Acceptability of a Just-in-Time Adaptive Intervention for HIV Prevention among Youth Experiencing Homelessness: A Qualitative Analysis

Darlene E. Acorda, Jennifer Torres Jones, Diane Santa Maria

Journal of Health Care for the Poor and Underserved, Volume 32, Number 2, May 2021 Supplement, pp. 25-42 (Article)

Published by Johns Hopkins University Press

DOI: <https://doi.org/10.1353/hpu.2021.0049>

➔ *For additional information about this article*

<https://muse.jhu.edu/article/789656>

Acceptability of a Just-in-Time Adaptive Intervention for HIV Prevention among Youth Experiencing Homelessness: A Qualitative Analysis

Darlene E. Acorda, PhD, RN, CNE, CPNP-PC

Jennifer Torres Jones, MPH, CHES

Diane Santa Maria, DrPh, MSN, RN, PHNA-BC, FAAN

Abstract: **Background.** Few interventions leverage technology to mitigate HIV risks in youth experiencing homelessness (YEH). This study assesses the acceptability and impacts of an app-based just-in-time adaptive intervention for HIV prevention from the YEH perspective. **Methods.** Sixteen interviews were conducted with YEH in a large, urban Southwest city. Inductive thematic analysis was used to explore YEH experience with the app, including recommendations for improvement and perceived impact. **Results.** Youth experiencing homelessness reported high acceptance of the app. Several youths described changing risk behaviors after enrolling in the study. Youth found the app easy to navigate and the goal interface helpful in tracking progress. Challenges included stolen phones and survey timing. Youth experiencing homelessness strongly recommended customized messages and questions to avoid redundancy, and that real-time support for struggling youth be accessible through the app. **Conclusion.** A just-in-time adaptive intervention for HIV prevention is acceptable to YEH. Larger studies are needed to evaluate long-term impacts on HIV risk behavior.

Key words: HIV prevention, homeless, youth, ecological momentary assessment, just-in-time adaptive intervention.

In 2019, over 38,000 unaccompanied youth aged 18–24 years in the United States were homeless.¹ Annually, approximately one out of 10 young adults between 18 and 25 experience homelessness.² Many homeless youths have chronic physical and mental conditions, engage in substance use, and have trouble accessing health care.^{3,4,5} As a result, they experience mortality rates higher than those of the general youth population.⁶ People experiencing homelessness also have higher rates of HIV than those who are stably housed.⁷ Although few data exist on HIV rates among youth experiencing homelessness (YEH), an older study reported a rate of 16%,⁸ while a more recent study found a self-reported HIV diagnosis rate among YEH of 4%.⁹

Unstable housing and homelessness pose several challenges for HIV care and prevention, including reducing HIV transmission, accessing HIV care, and sustaining viral

All the authors are affiliated with the Cizik School of Nursing at the University of Texas Health Science Center Houston. Please address all correspondence to: Darlene E. Acorda; Email: Darlene.E.Acorda@uth.tmc.edu.

suppression.¹⁰ In this context of need, YEH continue to be an underserved population.¹¹ Several HIV prevention interventions for YEH have shown promise, but are not readily available or widely disseminated.¹² The transience and mobility of YEH and their mental health and substance use issues¹³ make it challenging to access HIV prevention and care in traditional clinic settings. While previous prevention interventions demonstrated desirable outcomes, including a decrease in condomless sex frequency in females among mostly substance-using youth,^{14,15,16,17} these interventions are rarely available and accessed by YEH. Given these challenges, interventions that adapt to the mobility of YEH are needed. The widespread use of smartphones¹⁸ in this population provides an opportunity to explore mobile HIV prevention strategies serving YEH.

Mobile-based interventions have been pilot-tested with youth living with HIV. In a pilot study looking at the use of cell phone reminder calls for assisting HIV-infected adolescents and young adults in adhering to antiretroviral therapy, most participants found reminder calls helpful and acceptable.¹⁹ Among youth living with HIV in San Francisco, text messaging was a feasible and acceptable way to improve HIV care; participants engaged with the intervention and felt that it improved their HIV care, medication adherence, and viral suppression.²⁰ Combining mobile technology with ecological momentary assessments (EMA) has proved to be an effective way of assessing risk and has the potential for intervention research.²¹ Ecological momentary assessment is a promising method to assess and predict risk behaviors in YEH; EMA measures changes in behaviors, cognitions, and environmental factors that vary throughout a given day by asking participants about these factors using assessments delivered throughout the day.²² It remains the most accurate way to measure real-time factors such as behaviors and cognitions in natural settings,^{23,24} and has demonstrated high youth compliance rates.²⁵ In one YEH study, EMA was used to predict associations of high-risk behaviors finding that despite adjusting for sexual urge, the odds of engaging in sex increased 8.8 times when youth used drugs.²¹ Monitoring one's affect and behavior with EMA may increase HIV risk self-awareness and lead to preventative behaviors.

Just-in-time adaptive interventions (JITAI), coupled with EMA, may be an effective strategy for delivering personalized informational and motivational HIV prevention messages to YEH at the time of heightened risk. Just-in-time adaptive interventions are designed to provide the right type and dose of an intervention at the right time.²⁶ While not yet widely tested among YEH, JITAI have demonstrated efficacy in reducing substance use,^{27,28} sexual risk behaviors,²⁹ and mental health symptoms.^{30,31,32} Despite its potential, there are currently no interventions developed and tested for YEH focused on HIV prevention that address modifiable real-time factors such as stress, urge, and substance use. Since JITAI are often delivered via mobile devices, they can facilitate the disclosure of sensitive information, be customizable, and be completed despite transportation and transiency barriers.³³ Additionally, YEH show improved outcomes when a program was tailored and relevant.³⁴ Thus, an intervention using co-designed personalized prevention messages, delivered in real-time, and in response to reported risk factors collected using EMA, could provide information and motivation necessary to build skills and change HIV risk behavior.

