dunlap A, Goolsby R, Johnson MM, Heckman B, Crawford J *et al*: Randomized Controlled Trial of a Remote Coaching mHealth Adherence Intervention in Youth Living with HIV. *AIDS Behav* 2022, 26(12):3897-3913.
27. Garofalo R, Kuhns LM, Hotton A, Johnson A, Muldoon A, Rice D: A Randomized Controlled Trial of Personalized Text Message Reminders to Promote Medication Adherence Among HIV-Positive Adolescents and Young Adults. *AIDS Behav* 2016,

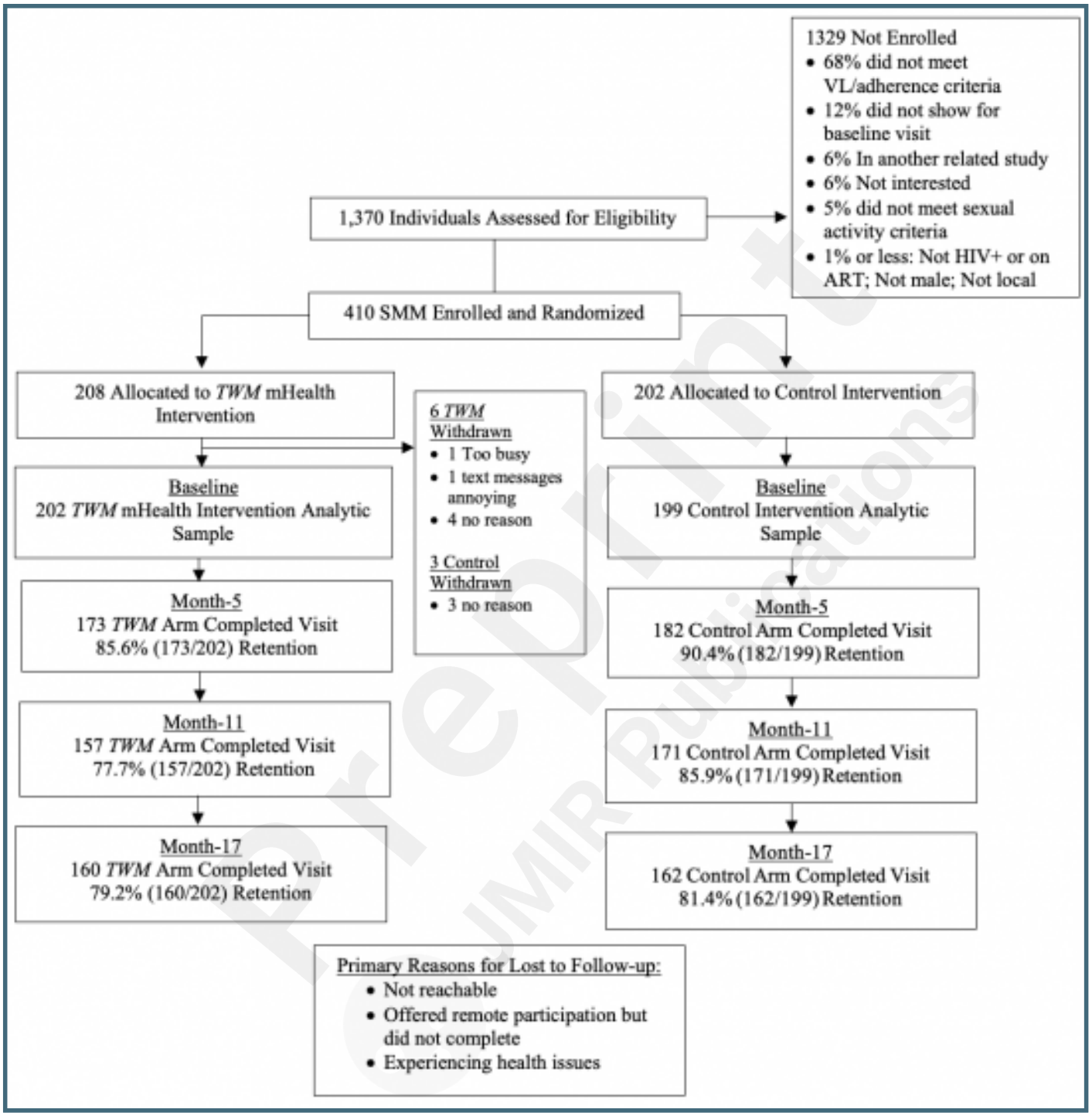
20(5):1049-1059.
28. Lewis MA, Harshbarger C, Bann C, Marconi VC, Somboonwit C, Piazza MD, Swaminathan S, Burrus O, Galindo C, Borkowf CB *et al*: Effectiveness of an Interactive, Highly Tailored "Video Doctor" Intervention to Suppress Viral Load and Retain Patients With HIV in Clinical Care: A Randomized Clinical Trial. *J Acquir Immune Defic Syndr* 2022, 91(1):58-67.
29. Hightow-Weidman L, Muessig KE, Egger JR, Vecchio A, Platt A: Epic Allies: A Gamified Mobile App to Improve Engagement in HIV Care and Antiretroviral Adherence among Young Men Who have Sex with Men. *AIDS Behav* 2021, 25(8):2599-2617.
30. Choi SK, Muessig KE, Hightow-Weidman LB, Bauermeister JA. Paradata: Measuring Engagement in Digital HIV Interventions for Sexual and Gender Minorities. Curr HIV/AIDS Rep. 2023 Dec;20(6):487-501. doi: 10.1007/s11904-023-00679-5. Epub 2023 Nov 6. PMID: 37930613.
31. Bauermeister JA, Golinkoff JM, Muessig KE, Horvath KJ, Hightow-Weidman LB: Addressing engagement in technology-based behavioural HIV interventions through paradata metrics. *Curr Opin HIV AIDS* 2017, 12(5):442-446.
32. Hightow-Weidman LB, Bauermeister JA. Engagement in mHealth behavioral interventions for HIV prevention and care: making sense of the metrics. Mhealth. 2020 Jan 5;6:7. doi: 10.21037/mhealth.2019.10.01. PMID: 32190618; PMCID: PMC7063263.
