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ORIGINAL PAPER

More than just Reminders: Using text Messaging to Improve HIV care Outcomes Among Youth and Young Adults Living with HIV

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Abstract
This study evaluated engagement, satisfaction, and efficacy of an automated and live two-way text messaging intervention that linked youth and young adults at high risk for poor HIV outcomes to their medical case managers, with the aims of increasing viral load suppression rates and improving medical visit attendance. Participants (N = 100) were an average age of 22–23 years old. Most were Black (93%) and men who have sex with men (82%). A total of 89,681 automated text messages were sent to participants; and 62% of participants engaged in monthly text-message exchanges with medical case managers. McNemar's test results indicated that a significantly greater proportion of intervention participants were virally suppressed at 6 and 12 month follow-up than at enrollment. Adjusted odds ratio results showed a significant association between likelihood of achieving viral suppression at 6 and 12 months, and a greater number of participant responses to automated text messages. Future research should prospectively compare outcomes between usual care case management and usual care plus text-messaging to test for significant differences between groups.

Resumen
La presente investigación evaluó el compromiso, la satisfacción y la eficacia de una intervención de mensajes de texto bidireccional automatizada y en vivo que vinculó a jóvenes y adultos jóvenes con altos riesgos de resultados deficientes del VIH con sus administradores de casos médicos, con el objetivo de aumentar las tasas de supresión de la carga viral y mejorar la asistencia a las visitas médicas. Los participantes (n = 100) tenían una edad promedio de 22 a 23 años. La mayoría eran negros (93,0%) y hombres que tienen sexo con hombres (82,0%). Un total de 89.681 mensajes de texto automatizados fueron enviados a los participantes; y 62,0% de los participantes participaron en intercambios de mensajes de texto mensuales con los administradores de casos médicos. Los resultados de la prueba de McNemar indicaron que una proporción significativamente mayor de participantes de la intervención fueron suprimidos viralmente a los 6 y 12 meses de seguimiento que al momento de la inscripción. Los resultados del índice de probabilidad ajustado mostraron una asociación significativa entre la probabilidad de lograr la supresión viral a los 6 y 12 meses, así como un mayor número de respuestas de los participantes a los mensajes de texto automatizados. Las investigaciones futuras deben comparar prospectivamente los resultados entre la gestión de casos de atención habitual y la atención habitual más mensajes de texto para evaluar las diferencias significativas entre los grupos.

Keywords HIV · Youth · Text messaging · mHealth · Technology

Introduction

Although HIV infection rates have declined in the United States [1], certain marginalized populations, including people of color, young adults, and men who have sex with men, still experience disproportionate infection rates. In addition,

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youth have the poorest HIV care continuum outcomes, including lower rates of linkage to care, retention, and viral load suppression (VLS) [2]. These disparities highlight a need to implement novel approaches tailored to youth and young adults living with HIV (YLWH) that are synergistic with existing services available to individuals living with HIV/AIDS.

Previous studies have identified several factors that contribute to poor HIV care continuum outcomes among YLWH. Psychosocial factors such as depression and other mental health problems, and social determinants of health like unstable housing, low educational attainment, and under-unemployment are all associated with decreased linkage to and engagement in HIV care in this population [2–4]. For YLWH, the social determinants of health may manifest as inability to pay rent and/or needing to move often, low-wage jobs with unpredictable work schedules, and unreliable transportation-all of which act as barriers to healthcare access [5, 6]. Among Black YLWH, these social determinants of health are heavily influenced by the materialization of racism, and the intersectional oppressions of racism and homophobia, which have created systems that devalue the economic, physical, and emotional wellbeing of Black, gay, and bisexual men, and other men who have sex with men [7].

Given this adversity, novel support strategies are needed to effectively engage YLWH in care and improve HIV care continuum outcomes. Text messaging is a novel approach that has been tested with some success. For example, in a randomized clinical trial of adults in Kenya living with HIV, patients who received text messaging support had significantly improved antiretroviral adherence and viral load suppression (VLS) [8]. Similarly, text message appointment reminders increased attendance rates at HIV clinics in Brazil [9] and provided personalized affirming or intervention messages for HIV medical care among individuals who used substances [10]. Studies have also shown that two-way text messaging programs are more effective for behavior change than single "push" messages [11]. Mobile technology and text messaging may be particularly appropriate for HIV care among adolescents and young adults, as texting is the preferred method of communication in this age group. With 1 in 3 adolescents sending more than 100 texts a day [12] and 98% of YLWH reporting regular cell phone access [4], mobile phones are indispensable tools in teen communication.