There is growing support for the view that a JITAI would be acceptable and feasible for YEH. Although few studies have provided real-time interventions, technology-

based interventions for mental health delivered to YEH found that such interventions are feasible and satisfactory.³⁵ Adolescent mothers experiencing homelessness found a mobile app for emotion regulation valuable for managing stress in real-time; mothers who received sensor alerts rated the sensors as acceptable and helpful during stressful situations in recognizing emotions and using adaptive behaviors.³⁶ To our knowledge, no JITAIs that respond to EMA and deliver individualized, timely HIV prevention messages have been developed for YEH; thus, there are no data about this intervention's acceptability. This study's primary objective was to explore YEH's perceptions toward an HIV just-in-time adaptive HIV Prevention intervention delivered via a mobile app and to identify the benefits and barriers to app use.

Conceptual framework. The intervention was developed using the Information-Motivation-Behavioral Skills (IMB) model that posits that individuals need relevant health information, motivation, and behavioral skills in order to initiate and maintain health behaviors.³⁷ The IMB model has been extensively used in HIV/AIDS prevention research, including the maintenance of safe sex behaviors and compliance with antiretroviral drug therapies.³⁸ The IMB model served as the guiding framework used in the co-development of the targeted HIV prevention messages YEH received through the intervention.

Methods

Design. We used a qualitative, descriptive design to understand the perspectives of YEH with regard to their experiences using an HIV JITAI delivered via a mobile app. Qualitative descriptive designs are appropriate for describing experiences of a poorly understood phenomenon, and findings are often used to develop measurements or refine interventions.³⁹ The study was approved by the Institutional Review Board of the University of Texas Health Science Center—Houston.

Recruitment. Youth were recruited from participants enrolled in the JITAI pilot study's intervention arm testing the *Motivating Youth to Reduce Infection and Disconnection* (MY-RID) intervention. Participants in the parent study (n=97) were between 18 and 25 years old, able to speak and read English, experiencing homelessness or unstable housing, and recruited from shelters and drop-in centers serving YEH in one city in the South. Study staff posted fliers and delivered an informational group presentation during an existing class attended by all youth. Youth who expressed interest were then screened by study staff and underwent the consent procedure in a semi-private area at the shelter or drop-in center. At the end of the parent study, youth were invited to participate in an exit interview about their app experience.

Intervention description. All participants in the parent study received smartphones with the MY-RID app installed and received assessments and HIV prevention messages for up to six weeks. Youth in the intervention arm set a behavioral goal related to HIV prevention at the beginning of the study. Participants chose one of the following goals: condom use, pre-exposure prophylaxis (PrEP) use, non-occupational post-exposure prophylaxis (nPEP) use, reducing the number of sexual partners, not having sex when using drugs or drinking alcohol, avoiding injection drug use, testing for HIV, and testing and treating STIs as needed. The app signaled all participants visually and audibly

one to four times a day to answer brief assessments, which required less than five minutes to complete. Assessments asked about feelings, stress, sexual and drug urges, environmental factors, and risk behaviors such as drug use and condomless sex during the past 24 hours and at the assessment time. Assessment responses populated a graph depicting progress towards the chosen HIV prevention goal. Participant responses were maintained confidentially on the mHealth platform and were only accessible by the investigators after study completion for data analysis. The investigators were blinded to group assignment. Participants also received targeted messages that addressed safer sexual behaviors, reduced alcohol/drug use, PrEP interest, and HIV/STI testing based on the IMB model. Youth in the attention control arm also set behavioral goals; however, goals were related to general health, sleep hygiene, nutrition, tobacco avoidance, and exercise. Upon completing the daily diary EMA, the control group received untargeted messages related to nutrition, physical activity, sleep hygiene, and risk of tobacco use. No graphic depicting goal progress was generated. Figure 1 displays an example of an EMA question, message received, and the goal progress interface.

Figure 1. Example EMA question, message, and goal progress.

Table 1.

INTERVIEW GUIDE

What was your goal for HIV prevention?
What features helped you stick to your goal? (The surveys, the messages, the behavioral interface, the gift cards?)
What made it easy to stick to your goal?
What made it difficult to stick to your goal?
What did you think about the number of questions and the questions themselves on the phone surveys?
What did you think of the messages? Did they help? Any other messages you'd like to see?
What did you think about the app in general?
What suggestions do you have to improve the study?

Financial compensation. Youth received compensation in the form of gift cards for a local grocery store. Youth who completed the first study visit, which consisted of baseline data collection, received \$25. Compensation during the remaining six-week study period was based on response rate to the EMA assessments: for 90% or higher they received \$40, for 75–89% they received \$35, for 50–74% they received \$30, for 25–49% they received \$20, and if they responded to less than 24% of EMA assessments they received \$15. The amounts based on EMA response rate were paid every two weeks during check-in sessions. Participants received an additional \$10 if they agreed to participate in an exit interview.

Current study. A semi-structured interview guide focused on YEH's experiences with MY-RID (Table 1). The interview guide aimed to explore predetermined themes, including desirable features, perceived impact of the app on goal attainment, acceptability of EMA questions and messages, and overall impression of the intervention. Respondents were also asked about general feedback regarding the study. Sixteen interviews were conducted by the research team, audio-recorded, and transcribed verbatim.

