Development, Refinement, and Acceptability of Digital Gaming to Improve HIV Testing Among Adolescents and Young Adults at Risk for HIV

Brittany Wilbourn, MPH,¹ Tyriesa Howard Howell, PhD, LMSW,^{1,2} Amanda D. Castel, MD, MPH,¹ Lawrence D'Angelo, MD, MPH,³ Connie Trexler, RN, CPN, MSHS,³ Rashida Carr,³ and Daniel Greenberg⁴

Abstract

Objective: Adolescents and young adults (AYAs) account for >20% of new HIV diagnoses in the United States, yet >50% are unaware of their infection. Digital gaming is widespread among youth and has proven efficacious in other disease areas; thus, we sought to determine whether a life-and-dating simulation game to increase HIV testing would be acceptable among AYAs.

Materials and Methods: Focus groups and surveys were administered to health care providers and AYAs in Washington, DC. AYAs were shown a life-and-dating simulation game that incorporated the Centers for Disease Control and Prevention Risk Estimator tool to demonstrate the potential HIV risk of selected behaviors and a zipcode-level HIV testing locator. Thematic analysis was used to identify general gaming themes and game acceptance. Descriptive statistics were used to summarize response frequencies and Likert scales were used to evaluate game acceptability.

Results: Providers, some of whom (38%, $n=5/13$) had significant experience caring for youth living with or at increased risk for HIV, advised against the game forcing youth to disclose sexual identity or labeling youth “at risk.” AYAs ($n=46$) found the initial and revised versions of the game to be highly acceptable: youth thought the game was interesting [mean (standard deviation, SD)=4.8/5 (0.4)]; liked playing games about HIV-related behaviors [mean (SD)=4.8/5 (0.5)]; and would share the game to help friends get tested for HIV [mean = 4.6/5 (0.8)].

Conclusions: This study suggests that a digital game to improve HIV testing is acceptable among youth. An efficacy trial is planned to determine the impact of the game on improving HIV testing.

Keywords: Youth, HIV, Testing, Videogames, Adolescents, Technology

Introduction

HIV PREVALENCE AND INCIDENCE among adolescents and young adults (AYAs) aged 13–24 years remain high: ~60,300 AYAs were living with HIV in the United States in 2015 and AYAs accounted for 21% of new HIV infections in 2016.¹ Furthermore, >50% of AYAs living with HIV in the United States are unaware of their infection.² In Washington, DC, youth aged 13–29 years account for 41% of new diagnoses.³ Some youth in DC are more impacted by HIV than others, with black youth and young men who have sex with men (YMSM) accounting for 80% and 67% of new HIV diagnoses among youth, respectively, in 2017.⁴

Despite engaging in high-risk behaviors, many AYAs do not get tested regularly for HIV, resulting in missed opportunities for early diagnosis and treatment.^{5–7} Yet, when offered rapid HIV testing, AYAs are generally receptive to being tested and awaiting receipt of their results.^{8–11} Despite acceptability rates as high as 93.4% among AYAs,⁹ barriers to actual testing include lack of self-perceived risk,¹² stigma regarding sexual orientation,¹² hesitancy to discuss sexual behaviors with parents and providers¹³ or providers not assessing sexual behavior,⁵ and low HIV health literacy.^{12,14} As AYAs, particularly those of color and YMSM, become a leading edge of the HIV epidemic, creative strategies to deliver accurate health information, encourage routine HIV

¹Department of Epidemiology, The Milken Institute School of Public Health, The George Washington University, Washington, District of Columbia.

²George Warren Brown School of Social Work, Washington University in St. Louis, St. Louis, Missouri.

³Burgess Clinic, Children's National Health System, Washington, District of Columbia.

⁴Media Rez, Washington, District of Columbia.

testing, and link positive persons to care are increasingly paramount. Specifically, there is a need to improve youth-friendly nonjudgmental HIV testing interventions.^{7,12,15}

Digital game-based interventions offer a potential strategy for promoting HIV testing, as they capitalize on the inherent interest of AYAs in technology (including social media sites such as Snapchat and Instagram)¹⁶ and avoid traditional barriers faced by this age group.¹⁷ Because of their highly engaging nature and intense level of participant interaction, digital games can provide educational opportunities while simultaneously motivating AYAs.¹⁸ These types of interventions have focused on promoting health literacy,¹⁹ physical health and exercise,^{20,21} as well as HIV prevention among adolescents.^{16,22–24} Although these programs have yielded early success for increasing desired health behaviors among their sample populations, there has been limited research on increasing HIV testing among AYAs through gaming,^{25–29} an approach that has been endorsed by the U.S. Centers for Disease Control and Prevention (CDC) to reduce HIV risk among adolescents.²⁹ The use of a gaming approach that can be shared with peers through social media is even more limited.