Though previous studies have demonstrated the effectiveness of text messaging to improve HIV care outcomes among adults in Kenya and Brazil, literature on text messaging interventions among YLWH in the United States is limited. However, this is a growing area of literature and practice as documented in the United States Department of Health and Human Services Guidelines for the Use of Antiretroviral Agents in Adults and Adolescents with HIV [13], which recommends developmentally appropriate adherence reminders such as apps and cell phone alerts. A small number of recent studies examined the effectiveness of social media-based interventions on HIV care outcomes for YLWH [14–17], finding that bidirectional messaging through apps or texts was associated with improved care engagement [15, 17] and increased viral suppression [15]. Yet, several gaps remain. For example, there is little discussion in the literature on using text messaging to address psychosocial factors (e.g., depression) and social determinants of health (e.g., unstable housing, transportation issues) that impact YLWH care outcomes. Widespread use of text messaging offers an intervention mode to improve communication between young people living with HIV and their care teams-ultimately leading to improved HIV care outcomes for those at highest risk for poor care continuum outcomes (i.e. Black/African American youth and young adults). Accordingly, the aims of the current study were to (1) assess participant engagement and satisfaction with an automated and live two-way text messaging intervention, and (2) evaluate the efficacy of an innovative automated and live two-way text messaging intervention for improving VLS and medical-visit attendance among YLWH.

Methods

Intervention Description & Procedures

The E-VOLUTION text messaging program aimed to improve HIV health outcomes among YLWH (ages 18–29) by increasing VLS rates, retention in HIV medical care, and assistance with overcoming barriers to improve health outcomes. This mobile health (mHealth) intervention was implemented at [blinded for review]-a Ryan White Part D HIV/AIDS services program (a United States federal funding mechanism for HIV services for woman, infants, children, and youth). The intervention included two components: automated, two-way text messaging, and live text messaging between medical case managers (MCMs) and participants. The automated two-way text message system included daily medication reminders, appointment reminders, semi-weekly mood checks, and monthly questions about housing and financial needs. Responses indicating a challenge for participants in any of these areas generated an alert to the MCM's phone to intervene. Once case managers received an alert, they responded with 24 hours (excluding weekends and holidays). In addition, at least once a month, a two-way texting exchange was initiated by the MCM to inquire about participant wellbeing. As is typical of Ryan

White programs, MCMs had ready access to service supports and medical teams (doctors, nurse practitioners, and schedulers), and made referrals to resources as indicated. Most text message exchanges involved appointments, organizing meetups for assistance or documentation completion/exchange, and resources and problem-solving. (A more detailed qualitative analysis of participant and case manager experiences with text messaging is reported elsewhere)[18]. Prior to implementing this intervention, MCMs did not communicate with clients using text messaging.

Participants were recruited into the intervention by project staff at three HIV clinic sites at Washington University School of Medicine in St. Louis, Missouri. Recruitment and data collection occurred from February 2017 through May 2019, with analysis completed in 2019. Self-report data were collected using audio-computer assisted surveys at time of consent and at 6 and 12 months post-consent. Additionally, viral load and medical appointment attendance was extracted from electronic medical records at consent and 6 and 12 months post-consent.

Participants received a $25 gift card for each survey they completed. The study was approved by the Human Research Protection Office (IRB) at [blinded for review].

Theoretical Model

The theoretical foundation for E-VOLUTION comes from supportive accountability theory (SAT) [19]. Derived primarily from the fields of organizational psychology, motivation theory, and computer-mediated communication, SAT posits that adherence to and the effectiveness of an mHealth intervention is affected by human support. According to the theory's authors, human support contains three constructs: bond, legitimacy, and accountability. The model suggests that a strong bond with a supportive human who is perceived to be a legitimate, trustworthy, and benevolent expert creates greater accountability for the mHealth user to engage in the intervention. Greater accountability is also achieved by providing the mHealth intervention user with clear expectations, monitoring their performance in the intervention, and creating a consistent social presence. A higher level of accountability then leads to greater adherence to and effectiveness of the intervention.