Data analysis. Interview transcripts were first reviewed for accuracy with the audio recordings. An inductive thematic approach was used to analyze the data within the IMB model context and to allow themes to emerge. First cycle coding was performed to identify initial codes.⁴⁰ Codes were then independently reviewed by each study team member. Peer debriefing was used to address discrepancies and form a consensus on the interpretation of the data. The second and third cycles of coding were subsequently conducted to formulate significant themes and subthemes and refine the final codebook. The codebook tracked the coding process and included code definitions, exemplars, and contrast cases. Comparison of emerging themes between those who received preventive versus general messages was also conducted. ATLAS.ti 8 Windows qualitative software was used to organize and code the data. Rigor and credibility were established by triangulating the data through member-checking, thick descriptions, and analytic memos.⁴¹

Results

Participant characteristics. The average age of participants in this study ($n=16$) was 20 years old; the majority of youth identified as African American (68.8%, 11/16), heterosexual (62.5%, 10/16), and cisgender male (50%, 8/16). The respondents represented the intervention and control arms equally. Most youths had a GED or a high school diploma (68.8%, 11/16). Table 2 provides additional participant characteristics. Table 3 displays a summary of the major themes and subthemes along with exemplars.

Goal choice. Participants reported a variety of goals they wanted to achieve during the study. Most goals aligned with the study's objective to decrease HIV risk, including limiting sexual partners and reducing drug and alcohol use. Other youth, particularly

Table 2.

PARTICIPANT CHARACTERISTICS

	n	%
Age (mean)	20	
Currently in school	3	18.8
Currently working	6	37.5
Gender		
Female	7	43.8
Male	8	50.0
Trans male	0	0.0
Trans female	1	6.3
Genderqueer	0	0.0
Race/ethnicity		
Black	11	68.8
Latino	3	18.8
American Indian	2	12.5
White	0	0.0
Asian or PI	0	0.0
Other	2	12.5
Sexual orientation		
Heterosexual	10	62.5
Bisexual	4	25.0
Lesbian	1	6.3
Pansexual	1	6.3
Education level		
High school diploma	8	50.0
GED	3	18.8
Less than GED	5	31.3
Study assignment (parent study)		
Intervention	8	50.0
Control	8	50.0

Table 3.
THEMES AND EXEMPLARS

Theme	Sub-theme	Exemplars
Information- Motivation- Behavioral Skills	Receiving health-related information	"It helped me get better and like teach me more about the condom."
	Motivate and provide support	"I like how [messages] motivated. Like it was telling you to never give up, keep your head high."
	Behavioral skills supported by the app	"It made me think before I want to go out and have sex. I'd go through the message or look in the survey and realize, oh, I'm good. I don't need to."
Acceptability	Relevance to the YEH experience	"[questions], it's like as I'm talking with one of my friends . . . like an everyday conversation."
	Risk for triggering	"Well, it was a little exhausting mentally, more than anything, because you have to trace back to those issues or whatever problem was going on, but it was okay."
Usability	Easy to navigate	"If you forget how to do it, it's easy . . . all you got to do is slide left and press sync."
	Timing	". . . Every other three hours, the survey text message would pop up and inform me I was going to get on survey . . . I just added another schedule in my life because it's like your moving on a time schedule on that too."
Barriers	Redundancy	"I mean, they were the same [questions] every time. It was just, like, "Okay, if you're going to ask me the same thing, why am I taking it so often?"
Recommendations for future studies	Personalized messages with real time advice or support	"I feel like they need to have more detailed, encouraging messages. It asks if you were depressed or if you felt like self-harming. The only thing they would say is seek help or whatever, but it should have more behind that or like, more advice."
	Question variety	"Add ten more questions . . . The first questions will be where do you see yourself in five years? What are your three main goals? Do you plan on going back to school? What's your dream job? That's like a couple of them."
	Additional features	" . . . put some games on them." " . . . I'm a huge gamer, which is why I downloaded video games, also downloaded Facebook."

from the control condition, conveyed goals such as increasing frequency of exercise. However, the majority chose to focus on increasing condom use, followed by getting on PrEP. One youth explained their reason for choosing PrEP: “To look more into PrEP . . . like not just what it’s used for but how it could help the body more. And I wish there was more information about it.”

YEH desire health-related information. Youth were asked about the information they received through the app and whether this information was helpful towards achieving their goals. The majority of youth reported that the messages provided valuable information on minimizing their risk. “It helped me get better and like teach me more about the condom,” “I think it’s an interesting survey to let people know how to protect from HIV.” One youth described how he processed a message related to PrEP and condom use:

I think it’s the most intelligent idea that you could actually think of because it’s not only just loving and protecting yourself, but it’s also making sure that the other person is loved and protected as well due to the fact that . . . you don’t want to give the girl that you’re with the same thing that you have.

Youth also conveyed that answering the survey and seeing their responses provided them information on the frequency of their high-risk behaviors. One youth reported, “The questions were actually all right . . . [questions] mostly helped me to stay away from [drugs] because I knew.” Aside from receiving health-related information, youth also enjoyed other types of messages. One youth expressed that the messages were like “fortune cookies that you open up.” Some youth felt that some of the messages were “cheesy,” but they nonetheless valued the information they received. “It was giving me like short facts or just reminders. I think one of them was like “You’re going to have a good day” or something like that. So, it was really cool.”

Several youths noted that although the information they received through the messages was helpful, the messages were not new to them. Others were suspicious of the meaning and the intent behind the messages. One youth expressed:

I hear it all the time. To me, I’m more one of those blunt persons. Get out of my face with that because I know what you’re telling me is not true because I know how reality works. They’re trying to slightly alter it for me. If I’m going to alter it, then I might as well go to drugs.