33. Horvath KJ, Amico KR, Erickson D, Ecklund AM, Martinka A, DeWitt J, McLaughlin J, Parsons JT: Thrive With Me: Protocol for a Randomized Controlled Trial to Test a Peer Support Intervention to Improve Antiretroviral Therapy Adherence Among Men Who Have Sex With Men. *JMIR Res Protoc* 2018, 7(5):e10182.
34. Horvath KJ, Oakes JM, Rosser BR, Danilenko G, Vezina H, Amico KR, Williams ML, Simoni J: Feasibility, acceptability and preliminary efficacy of an online peer-to-peer social support ART adherence intervention. *AIDS Behav* 2013, 17(6):2031-2044.
35. Fisher J, Fisher W, Bryan A, Misovich S: Information-motivation-behavioral skills model-based HIV risk behavior change intervention for inner-city high school youth. *Health Psychology* 2002, 21(2):177-186.
36. Fisher WA, Fisher JD, Harman JJ: The information-motivation-behavioraI skills model: A general social psychological approach to understanding and promoting health behavior. Malden, MA, US: Blackwell Publishing; 2003.
37. Radloff LS: The CES-D scale: A self-report depression scale for research in the general population. *Applied Psycholgical Measurement* 1992, 1:385-401.
38. The LifeWindows Project Team: The LifeWindows Information Motivation Behavioral Skills ART Adherence Questionnaire (LW-IMB-AAQ). In.: Center for Health, Intervention, and Prevention. University of Connecticut; 2006.
39. Earnshaw VA, Smith LR, Chaudoir SR, Amico KR, Copenhaver MM: HIV stigma mechanisms and well-being among PLWH: a test of the HIV stigma framework. *AIDS Behav* 2013, 17(5):1785-1795.
40. Sherbourne CD, Stewart AL: The MOS social support survey. *Soc Sci Med* 1991, 32(6):705-714.
41. Wong MD, Sarkisian CA, Davis C, Kinsler J, Cunningham WE: The association between life chaos, health care use, and health status among HIV-infected persons. *Journal of General Internal Medicine* 2007, 22(9):1525-1497.
42. Cohen S, Kamarck T, Mermelstein R: A global measure of perceived stress. *Journal of*