In the context of the E-VOLUTION intervention, the human support element was reflected in the relationship between medical case managers (MCMs) and E-VOLUTION participants. MCMs maintained a consistent social presence through regular automated and live text messaging with participants. Additionally, clear expectations were conveyed through medication and appointment reminders. Finally, performance monitoring was represented by client responses to automated text messages over the intervention period, and through reminder text messages related to medication adherence and medical appointments.

Table 1 Participant withdrawal from study

Reasons for Withdrawal	Number of Withdraws Before 6 months	Number of Withdraws 6–12 months
Moved	2	2
Changed to medical provider outside of study	3	1
Incarcerated	0	1
Transferred to MCM outside of study*	3	3
Asked to withdraw	5	1
Other	0	1
TOTAL	**13**	**9**

*medical case manager

Participants

Participants were eligible to enroll in the E-VOLUTION program if they were aged 18–29 years, received HIV medical and case management services at the clinic sites, had access to a private cell phone with texting ability, and experienced at least one of the following criteria that would place an individual at risk for poor HIV outcomes: diagnosis within the last 12 months; out of care for more than 6 of the last 24 months; or a viral load > 200 copies/mL of blood.

A total of 100 youth enrolled in the program; 87 participated in the E-VOLUTION intervention for at least 6 months; and 78 participated for at least 12 months. Of those who participated, 84 completed surveys at 6 months and 75 completed surveys at 12 months. Table 1 provides the number of participants who withdrew from the study at 6 and 12 months, and includes reasons for withdrawal. Due to differences in the number of overall intervention participants and those who completed 6 and 12 month surveys, the sample sizes for analyses using medical record data differ from self-report data. Additionally, not all participants who attended medical visits completed lab work, which resulted in different sample sizes for the outcomes of kept medical visits and viral load suppression.

Most participants identified as Black (93%) and were young men who have sex with men (82%). Approximately 26% of participants scored above the clinical cut-off for depression, and nearly one third experienced physical intimate partner violence (28%) and/or sexual assault (34%) in their lifetime. Table 2 describes participant demographics and risk factors at consent.

Table 2 Intervention participant demographics and risk factors at enrollment (n = 100)

Demographics	N (%)
Race	
Black	93 (93)
White	7 (7)
Gender	
Male	91(91)
Female	9 (9)
Education level	
Some high school	15 (15)
High school diploma or GED	39 (39)
Some college, professional, vocational, or trade school	38 (38)
Associates degree or trade certificate	5 (5)
Bachelor's degree	3 (3)
Current employment status	
Full-time employed	36 (36)
Part-time employed	26 (26)
Disabled	6 (6)
Unemployed – Looking for work	32 (32)
Unemployed – Not looking for work	2 (2)
Income levels	
At or Below 100% of federal poverty line	53 (53)
Between 100% and 200% of federal poverty line	18 (18)
Greater than 200% of federal poverty line	29 (29)
HIV acquisition category	
Male-to-male sexual contact	82 (82)
Male-to-male sexual contact & intravenous drug use	1 (1)
Heterosexual contact	10 (10)
Perinatal	7 (7)
Newly diagnosed	37 (37)
*Age**	22.87 (2.30)
*Monthly income (USD)**	1,430 (3,562)
Psychosocial risk factors	
Depression (PHQ-2 ≥ 3; last 2 weeks)	26 (26)
Experienced physical intimate partner violence (ever)	28 (28)
Used alcohol several times a week (last 6 months)	18 (18)
Used marijuana several times a week (last 6 months)	44 (44)
Used tobacco daily (last 6 months)	28 (28)
Misused prescription painkillers/opioids (ever)	13 (13)
Used methamphetamine (ever)	9 (9)
Experienced sexual assault (ever)	34 (34)
Traded sex (ever)	22 (22)
Received payment for sex (ever)	28 (28)
Paid for sex (ever)	6 (6)
Spent time in jail or prison (ever)	47 (47)

*M (SD)