Messages and surveys motivated youth and provided a sense of support. Youth were asked what helped them stick to their goals, and several expressed that the messages motivated them and made them feel less alone in their struggle with homelessness. “They help, they did help . . . as far as uplifting, they helped, they helped a lot. They were able to put a smile on my face. I don’t know, I like little stuff like that.” One youth explained how the messages kept her going:

I like how they motivated. Like it was telling you to never give up, keep your head high. I like how they did that at the end . . . and they read that quote and makes them have a little motivation, like, “You know what, they’re right. I can do it.” But that’s really what got me was it was motivating.

Perceived support through their interactions with the app also provided a sense of caring for some youth. “Felt like a parent was in my phone . . . make me feel like somebody was watching over me.” Another reported “. . . It actually helped me to understand that there are people that care, and I was able to be me and answer them by who I am.” One youth described how answering the surveys prevented them from engaging in high-risk behaviors:

The questions were—they were actually all right. I mean, most of them had to deal with like, if I was going to kill myself or if I did a drug or something. And actually, that mostly helped me to stay away from those things because I knew that somebody was out there caring about me at that point in time.

Several youths reported that they were already working towards a specific goal or had a plan in place. “It was kind of hard for me to pick one because I already did something. I already have a plan.” Another described already being motivated to start PrEP:

I had already planned on doing PrEP before the whole [app] thing. So like it really wasn't hard to like go and get on it and stick to it especially since I already have pills I take every day. So that was just a plus.

Other motivations for participation included the study incentives. A few youth reported that the study compensation was a motivating factor for high participation in the study. “Honestly, I'm really ambitious, so I got to say it was the cash I was going to earn.”

Behavioral skills were supported. Most of the youth reported that the combination of receiving messages and answering the surveys helped them to attain their goal or decrease the frequency of their high-risk behaviors. Several described planning their day and making behavioral changes as a result of participating in the study. “The app made it easier, a reminder to do what I needed to do.” “I get up and okay, I got to do this, this, and this, mentally check it off.” Describing their plan to achieve their goal of increasing condom use, one youth stated, “I got a little Ziploc bag and put a bag of condoms in each bag.” Another youth who selected decreasing drug use as their goal reported, “I've limited [drug use] all the way to zero when I had the phone.” For one youth, the messages and surveys served as reminders, stating, “It'd make me think before I want to go out and have sex. I look—I'd go through the message or look in the survey and realize, oh, I'm good. I don't need to.”

The majority expressed that the app was instrumental in assisting them in attaining their goals. “The app I think is probably by far the best app anybody could have on their phone, especially if they want to like make progress and be a better person.” One youth emphasized the value of the app for him: “My overall thoughts on it is it's very helpful. If I don't get a phone, I would definitely not be against bringing my own phone.” Another youth stated, “I feel like it's a good app, a good survey, and it helped you more in life with things that you need to cope with or get through with in life. So that's why I would recommend it.”

Acceptability of surveys, messages, and app. When asked about feedback on the survey questions, most youth in this study conveyed that the questions were accept-

able and relevant to their experience. Most reported that they liked receiving personal questions. “It slowly went into your personal life which I like about that. It’s like a conversation, but it was asking questions.” For some of the youth, a few of the questions were perceived as possibly triggering to youth, reporting:

... they’ll ask you, “Did you do this today?” or “Did you watch this today?” or “Has anybody assaulted you?” or anything like that. And I just kind of feel like for some people that’s a trigger. So, I feel like that should be left off.

Another youth voiced reluctance about answering the survey: “Unless something happened, then I’m like—I’m not even going to tell ... there’s no point in telling them. It’s just a survey.” Another expressed confusion over the wording of the questions: “Some of them was like “I’m irritated,” “I’m angry,” I’m like, these are just the same emotions.”

Usability of the app. Youth reported that the app was easy to navigate. “If you forget how to do it, it’s easy ... it’s only two things you got to do, and then just answer the questions and you don’t have to link it. All you got to do is slide left and press sync.” Youth also relayed that answering the survey questions was easy despite experiencing glitches with survey tracking. Youth had variable feedback on the timing of the surveys. Some felt that the timing was appropriate: “I had it on a time schedule so it was good. It worked out. And it wouldn’t even take two minutes or a minute to do the surveys.” Others reported that it interfered with work and other activities:

... I didn’t always get the assessment because I could be watching something on my phone, like Netflix or something, and it never comes on. So, I wish it would come on even though I am watching something, so that way it can remind that I have to take it at this time.

Youth especially liked the additional features of tracking their progress on their behavioral goal and their survey completion rate. This also helped them to gauge their level of compensation based on survey completion rates. “If you wanted to check on the compensation, you just go and check on it.” Although the ability to track progress was a popular feature, one youth reported that they believed the app did not record all of their completed surveys.

Perceived barriers. The most common survey issue reported by youth was the repetition of the questions. “I thought it was neat how it was scheduled throughout the day, the only thing is it asked the same questions every day.” Another youth reported that the repetition made them less inclined to answer truthfully. “It’s just so ... repetitive. I’m like, Man, who really cares. It’s not going to tell them anything if I accidentally put ‘yes.’” For some, repeated questions led to confusion. “People got confused, like, okay, do I put the same answer, or do they ask me over again just to see how I feel or if I’m doing any better?” One of the barriers encountered by youth in this study was stolen phones. “The difficult things? The fact that the phone was stolen from me while I was asleep. I hate pick pocketers.”

YEH recommendations for future studies. The majority of youth recommended that questions should be customized to each individual’s experience. One youth stated

that receiving tips on how to control emotions would be helpful while others preferred more detailed information, including receiving advice:

I feel like they need to have more detailed, encouraging messages. It asks if you were depressed or if you felt like self-harming. The only thing they would say is seek help or whatever, but it should have more behind that or like more advice.