Combining social media and youths' interest in digital gaming, we aimed to develop an intervention to facilitate HIV testing for AYAs who may be at risk for HIV. The objectives of this analysis were to utilize a mixed methods research design to (1) elicit recommended strategies from health care providers to increase HIV testing among AYAs, (2) assess technology and digital gaming use among AYAs and elicit their preferred digital game features of a life-and-dating simulation game, and (3) determine the acceptability of the proposed intervention among AYAs after an iterative process of development and refinement of the digital game.

Materials and Methods

Game prototype

For the purpose of this study, a life-and-dating simulation game codenamed "My Liife" was developed by the study team that allowed young people to spend their leisure time going to interesting locations, hanging out with friends, meeting new people, and engaging in relationship scenarios tailored to both same-sex and opposite-sex couples. The researchers have used the process of starting with a prototype to be modified based on participant feedback in other similar studies.^{30,31} The initial prototype displayed social aspects of the game, and plans to incorporate HIV risk were verbally communicated by the research team (Fig. 1). Youth and health care providers were asked to provide input after viewing the prototype.

Procedures

The study was conducted by a team of HIV pediatric and adolescent specialists, medical epidemiologists, qualitative researchers, and game development experts in DC. Study materials were reviewed and approved by the George Washington University Institutional Review Board (IRB) and the Children's National Medical Center IRB.

One semistructured focus group using a single-category design (i.e., no participant stratification)³² was conducted among the HIV provider team at Children's National Med-

ical Center (CNMC), aiming to elicit strategies to improve HIV testing among AYAs and feedback on the initial game prototype. The semistructured format allowed focus group moderators to probe emergent topics and themes during the discussion. Before the focus group, providers were administered a survey to collect demographic and practice-related characteristics. Providers were not remunerated for their participation.

HIV-negative or status-unknown AYAs aged 13–24 years were recruited during routine visits from the CNMC Goldberg Adolescent Health Center in Washington, DC. AYAs were also recruited from two community-based organizations primarily serving youth and young adults at risk for HIV including lesbian, gay, bisexual, transgender, and queer (LGBTQ) youth, as well as youth participating in a DC Office of the State Superintendent Youth Advisory Council. Two rounds of focus groups (n =seven total focus groups) were conducted among a total of 46 AYAs. The groups were stratified by sexual orientation (heterosexual and LGBTQ youth) to facilitate comfort discussing sexual activity and HIV testing.

Feedback from providers and AYAs in the first round of focus groups (n =three groups) was analyzed and revisions were made to the game prototype. During the second round of AYA focus groups (n =four groups), the revised version of the game was demonstrated to AYAs. One second-round focus group was conducted with AYAs from the first round to determine the acceptability of revisions and three second-round focus groups were conducted among AYAs who had not previously viewed the prototype. Focus groups in both rounds covered the following topics: (1) current use of and access to gaming technology and (2) perceptions regarding the life-and-dating simulation game and its potential role in increasing HIV testing. Table 1 outlines a sample of focus group questions related to these topics.

During both rounds, different scenarios within the game were demonstrated by the developer and AYAs provided unrestricted input regarding user interface, performance, acceptability of the art and animation, and response to game play. Before each focus group, AYAs completed a survey to collect demographic data and data on gaming and social media use. Following each focus group, AYAs completed a survey using Likert scales to indicate their acceptability of the game. All AYA participants were remunerated with gift cards and transportation vouchers for their participation.

Data analysis

All focus groups were audio recorded, professionally transcribed verbatim, and imported into NVivo 11[®] for data management and analysis. One of the coders drafted an initial codebook containing codes and descriptive labels used to define concepts, which were organized into broader conceptual categories. The codebook was subsequently refined through an iterative process during which the two coders initially conducted independent thematic coding to link the common themes and ideas discussed among study participants.³³ Next, the coders discussed, revised, and added new codes as needed to reach intercoder agreement through reconciliation of discrepant coding. Lastly, final coding across focus groups and coders was compared to generate overall themes that supported the study's purpose. Data collected from surveys were summarized using descriptive statistics in SAS 9.3[®] and surveys

FIG. 1. Dialogue between opposite-sex characters in party scene of game.