Measures

HIV Care-Continuum Outcomes

All HIV care continuum outcomes were captured using medical record data at enrollment, 6 month, and 12 month follow-ups. These data included viral load (the number of viral copies/mL of blood), viral load suppression (fewer than 200 viral copies/mL of blood), and kept medical visits (whether or not participants attended regular semi-annual HIV medical visits). For all participants, baseline viral load was defined as the viral load available in the medical chart closest to but before the date of consent to participate in the study. Baseline viral load for all participants was available within 6 months of intervention enrollment. For 6 and 12 month follow-up measures, we used the viral load closest to the timepoint, allowing for a 3 month window around the date. If a viral load was not available within the 3 month window, it was coded as missing. Regarding kept medical appointments, participants were considered not linked to care if they were aware of their HIV infection status and had never had a post-diagnosis HIV medical visit. Participants were considered not fully retained in care if they had been diagnosed with HIV more than 12 months before baseline and had a gap in HIV care of greater than 6 months over the last 24 month. At 6 and 12 month assessment timepoints, participants were considered to have kept their HIV medical visits if they attended their scheduled 6 month appointment or had been able to attend an appointment within 3 months of their scheduled appointment date. Viral load and kept medical appointments were extracted from electronic medical charts.

Text Messaging Outcomes

Automated text messaging outcome data were collected through the text messaging platform and included number of automated texts received, number of responses to automated texts, and number and type of alert triggered by participants in response to automated texts. The number of MCM texts and participant responses exchanged monthly were also collected.

Psychosocial & Behavioral Risk Factors

A self-report questionnaire measured severity of depression symptoms using the Patient Health Questionaire-2 (PHQ-2) [20], as well as frequency of alcohol and marijuana use in the last 6 months. A score of three or greater on the two-item PHQ-2 indicated a positive screen for depression. Frequency of alcohol and marijuana use was measured using a Likert scale that ranged from 0 to 6 (0 = zero times, 1 = once a month or less, 2 = several times a month, 3 = once a week, 4 = several times a week, 5 = once a day, 6 = more than once a day). Additionally, participants were asked to report lifetime experiences (yes/no) of physical intimate partner violence, sexual assault, trading sex, receiving money in

exchange for sex, paying for sex, or spending time in jail or prison (see frequencies in Table 2).

Participant Satisfaction

Participant satisfaction with the intervention was assessed using a three-item self-report survey administered through the automated text messaging service. Items measured perceived quality of care provided by MCM (1 = terrible, 9 = excellent), perceived improvement in communication with MCM (1 = significantly worsened, 9 = significantly improved), and acceptability of text message frequency (1 = too few, 5 = perfect, 9 = too many).

Sociodemographic Variables

Participants self-reported a number of sociodemographic variables at time of enrollment, including race, gender, education level, employment status, income, age, and mode of HIV acquisition (see frequencies in Table 2).

Data Analysis

Frequencies and means were used to describe the sample and number of text messages to which participants responded; the number of types of alerts triggered by participants; and to analyze participant satisfaction with the intervention. McNemar's tests were computed to examine significant changes in the proportion of participants with VLS at enrollment compared to 6 and 12 month follow-ups. McNemar's test was chosen because it accounts for paired sampling, unlike standard chi-square tests. For McNemar's tests, viral load suppression was dummy coded where 0 = not virally suppressed and 1 = virally suppressed. Wilcoxon Signed Rank tests were used to test for significant differences in the mean viral load of participants at enrollment compared to 6 and 12 month follow-ups. The Wilcoxon Signed Rank test was chosen to account for the non-normal distribution of the viral load variables and the paired samples used in the tests. Multivariable logistic regression models were used to analyze associations between text messaging engagement and HIV care continuum outcomes of kept medical visits and viral load suppression. The outcome variables for these models were dummy coded to (0 = not virally suppressed, 1 = virally suppressed) and (0 = did not keep medical visit, 1 = kept medical visit).