One youth recommended that questions addressing future goals should be included in the survey: “Where do you see yourself in five years? What are your three main goals? Do you plan on going back to school? What’s your dream job? That’s like a couple of them.” Another stated that guidance on how to achieve goals would be helpful. Describing that messages should convey a shared experience, one youth said:

I mean, we’re human, you know, everybody makes mistakes, but nobody’s perfect. So, it doesn’t mean it makes you a bad person . . . something like that in a quote. So, it makes everybody feel like, “Oh, so we’re all the same.” So, there’s—nobody’s perfect. So, there’s no need for me to drink my pain away or to drug my pain away.

To avoid boredom, a few youths suggested that video and quiz games be added to the phones. “I just wish that it had games in there. So that people can be on it a little longer. You know what I’m saying? But I liked it. I thought it was all right.”

Discussion

In this qualitative study, we explored the perceptions of YEH on the impacts, acceptability, and usability of a JITAI HIV prevention app called MY-RID within the context of the IMB model. Mobile health (mHealth) HIV prevention interventions designed for and tested among YEH are limited. To our knowledge, this is the first study to investigate YEH perceptions of acceptability and usability of a JITAI HIV prevention app-based intervention. Previous prevention strategies in this population have involved curriculum-based, face-to-face sessions, counseling, single event workshops, and other training programs.^{13,16,15} However, these sessions are resource-intensive, have sustainability challenges, and demonstrate minimal long-term efficacy.⁴² Interventions that require fewer resources are desired, and a mobile JITAI HIV prevention intervention app may be ideal in reaching YEH as they go about their daily lives, during which they can access the app regardless of where they are staying. Findings in this study reveal that YEH found the mobile app acceptable and easy to use, and perceived that it provided information that motivated and supported their behavioral goals.

Youth reported that the information from the surveys and the messages was useful and valuable; some expressed a desire to learn more about HIV and prevention methods. Youth also preferred positive, uplifting messages, and they generally perceived the information they received as motivating and supportive. Other YEH studies have also found that daily motivational tips were preferred by youth over other types of messaging.^{35,43} Although only one youth expressed being suspicious about the meaning of the messages, care should be taken when developing motivational messages and survey

questions to ensure authenticity and relevancy to the experience of homelessness. We did not find differences in perceptions between youth who received prevention messages and those who received general messages; however, this may be due to the limited sample size and the focus on eliciting overall experience rather than differences.

Several youths conveyed that the surveys and messages made them feel cared for; a previous YEH EMA study found similar “perceptions of care” with youth expressing that receiving frequent assessments throughout their day made them feel as though someone was checking in on them or watching over them.⁴⁴ Research shows that participants can develop a bond with mobile interventions despite knowing that the responses are automated.^{45,46} For YEH in this study, this constant interaction reminded them of their behaviors, brought increased affect and behavioral awareness, and motivated them to adopt and maintain health behaviors. Some reported adopting new routines, including carrying condoms, while others minimized their substance use frequency and high-risk sexual behaviors. It is important to note that some youth may have been more motivated than others; for example, some had established plans to get on PrEP before the study. However, it is unclear if youth’s behavior change was sustained during and after the study. Research shows that increasing knowledge of HIV prevention behaviors may not necessarily translate into long-term preventive behaviors.^{47,48} More research is needed to investigate mobile apps’ long-term impact on decreasing HIV risk behaviors in YEH.

Youth generally had positive experiences with the app; however, redundancy of questions and timing of surveys was a perceived barrier to engagement and compliance. Several youth reported that surveys sometimes interfered with work and other routines, a common issue encountered in other EMA studies. In a systematic review of EMA methods in youth, Heron et al. recommended that creating custom alarm schedules that adjust for daily routines may help minimize missed assessments.⁴⁹ Despite these challenges, youth described the app as easy to navigate. Some experienced a few glitches with a survey response not registering or the app not tracking response rates. The ability to track responses and goal progress was an important feature, and many YEH expressed that it was the app feature that was most valuable to them.

App-based interventions have had promising results in other populations experiencing homelessness. Schueller et al. found that young homeless adults engaged in and viewed the customized app positively despite a lack of compensation.³⁵ Glover et al. recommended that a co-design process be used to engage better and target YEH’s needs when developing apps.⁵⁰ Although YEH assisted in co-developing the messages used in the MY-RID app, youth in this study recommended that surveys and messages be further customized to individuals. Enhanced real-time support and guidance was requested for anyone indicating concern over engaging in self-harming behaviors. Expanding the questions beyond high-risk behaviors to include questions about everyday experiences and current and future goals was also desirable.

Stolen, lost, and damaged phones were a significant issue in this study. Although only a few youths reported their phones as stolen, 75% of phones from the original JITAI study were damaged, lost, or stolen. For many individuals experiencing homelessness, phones serve as lifelines to access support, resources, and for responding to emergencies.⁵¹ Jennings et al. found that it was common for many YEH to own more than one phone, one for regular use and a second phone for screening purposes.⁴⁴

However, phones were often disconnected from service due to YEH's inability to pay the bill.⁴⁴ Several youths suggested that they keep the phones after the study as part of the incentive for participation. More research is needed to identify strategies to help youth protect phones and increase the lifespan of a phone or phone number to stay connected.

This study aligns with current literature that EMA is acceptable to YEH. Findings also add to our understanding of the app-based MY-RID intervention for HIV prevention's feasibility and acceptability in YEH. As mobile technology evolves, more focus is needed on strategies that leverage technology to minimize health disparities. Youth experiencing homelessness face difficulties unlike those experienced by stably housed youth, yet only a few studies have used mobile technology to target the challenges posed by homelessness. This study reveals that real-time, technology-based interventions have a high potential for targeting risk behaviors in higher-risk youth populations and provide recommendations for the development of future app-based interventions.