TABLE 1. FOCUS GROUP DISCUSSION QUESTIONS

<i>Theme</i>	<i>Questions</i>
1. Interest and use of videogames	a. What do you like about the games that you play? Art? Animation? Characters? (rounds 1 and 2)
2. Acceptability of videogames for testing	a. What did you like about the game or want to see more of? Art work? Characters? (rounds 1 and 2) b. What did you dislike about the game or want to change? (rounds 1 and 2) c. What aspects of the game that we changed do you like? Are there any aspects of the previous version that you wish were still there? (round 2) d. What kind of locations do you suggest the game include? What kind of activities? What kind of interactions? (rounds 1 and 2) e. What did you learn, if anything, from the game? Did you learn anything about HIV or risky behaviors? (round 2)

using Likert scales evaluated acceptability of the game among AYAs stratified by sexual orientation.

Results

Provider focus groups

The HIV provider focus group included 15 participants, some of whom (38%, $n = 5/13$) had >20 years of experience caring for HIV-infected youth or youth at increased risk for HIV (data not shown). Services provided included primary care, HIV testing and counseling, and linkage to care. During the focus group, providers largely confirmed that the intervention approach was sound and found it acceptable. They suggested that the game not force players to define their sexual orientation. For example, many MSM may not identify as gay and providers felt that the game should allow MSM to seek and date other males without identifying in a prescribed way. Providers also emphasized that being considered “at risk” is distressing to many AYAs and makes them feel less valued. Thus, when providing information pertaining to HIV risk, providers suggested that the game avoid labeling the youth themselves as “at risk” or “high risk.”

AYA focus groups

A total of 46 AYAs participated in the 7 focus groups; 30 (65%) identified as heterosexual and 16 (35%) identified as LGBTQ. The mean age of AYA participants was 17.6 years; 74% ($n = 34$) were black; and 63% ($n = 29$) were female (Table 2). The majority of participants lived in DC (96%, $n = 44$) and had not yet graduated from high school (67%, $n = 30$; data not shown). Most participants reported owning a mobile phone (91%, $n = 42$), playing games on their phone (71%, $n = 30$), and playing anytime (35%, $n = 16$) or every-day (15%, $n = 7$) (Table 2). The majority of participants reported using the social media sites Snapchat (87%, $n = 40$) and Instagram (85%, $n = 35$) although very few reported using social media to access sex-related topics and HIV information (28%, $n = 13$).

Interest in and use of videogames

Before introducing both the videogame prototype and the revised version, participants were asked to describe enjoyable aspects of videogames and motivating factors for gameplay. Both heterosexual and LGBTQ youth stated they played games as a form of stress reduction to “keep calm,”

TABLE 2. ADOLESCENTS AND YOUNG ADULTS DEMOGRAPHIC, SOCIAL MEDIA USE, AND ACCESS TO VIDEOGAMES CHARACTERISTICS ($n = 46$)

	HET $n = 30^a$ n (%)	LGBT $n = 16^a$ n (%)	Total $n = 46$ n (%)
Age (mean, range)	17.1 (13–23)	18.6 (15–24)	17.6 (13–24)
Gender			
Male	10 (33)	6 (37)	16 (35)
Female	20 (67)	9 (56)	29 (63)
Transgender female	0 (0)	1 (6)	1 (2)
Race/ethnicity			
Hispanic	2 (7)	1 (6)	3 (6)
Non-Hispanic black	23 (77)	11 (69)	34 (74)
Non-Hispanic white	0 (0)	1 (6)	1 (2)
Other ^b	5 (17)	3 (19)	8 (14)
Social media sites used ^c			
Snapchat	29 (97)	11 (69)	40 (87)
Instagram	24 (80)	15 (94)	39 (85)
Twitter	18 (60)	6 (37)	24 (52)
Facebook	11 (37)	7 (44)	18 (39)
Retrieves sensitive information (e.g., HIV information, sex) from social media ^c	11 (37)	2 (12)	13 (28)
Owens a mobile phone	29 (97)	13 (81)	42 (91)
Plays games on phone	20 (69)	10 (77)	30 (71)
Gaming modality ^c			
Games on own phone	22 (73)	8 (50)	30 (65)
Games on own console	17 (57)	8 (50)	25 (54)
Games on own PC	12 (40)	3 (19)	15 (33)
Games on other people's consoles	11 (37)	6 (37)	17 (37)
Frequency of gameplay ^c			
Anytime	10 (33)	6 (37)	16 (35)
Everyday	2 (7)	5 (31)	7 (15)
Weekends only	4 (13)	1 (6)	5 (11)
After homework is done	4 (13)	2 (12)	6 (13)

^aTotals may not sum to n (100%) due to missing data.