Table 3 Frequencies of types of alerts triggered via Epharmix by participants

Did not take medication (reasons below)	162
Out of medication	66
Felt sick	12
Felt better	1
Forgot	2
Other (not specified)	72
No reason	9
Stopped taking medication (reason below)	**5**
Felt sick	3
Doctor instruction	2
Mood check – Felt worse than usual	**47**
Housing – Want to discuss housing	**94**
Need to miss appointment (reasons below)	**59**
Work conflict	22
No childcare	1
Transportation problems	6
Other (not specified)	14
No reason	16
Missed appointment (reasons below)	**83**
Work conflict	17
No childcare	1
Transportation problems	13
Cancelled	10
Other (not specified)	28
No reason	14

Results

Engagement with the Intervention

During the intervention period, 89,681 automated messages were sent to participants, yielding a total of 24,926 responses for an overall automated text response rate of approximately 28%. The participant response rate to automated messages was higher in the first 3 months of the program (36.6%) and steadily decreased over the intervention period. Additionally, in response to automated text messages, participants triggered 450 alerts. The most common alerts were in response to not taking one's medication for the day (n = 162, 36%), a request to discuss housing (n = 94, 21%), and missed appointments (n = 83, 18%). The most commonly reported reason for not taking medication was being out of medication, and the more frequently cited reasons for missing appointments were work schedule conflicts and transportation barriers. Table 3 provides a detailed breakdown of alert types of frequencies.

In addition to automated texts, most participants (n = 98) engaged in live text message conversations with their case managers at some point during the intervention. Moreover, nearly two-thirds (n = 62) of participants initiated or responded to text messages with their case manager at least monthly.

Table 4 Differences in viral suppression, kept medical visits, and mean viral load among participants at consent, 6 month, and 12 month timepoints

Sample (n)	Frequencies of Suppressed v. Not Suppressed VL		*p-value*
Baseline (100)	49 v. 51		
6mo (82)	58 v. 24		0.003
Baseline (100)	49 v. 51		
12mo (74)	52 v. 22		0.038
6mo (82)	58 v. 24		
12mo(74)	52 v. 22		0.581
	Frequencies of Kept v. Not Kept Medical Visit		***p-value***
Baseline (100)	44 v. 56		
6mo (87)	87 v. 0		0.000
Baseline (100)	44 v. 56		
12mo (84)	70 v. 14		0.002
6mo (87)	87 v. 0		
12mo (84)	70 v. 14		0.000
	Average Viral Load (*M, SD*)	***z score***	***p-value***
Baseline (100)	23,151.55 (72,753.45)		
6mo (82)	8,651.63 (29, 844.61)	-2.09	0.037
Baseline (100)	23,151.55 (72,753.45)		
12mo (74)	6,371.36 (17,697.30)	-2.62	0.009
6mo (82)	8,651.63 (29, 844.61)		
12mo (74)	6,371.36 (17,697.30)	-0.29	0.828

HIV Care-Continuum Outcomes over Time

Viral Load Suppression

Frequency results indicated that 35 participants remained virally suppressed, 23 became virally suppressed, 18 remained virally unsuppressed, and 6 became virally unsuppressed from consent to 6-month follow-up. Results of McNemar's exact tests showed a significant difference in the proportion of participants who were virally suppressed at 6 months compared to consent (χ^2 (1, 82) = 8.83, p = .003).

Results of frequencies also demonstrated that of the 74 participants who completed 12 months of the intervention, 32 remained virally suppressed, 20 became virally suppressed, 14 remained virally unsuppressed, and 8 became virally unsuppressed during the full intervention period. McNemar's exact tests results showed a significant difference in the proportion of participants who were virally suppressed at 12 month follow-up compared to consent (χ^2 (1, 74) = 4.32, p = .038).

There was not a significant difference in the proportion of participants who were virally suppressed at 6 and 12 months. Numbers of participants who were virally suppressed and not suppressed at each time point are depicted in Table 4.

Understanding that there may be significant differences in viral load progression among those who were newly diagnosed with HIV (e.g., diagnosed within 12 months prior to intervention enrollment) and those diagnosed more than a year ago, we conducted Spearman correlations to test for associations between being newly diagnosed and HIV viral suppression at baseline, 6 month, and 12 month timepoints. Results indicated no significant association between being newly diagnosed and viral load suppression at baseline (r_s=.-0.10, p = .33) or 6 months (r_s=0.20, p = .08). However, there was there was a significant association between being newly diagnosed and achieving viral load suppression at the 12 month timepoint (r_s=0.34, p = .003).