Limitations. This study had several limitations. The experiences reflected in this report may be unique to the youth who volunteered to participate in the exit interviews rather than to all youth who participated in the parent JITAI study or all youth experiencing homelessness. The youth in this study may have also been more motivated to change and therefore were more receptive to the intervention. Social desirability and participant compensation may have also influenced participation and responses related to the acceptability and usability of the app. Our analysis focused primarily on acceptability and usability related to the app, messages, and surveys; there may have been other contributing factors that affected YEH's overall experience with the MY-RID intervention and the app in general that were not explored in this study. Despite these limitations, this study's findings align with and add to previous YEH mobile health studies suggesting that the use of JITAIs may be acceptable to YEH and should be tested in a wider sample of YEH in other geographical locations.

Conclusion. This study's findings revealed that the MY-RID HIV prevention intervention was acceptable, informative, and motivating for YEH. The results are a promising indication that mobile apps may be one way to increase the reach of HIV prevention interventions to hard-to-reach groups of youth experiencing homelessness. Redundancy of questions, the timing of the surveys, and damaged and lost phones were common barriers to continued engagement and compliance during the study period. Although some youth reported behavioral changes due to participation in this study, more research is needed to determine the behavioral impacts of an HIV prevention app on high-risk behaviors among this population. Future studies should tailor JITAIs to include more personalization and tailored questions and messages and be tested in a larger sample of YEH to determine behavioral impact over time.

Acknowledgments

The authors acknowledge that this study was funded by an internal grant from the University of Texas Health Science Center at Houston Cizik School of Nursing PARTNERS (Providing Advancement Resources to Nursing Education, Research, and Students) Grant 8.2018-7.2020.

References

1. US Department of Housing and Urban Development (HUD). HUD 2019 continuum of care homeless assistance programs homeless populations and subpopulations report. Washington, DC: US Department of Housing and Urban Development, 2020.
2. Morton MH, Dworsky A, Matjasko JL, et al. Prevalence and correlates of youth homelessness in the United States. *J Adolesc Health*. 2018 Jan;62(1):14–21. Epub 2017 Nov 15.
<https://doi.org/10.1016/j.jadohealth.2017.10.006>
PMid:29153445 PMCID:PMC5826721
3. Edidin JP, Ganim Z, Hunter SJ, et al. The mental and physical health of homeless youth: a literature review. *Child Psychiatry Hum Dev*. 2012 Jun;43(3):354–75.
<https://doi.org/10.1007/s10578-011-0270-1>
PMid:22120422
4. Kulik DM, Gaetz S, Crowe C, et al. Homeless youth's overwhelming health burden: a review of the literature. *Paediatr Child Health*. 2011 Jun;16(6):e43–7.
<https://doi.org/10.1093/pch/16.6.e43>
PMid:22654549 PMCID:PMC3328221
5. Hwang SW, Ueng JJ, Chiu S, et al. Universal health insurance and health care access for homeless persons. *Am J Public Health*. 2010 Aug;100(8):1454–61. Epub 2010 Jun 17.
<https://doi.org/10.2105/AJPH.2009.182022>
PMid:20558789 PMCID:PMC2901287
6. Baggett TP, Hwang SW, O'Connell JJ, et al. Mortality among homeless adults in Boston: shifts in causes of death over a 15-year period. *JAMA Intern Med*. 2013 Feb 11;173(3):189–95.
<https://doi.org/10.1001/jamainternmed.2013.1604>
PMid:23318302 PMCID:PMC3713619
7. Beijer U, Wolf A, Fazel S. Prevalence of tuberculosis, hepatitis C virus, and HIV in homeless people: a systematic review and meta-analysis. *Lancet Infect Dis*. 2012 Nov;12(11):859–70. Epub 2012 Aug 20.
[https://doi.org/10.1016/S1473-3099\(12\)70177-9](https://doi.org/10.1016/S1473-3099(12)70177-9)
8. Beech BM, Myers L, Beech DJ, et al. Human immunodeficiency syndrome and hepatitis B and C infections among homeless adolescents. *Semin Pediatr Infect Dis*. 2003 Jan;14(1):12–9.
<https://doi.org/10.1053/spid.2003.127212>
PMid:12748917
9. Santa Maria D, Flash CA, Narendorf S, et al. Knowledge and attitudes about pre-exposure prophylaxis among young adults experiencing homelessness in seven U.S. Cities. *J Adolesc Health*. 2019 May;64(5):574–80. Epub 2018 Sep 22.
<https://doi.org/10.1016/j.jadohealth.2018.06.023>
PMid:30254009
10. Aidala A, Cross JE, Stall R, et al. Housing status and HIV risk behaviors: implications for prevention and policy. *AIDS Behav*. 2005 Sep;9(3):251–65.
<https://doi.org/10.1007/s10461-005-9000-7>
PMid:16088369
11. Slesnick N, Meyers RJ, Meade M, et al. Bleak and hopeless no more. Engagement Of reluctant substance-abusing runaway youth and their families. *J Subst Abuse Treat*. 2000 Oct;19(3):215–22.
[https://doi.org/10.1016/S0740-5472\(00\)00100-8](https://doi.org/10.1016/S0740-5472(00)00100-8)