Health and Social Behavior 1983, 24:385-396.
43. Saunders JB, Aasland OG, Babor TF, de la Fuente JR, Grant M: Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption--II. *Addiction* 1993, 88(6):791-804.
44. StataCorp. Stata Statistical Software: Release 14. . In: College Station, TX: StataCorp LP.,; 2015.
45. Lechner M. The estimation of causal effects by difference-in-difference methods. *Foundations and Trends® in Econometrics*. 2011;4:165-224.
46. Schulz KF, Altman DG, Moher D. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. *Bmj*. 2010;340:c332. doi: 10.1136/bmj.c332
47. Pantalone DW, Nelson KM, Batchelder AW, Chiu C, Gunn HA, Horvath KJ: A Systematic Review and Meta-Analysis of Combination Behavioral Interventions Co-Targeting Psychosocial Syndemics and HIV-Related Health Behaviors for Sexual Minority Men. *The Journal of Sex Research* 2020, 57(6):681-708.
48. Lee SB, Valerius J: mHealth Interventions to Promote Anti-Retroviral Adherence in HIV: Narrative Review. *JMIR Mhealth Uhealth* 2020, 8(8):e14739.
49. Muessig KE, Nekkanti M, Bauermeister J, Bull S, Hightow-Weidman LB: A systematic review of recent smartphone, Internet and Web 2.0 interventions to address the HIV continuum of care. *Curr HIV/AIDS Rep* 2015, 12(1):173-190.
50. Sullivan PS, Hightow-Weidman L: Mobile apps for HIV prevention: how do they contribute to our epidemic response for adolescents and young adults? *Mhealth* 2021, 7:36.
51. Horvath KJ, Lammert S, MacLehose RF, Danh T, Baker JV, Carrico AW: A Pilot Study of a Mobile App to Support HIV Antiretroviral Therapy Adherence Among Men Who Have Sex with Men Who Use Stimulants. *AIDS Behav* 2019, 23(11):3184-3198.
52. Bonett S, Connochie D, Golinkoff JM, Horvath KJ, Bauermeister JA: Paradata Analysis of an eHealth HIV Testing Intervention for Young Men Who Have Sex With Men. *AIDS Educ Prev* 2018, 30(5):434-447.
53. Sun CJ, Shato T, Steinbaugh A, Pradeep S, Rivet Amico K, Horvath K: Virtual voices: examining social support exchanged through participant-generated and unmoderated content in a mobile intervention to improve HIV antiretroviral therapy adherence among GBMSM. *AIDS Care* 2022:1-9.
54. Bauermeister JA, Muessig KE, LeGrand S, Flores DD, Choi SK, Dong W, Sallabank G, Hightow-Weidman LB: HIV and Sexuality Stigma Reduction Through Engagement in Online Forums: Results from the HealthMPowerment Intervention. *AIDS Behav* 2019, 23(3):742-752.
55. Reback CJ, Rusow JA, Cain D, Benkeser D, Arayasirikul S, Hightow-Weidman L, Horvath KJ: Technology-Based Stepped Care to Stem Transgender Adolescent Risk Transmission: Protocol for a Randomized Controlled Trial (TechStep). *JMIR Res Protoc* 2020, 9(8):e18326.

Supplementary Files

Figures

Thrive with Me (TWM) intervention trial CONSORT diagram.



Multimedia Appendixes

Example newsletter received by participants randomized to the control group.
URL: http://asset.jmir.pub/assets/d5bebe298f77bafba18f252d09b873e4.pdf