^bIncludes Native American/Alaska Native, Asian, Native Hawaiian/Pacific Islander.

^cParticipants were able to check all responses that were applicable.

HET, heterosexual; LGBT, lesbian, gay, bisexual, transgender.

and preferred games that kept their attention, had many options, and were realistic (Table 3).

Round 1: acceptability of initial videogame prototype

Regarding the initial prototype, LGBTQ youth were less enthusiastic about the game and its features than heterosexual youth. One LGBTQ youth thought the party scene was not lively enough. Both groups had several recommendations to enhance the prototype such as allowing players to synchronize their own music and the addition of other features, activities, and locations (e.g., stylish clothes and natural hair, sporting events, shopping malls, and restaurants). To convey HIV risk within the game, heterosexual youth were receptive to the idea of using a traffic light scheme where green represents low HIV risk, yellow

represents moderate HIV risk, and red represents high HIV risk. However, they emphasized that no matter the risk, all players should be provided with information about HIV and current statistics. When viewing the CDC Risk Estimator Tool,³⁴ one LGBTQ youth suggested incorporating it into the game to demonstrate HIV risk based on the sexual activity of the character. Other youth also found this idea to be acceptable.

Game modifications

Feedback from both health care providers and AYAs was analyzed and informed revisions made to refine the game prototype and determine the optimal set of game features (Table 4). The following major revisions were made: (1) an additional location was added to the game (Fig. 2); (2) a menu displaying

TABLE 3. SUMMARY THEMES IDENTIFIED FROM THE YOUTH AND YOUNG ADULT FOCUS GROUP DISCUSSIONS

Themes	Subthemes	Representative quotes
Interest and use of videogames	Appeal of games (rounds 1 and 2)	<p>“They keep you calm, they keep you civilized.” (Round 1 Heterosexual youth)</p> <p>“I like realistic games like free will games, simulation games.” (Round 2 Heterosexual youth)</p> <p>“...yeah I play games because it calms me.” (Round 1 LGBTQ youth)</p> <p>“I also like games where you can make choices and things are affected by the choice you make so yeah.” (Round 2 LGBTQ youth)</p>
	Perceptions of prototype (round 1)	<p>“That’s like Sims, Sims is lit.” (Round 1 Heterosexual youth)</p> <p>“That game is going to be wild. People will like it though... because it’s real, that’s how it is.” (Round 1 Heterosexual youth)</p> <p>“Yeah, but this party is a little dry it’s only four people in there.” (Round 1 LGBTQ youth)</p> <p>“It’s okay...” (Round 1 LGBTQ youth)</p>
Acceptability of videogames for testing	Additions and modifications to prototype (round 1)	<p>“...As far as the characters...they should add different ...idol stances for the characters would be pretty cool.” (Round 1 Heterosexual youth)</p> <p>“[Regarding all risk levels] you should have information about HIV. So you can educate kids and people about HIV period...Like give statistics of different situations.” (Round 1 Heterosexual youth)</p> <p>“I think... there should be constant ...like education and like constant reminders like ...a poster somewhere saying know your status or it’s like an ad or something...” (Round 1 LGBTQ youth)</p> <p>“Okay, can we... promote this tracker [CDC Risk Estimator] like in the game?” (Round 1 LGBTQ youth)</p>
	Perceptions of revised game (round 2)	<p>“Yeah. I learned something from the graph [in reference to the CDC Risk Estimator]” (Round 2 Returning heterosexual youth)</p> <p>“This game is very fun and it has endless possibilities so that’s what makes it really fun...” (Round 2 New heterosexual youth)</p> <p>“I like that...it shows you the places that you can go to ‘cause you get real curious so if you don’t want to look it up on the computer...or you have to ask somebody which is embarrassing...plus you know the risk once you type all the things in and they can show what’s more riskier.” (Round 2 New LGBTQ youth)</p>
	Additions and modifications to revised game (round 2)	<p>“It’s awesome. I like it.” (Round 2 New LGBTQ youth)</p> <p>“Y’all should show at least something funny like an explosion, make an explosion [to indicate sexual intercourse].” (Round 2 Returning heterosexual youth)</p> <p>“The cover of it and what the game is...was totally different. I suggest like a newer more attractive cover.” (Round 2 New heterosexual youth)</p> <p>“I would change the music that’s at the house party. To something that’s new. Like this generation’s music.” (Round 2 New LGBTQ youth)</p> <p>“I like the game it’s just I think...it should be more realistic like if somebody is like ‘I’d rather do you.’ Everyone is not going to say, ‘well ha-ha let’s go.’ Some people are going to say, ‘what are you crazy?’” (Round 2 New LGBTQ youth)</p>