Kept Medical Visits

McNemar's exact tests were also used to examine changes in the proportion of clients who attended a medical visit over the course of the intervention. Change was measured by comparing the proportion of participants who qualified as out-of-care at time of enrollment to the proportion who attended scheduled HIV-specific medical visits throughout the intervention period. Results indicated that a significantly greater proportion of participants attended medical visits at 6 (χ^2 (1, 87) = 34.03, p = .000) and 12-month (χ^2 (1, 74) = 9.59, p = .002) intervals than were considered out-of-care at baseline. However, significantly fewer participants attended their 12 month medical appointment when compared to their 6 month appointment (p = .000). Computation of this final McNemar's test result used a binomial distribution, so no chi-square value was computed. The proportion of participants who did and did not attend medical visits at each time point are provided in Table 4.

Average Viral Load

The average viral load for the sample at baseline was 23,151.55 (SD = 72,753.45) copies/mL of blood. Results of Wilcoxon Signed Rank tests indicated that average viral loads in the sample were significantly lower at six (z=-2.09, p = .037) and 12-month (z=-2.62, p = .009) follow-ups when compared to enrollment. As with viral load suppression, there was no significant difference between average viral loads at 6 and 12 month time points. Mean viral load scores and z-scores for viral load comparison by timepoint are summarized in Table 4.

Text-Messaging Predictors of Viral Load Suppression and Kept Medical Visits

Controlling for gender, results of logistic regression models showed that a greater number of responses to automated messages was significantly associated with a greater likelihood of viral suppression at 6 [*OR* = 1.007, *95% CI*

(1.003–1.012), $p < .01$] and 12 month [$OR = 1.006$, *95% CI* (1.003–1.010), $p < .001$] follow-ups. For every 10 responses, the likelihood of achieving or maintaining viral suppression at 6 and 12 months increased by 7% and 6% respectively. Notably, we also attempted to control for race in our multivariable models; however, doing so resulted in quasi-complete separation of data points. Therefore, race was not used as a control variable. There were no significant associations between text messaging and likelihood of keeping a medical visit at 12 months.

Participant Satisfaction with the Intervention

Participants rated MCM quality of care an average score of 8.35 ($SD = 1.46$) on a scale of 1 (terrible) to 9 (excellent). Participants also reported improved communication with case managers, with an average improved communication score of 6.79 ($SD = 2.39$) on a scale of 0 = significantly worsened and 9 = significantly improved. Furthermore, participants stated that messages were sent at an ideal frequency, with an average score of 5.47 ($SD = 1.64$) where 1 is too few, 5 is perfect, and 9 is too many.

Discussion

The E-VOLUTION intervention adds to previous studies that examined the use of text messaging in HIV care by focusing exclusively on a population of youth and young adults who are mostly Black and at high risk for, or currently experiencing, poor HIV health outcomes. To the authors' knowledge, this is one of the first studies to evaluate the use of both automated and live two-way text messaging to increase kept medical visits and viral load suppression among YLWH in the United States. Moreover, the E-VOLUTION intervention was unique in its inclusion of regular assessments of the psychosocial and financial wellbeing of participants using interactive, automated text messaging. In addition, this intervention used the current Ryan White care system and enhanced the opportunities for connection to supportive MCMs. Given the ubiquity of Ryan White programs across the United States that serve the population represented by the study sample, findings are likely widely generalizable. Despite the psychosocial and financial adversity faced by study participants, results showed a positive change in their trajectory in the HIV care continuum and indicate a need for further research in this area.

The ability of a majority of study participants to achieve viral suppression and/or maintain viral suppression during the intervention period may be due to E-VOLUTION's intentional focus on addressing the impacts of social determinants of health. Alerts triggered by YLWH in this study indicated that an unpredictable work schedule and unreliable transportation each contributed to missed or rescheduled medical appointments. Though not captured in the data for this study, participants who responded to an automated daily text message reminder to take their medication with an alert that indicated they ran out of medication may have been unable to get more medication because of work schedules and/or transportation challenges. In the absence of the E-VOLUTION intervention, these social determinants of health may have resulted in extended time out of care [6] or without medication while care teams attempted to contact youth via phone call or letter to reschedule or YLWH awaited their next medical appointment. This is supported by findings from previously published qualitative E-VOLUTOIN MCM and participant data [21]. Qualitative findings indicated that participants received higher quality and more frequent care from MCMs because they were able to communicate via text message. Additionally, MCMs believed that texting with clients allowed them to address housing and other financial challenges earlier than usual, preventing extreme hardship. Overall, the structure of E-VOLUTION enabled participants and MCMs to more proactively and quickly address manifestations of social determinants of health that impede treatment engagement and lead to poorer HIV care-continuum outcomes for this high-risk population [2].