12. Arnold EM, Rotheram-Borus MJ. Comparisons of prevention programs for homeless youth. *Prev Sci.* 2009 Mar;10(1):76–86.
<https://doi.org/10.1007/s11121-008-0119-4>
PMid:19067164 PMCID:PMC4028969
13. Naranbhai V, Abdool Karim Q, Meyer-Weitz A. Interventions to modify sexual risk behaviours for preventing HIV in homeless youth. *Cochrane Database Syst Rev.* 2011 Jan 19;(1):CD007501.
<https://doi.org/10.1002/14651858.CD007501.pub2>
PMid:21249691 PMCID:PMC3624078
14. Altena AM, Brilleslijper-Kater SN, Wolf JL. Effective interventions for homeless youth: a systematic review. *Am J Prev Med.* 2010 Jun;38(6):637–45.
<https://doi.org/10.1016/j.amepre.2010.02.017>
PMid:20494240
15. Rotheram-Borus MJ, Song J, Gwadz M, et al. Reductions in HIV risk among runaway youth. *Prev Sci.* 2003 Sep;4(3):173–87.
<https://doi.org/10.1023/A:1024697706033>
PMid:12940468
16. Slesnick N, Kang MJ. The impact of an integrated treatment on HIV risk behavior among homeless youth: a randomized controlled trial. *J Behav Med.* 2008 Feb;31(1):45–59. Epub 2007 Oct 17.
<https://doi.org/10.1007/s10865-007-9132-5>
PMid:17940861 PMCID:PMC2430633
17. Slesnick N, Prestopnik JL. Ecologically based family therapy outcome with substance abusing runaway adolescents. *J Adolesc.* 2005 Apr;28(2):277–98. Epub 2005 Apr 15.
<https://doi.org/10.1016/j.adolescence.2005.02.008>
PMid:15878048 PMCID:PMC1933523
18. Rhoades H, Wenzel S, Rice E, et al. No digital divide? Technology use among homeless adults. *J Soc Distress Homeless.* 2017;26(1):73–7. Epub 2017 Mar 22.
<https://doi.org/10.1080/10530789.2017.1305140>
PMid:31097900 PMCID:PMC6516785
19. Puccio JA, Belzer M, Olson J, et al. The use of cell phone reminder calls for assisting HIV-infected adolescents and young adults to adhere to highly active antiretroviral therapy: a pilot study. *AIDS Patient Care STDS.* 2006 Jun;20(6):438–44.
<https://doi.org/10.1089/apc.2006.20.438>
PMid:16789857
20. Trujillo D, Turner C, Le V, et al. Digital HIV care navigation for young people living with HIV in San Francisco, California: feasibility and acceptability study. *JMIR Mhealth Uhealth.* 2020 Jan 10;8(1):e16838.
<https://doi.org/10.2196/16838>
PMid:31922489 PMCID:PMC6996763
21. Santa Maria D, Padhye N, Yang Y, et al. Predicting sexual behaviors among homeless young adults: ecological momentary assessment study. *JMIR Public Health Surveill.* 2018 Apr 10;4(2):e39. Erratum in: *JMIR Public Health Surveill.* 2018 May 07;4(2):e10806.
<https://doi.org/10.2196/10806>
PMid:30578237 PMCID:PMC6304223
22. Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol.* 2008;4:1–32.

- <https://doi.org/10.1146/annurev.clinpsy.3.022806.091415>
PMid:18509902
23. Stone AA, Shiffman S. Capturing momentary, self-report data: a proposal for reporting guidelines. *Ann Behav Med.* 2002 Summer;24(3):236–43.
https://doi.org/10.1207/S15324796ABM2403_09
PMid:12173681
 24. Stone A, Shiffman S, Atienza A, et al. *The science of real-time data capture: self-reports in health research.* Oxford, England: Oxford University Press, 2007.
 25. Wen CKF, Schneider S, Stone AA, et al. Compliance with mobile ecological momentary assessment protocols in children and adolescents: a systematic review and meta-analysis. *J Med Internet Res.* 2017 Apr 26;19(4):e132.
<https://doi.org/10.2196/jmir.6641>
PMid:28446418 PMCID:PMC5425774
 26. Nahum-Shani I, Smith SN, Spring BJ, et al. Just-in-time adaptive interventions (JITAIs) in mobile health: key components and design principles for ongoing health behavior support. *Ann Behav Med.* 2018 May 18;52(6):446–62.
<https://doi.org/10.1007/s12160-016-9830-8>
PMid:27663578 PMCID:PMC5364076
 27. Whittaker R, McRobbie H, Bullen C, et al. Mobile phone-based interventions for smoking cessation. *Cochrane Database Syst Rev.* 2016 Apr 10;4(4):CD006611.
<https://doi.org/10.1002/14651858.CD006611.pub4>
PMid:27060875 PMCID:PMC6485940
 28. Suffoletto B, Kristan J, Callaway C, et al. A text message alcohol intervention for young adult emergency department patients: a randomized clinical trial. *Ann Emerg Med.* 2014 Dec;64(6):664–72. Epub 2014 Jul 10.
<https://doi.org/10.1016/j.annemergmed.2014.06.010>
PMid:25017822 PMCID:PMC4254153
 29. Jones K, Eathington P, Baldwin K, et al. The impact of health education transmitted via social media or text messaging on adolescent and young adult risky sexual behavior: a systematic review of the literature. *Sex Transm Dis.* 2014 Jul;41(7):413–9.
<https://doi.org/10.1097/OLQ.0000000000000146>
PMid:24922099
 30. Loo Gee B, Griffiths KM, Gulliver A. Effectiveness of mobile technologies delivering ecological momentary interventions for stress and anxiety: a systematic review. *J Am Med Inform Assoc.* 2016 Jan;23(1):221–9. Epub 2015 May 21.
<https://doi.org/10.1093/jamia/ocv043>
PMid:25997643 PMCID:PMC7814930
 31. Grassi A, Gaggioli A, Riva G. The green valley: the use of mobile narratives for reducing stress in commuters. *Cyberpsychol Behav.* 2009 Apr;12(2):155–61.
<https://doi.org/10.1089/cpb.2008.0156>
PMid:19275475
 32. Riva G, Grassi A, Villani D, et al. Managing exam stress using UMTS phones: the advantage of portable audio/video support. *Stud Health Technol Inform.* 2007;125:406–8.
 33. Serrano KJ, Yu M, Riley WT, et al. Willingness to exchange health information via mobile devices: findings from a population-based survey. *Ann Fam Med.* 2016 Jan–Feb;14(1):34–40.
<https://doi.org/10.1370/afm.1888>
PMid:26755781 PMCID:PMC4709153