The findings that viral load suppression and kept medical visit rates increased significantly among participants is consistent with results of other studies with adult samples and samples drawn from non-U.S. populations [22]. Moreover, this study enriches the limited existing knowledge of the use of text messaging as a means of improving HIV care continuum outcomes among youth and young adults in the United States [23, 24] through the addition of automated messages and results that indicate a significant dose-response between texting engagement and likelihood of viral load suppression and medical visit attendance.

Likewise, and similar to previous studies [23, 24], results indicated a high level of participant satisfaction with the intervention, including communication with MCMs and frequency of automated messages. However, despite high levels of satisfaction, participants' response rate to automated messages was somewhat low at 28%. An earlier study of the feasibility of using interactive text messaging to measure adherence to antiretroviral therapy among YLWH by Dowshen and colleagues also reported lower than expected rates, and posited that this may be explained by participant adaptation over time [25]. This may be true for participants in the current study as well. E-VOLUTION participants responded more frequently at the beginning of the intervention, with responses tapering off over time, perhaps because the automated messages became routine and facilitated the

formation of habits such as taking one's medication daily. Once the behaviors became routine, responding to the automated messages may not have seemed necessary, as clients began using the text as a reminder system. Importantly, these clients did not ask to be removed from the automated messages and continued receiving them as a reminder to take their medications.

Limitations

Findings from this study should be interpreted in the context of the study's limitations. Results regarding program effectiveness are restricted by the lack of a comparison group and limited number of control variables. As such, we cannot infer that the E-VOLUTION intervention caused increased viral load suppression and medical visit attendance among participants. However, the findings are promising and suggest a need for future research using similar interventions that include comparison groups (e.g., Garofalo and colleagues) [24]. Additionally, the study used a convenience sample recruited from clinics in a mid-sized midwestern city, so findings may not be generalizable to a broader population of YLWH. Nevertheless, a majority of the study sample reflects those at highest risk for poor HIV care outcomes in the U.S., namely young, lower-income, Black men who have sex with men-many of whom having experienced adversity as children and young adults, including depression, incarceration, sexual assault, and intimate partner violence. Moreover, the study excluded those without access to a mobile phone with texting ability. Although ideally all participants would have been provided with a mobile phone, this was not an expense that was feasible given the study budget, nor the standard operating budgets of most community-based HIV/AIDS service organizations. As such, enrolled participants likely reflect the demographics of those who would be served if this intervention were adopted by other community-based HIV/AIDS service providers. Finally, we did not account for time since diagnosis or time on ART in our bivariate and multivariable analyses. Since results indicated a significant association between being newly diagnosed and being virally suppressed at 12-months, future research should account for these differences.

Conclusion

Findings from the current study suggest that automated and live two-way text messaging with a MCM can improve medical appointment attendance and viral load suppression rates among YLWH who were mostly Black and experienced a number of psychosocial challenges and financial stressors rooted in the social determinants of health. Future research should prospectively compare outcomes between usual care case management participants and those who also receive text messaging to test for significant differences in HIV care outcomes between groups. Additionally, the field would benefit from future research that compares the effectiveness of automated and live two-way text messaging modalities.

Authors' contributions Donald Gerke led the evaluation of the intervention and the writing of the manuscript. Jeff Glotfelty and Stacey Slovacek coordinated the intervention and assisted with writing the manuscript. Maria Freshman and Julia Schlueter managed evaluation data and edited the manuscript. Katie Plax was the PI on the study and assisted with writing of the manuscript.

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Data Availability Not applicable.

Code Availability Not applicable.

Declarations

Conflicts of Interest/Competing Interests None to declare.

Ethics Approval This study was approved by the Human Research Protections Office at Washington University in St. Louis.

Consent to Participate All participants provided informed consent to participate in this study. Since the intervention was delivered via text message, special care was taken during the consent procedure to ensure participants had access to a private mobile phone before they were enrolled in the study.

Consent for publication Not applicable.

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