34. Bender K, Begun S, DePrince A, et al. Mindfulness intervention with homeless youth. *J Soc Social Work Res*. 2015;6(4):491–513.
<https://doi.org/10.1086/684107>
35. Schueller SM, Glover AC, Rufa AK, et al. A mobile phone-based intervention to improve mental health among homeless young adults: pilot feasibility trial. *JMIR Mhealth Uhealth*. 2019 Jul 2;7(7):e12347.
<https://doi.org/10.2196/12347>
PMid:31267980 PMCID:PMC6632101
36. Rice E, Tulbert E, Cederbaum J, et al. Mobilizing homeless youth for HIV prevention: a social network analysis of the acceptability of a face-to-face and online social networking intervention. *Health Educ Res*. 2012 Apr;27(2):226–36. Epub 2012 Jan 13.
<https://doi.org/10.1093/her/cyr113>
PMid:22247453 PMCID:PMC3303208
37. Fisher JD, Fisher WA, Amico KR, et al. An information-motivation-behavioral skills model of adherence to antiretroviral therapy. *Health Psychol*. 2006 Jul;25(4):462–73.
<https://doi.org/10.1037/0278-6133.25.4.462>
PMid:16846321
38. Chang SJ, Choi S, Kim S, et al. Intervention strategies based on information-motivation-behavioral skills model for health behavior change: a systematic review. *Asian Nurs Res (Korean Soc Nurs Sci)*. 2014 Sep;8(3):172–81.
<https://doi.org/10.1016/j.anr.2014.08.002>
39. Crabtree BF, Miller WL. *Doing qualitative research* (2nd ed.). Thousand Oaks, CA: Sage Publications, 1999.
40. Saldana J. *The coding manual for qualitative researchers* (3rd ed.). Los Angeles, CA: Sage Publications, 2016.
41. Lincoln YS, Guba EG. *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications, 1985.
[https://doi.org/10.1016/0147-1767\(85\)90062-8](https://doi.org/10.1016/0147-1767(85)90062-8)
42. Tucker JS, D'Amico EJ, Ewing BA, et al. A group-based motivational interviewing brief intervention to reduce substance use and sexual risk behavior among homeless young adults. *J Subst Abuse Treat*. 2017 Feb 12;76:20–7.
<https://doi.org/10.1016/j.jsat.2017.02.008>
PMid:28340904 PMCID:PMC5396394
43. Adkins EC, Zalta AK, Boley RA, et al. Exploring the potential of technology-based mental health services for homeless youth: a qualitative study. *Psychol Serv*. 2017 May;14(2):238–45.
<https://doi.org/10.1037/ser0000120>
PMid:28481610 PMCID:PMC5540313
44. Jennings L, Lee N, Shore D, et al. U.S. minority homeless youth's access to and use of mobile phones: implications for mHealth intervention design. *J Health Commun*. 2016 Jul;21(7):725–33. Epub 2016 May 27.
<https://doi.org/10.1080/10810730.2015.1103331>
PMid:27232544
45. Ben-Zeev D, Kaiser SM, Krzos I. Remote “hovering” with individuals with psychotic disorders and substance use: feasibility, engagement, and therapeutic alliance with a text-messaging mobile interventionist. *J Dual Diagn*. 2014;10(4):197–203.
<https://doi.org/10.1080/15504263.2014.962336>
PMid:25391277 PMCID:PMC4231298
46. Aguilera A, Muñoz RF. Text messaging as an adjunct to CBT in low-income populations: a usability and feasibility pilot study. *Prof Psychol Res Pr*. 2011 Dec 1;42(6):472–8.

- <https://doi.org/10.1037/a0025499>
PMid:25525292 PMCID:PMC4267577
47. Baybuga MS, Celik SS. The level of knowledge and views of the street children/youth about AIDS in Turkey. *Int J Nurs Stud*. 2004 Aug;41(6):591–7.
<https://doi.org/10.1016/j.ijnurstu.2003.12.010>
PMid:15240082
48. Snell CL. Help-seeking and risk-taking behavior among Black street youth: implications for HIV/AIDS prevention and social policy. *J Health Soc Policy*. 2002;16(1–2): 21–32.
https://doi.org/10.1300/J045v16n01_03
PMid:12809375
49. Heron KE, Everhart RS, McHale SM, et al. Using mobile-technology-based ecological momentary assessment (EMA) methods with youth: a systematic review and recommendations. *J Pediatr Psychol*. 2017 Nov 1;42(10):1087–1107.
<https://doi.org/10.1093/jpepsy/jsx078>
PMid:28475765
50. Glover AC, Schueller SM, Winiarski DA, et al. Automated mobile phone-based mental health resource for homeless youth: pilot study assessing feasibility and acceptability. *JMIR Ment Health*. 2019 Oct 11;6(10):e15144.
<https://doi.org/10.2196/15144>
PMid:31605516 PMCID:PMC6915810
51. Eyrich-Garg KM. Mobile phone technology: a new paradigm for the prevention, treatment, and research of the non-sheltered “street” homeless? *J Urban Health*. 2010 May;87(3):365–80.
<https://doi.org/10.1007/s11524-010-9456-2>
PMid:20397058 PMCID:PMC2871091