TABLE 4. CHARACTERISTICS OF A VIDEOGAME FOR HIV TESTING: “MY LIIFE”

<i>Characteristic</i>	<i>Focus</i>
Health topic(s)	HIV
Targeted age group(s)	13–24 years of age
Short description of game idea	A life-and-dating simulation game that allows participants to engage in relationship scenarios tailored to both same-sex and opposite-sex couples.
Target player(s)	Individual
Guiding knowledge or behavior change theory(ies), models, or conceptual framework(s)	Health Belief Model
Intended health behavior changes	HIV testing
Knowledge element(s) to be learned	HIV risk associated with different sexual acts
Behavior change procedure(s) (taken from Michie inventory) or therapeutic procedure(s) used	Monitoring, feedback
Clinical or parental support needed?	No
Data shared with parent or clinician?	No
Type of game	Simulation, educational
Story	
Synopsis (including story arc)	The player can try to befriend NPCs in the game, compete with them, impress them, help or harm them, make them look good or bad, and enter relationships with them. The player can make decisions related to dialogue, social interactions, and sexual behavior in the safety of the game world and then see what the real-world consequences would have been.
How the story relates to targeted behavior change	Players are able to see the immediate consequences of their decisions regarding sexual behaviors with NPCs (i.e., the CDC Risk Estimator tool will display the HIV risk of a particular sexual act).
Game components	
Player's game goal/objective	There is no concrete objective; through social interactions and decisions about sexual behavior, players become more educated about HIV risk associated with specific behaviors.
Rules	N/A
Game mechanics	Feedback, interactions with NPCs, decision-making, social community
Procedures to generalize or transfer what is learned in the game to outside the game	This game will enhance skill transference through social interaction with NPCs about HIV risk and the use of the CDC Risk Estimator.
Virtual environment	
Setting	Different parts of the city: a party, skatepark, etc.
Avatar	
Characteristics	Male/female/transgender
Abilities	Navigate through game world, build skills, socialize, experience dramatic ministories, make friends and rivals, talk to NPCs through interactive dialogue, flirt, make choices related to sexual behavior
Game platform(s) needed to play the game	OS, Android, Web
Sensors used	GPS
Estimated play time	Core story 20 hours, open ended character skill building functionally unlimited

HIV, human immunodeficiency virus; N/A, not applicable; NPC, nonplayable character.

different sexual acts and the option to use condoms with each of those acts was added if a player decided to engage in sexual intercourse with another character (Fig. 3); and (3) the CDC Risk Estimator Tool³⁴ was embedded in the game to display the risk of various sexual acts as well as the CDC HIV Testing locator (Fig. 4). The suggestion of providers not to force players to select a sexual orientation was also incorporated, and HIV risk is determined based on sexual behavior and not sexual identity. Also at the suggestion of providers, the revised version of the game does not use value laden or judgmental labels for the characters when displaying the HIV risk of various sexual acts.

Round 2: acceptability of revised videogame prototype

Both heterosexual and LGBTQ youth, including those who had viewed the prototype and those who had only seen the revised version, expressed positive comments regarding the graphics and method of displaying HIV risk. Participants from both groups suggested additional game modifications that included the capacity to imply sexual activity in a non-graphic manner (e.g., an explosion) and allowing players to create and design their own avatars. In addition, both heterosexual and LGBTQ youth recommended that characters

FIG. 2. Dialogue between same-sex characters in skateboard scene of game.

have the option to engage in sexual activity with someone they just met or the option to date someone for an extended period of time before engaging in sexual activity.

Regarding acceptability of the life-and-dating simulation game, on a scale of 1–5, with 5 indicating strong agreement, most participants agreed that the game was interesting [mean (standard deviation, SD)=4.8/5 (0.4)], fun [mean (SD)=4.6/5 (0.7)], easy to learn [mean (SD)=4.8/5 (0.4)], and that they liked the art and animation [mean (SD)=4.5/5 (0.8)], game environment [mean (SD)=4.4/5 (0.7)], and interactions with other characters [mean (SD)=4.6/5 (0.8)]. Participants also agreed that they liked playing games that featured behaviors associated with HIV [mean (SD)=4.8/5 (0.5)] and they would likely share the game with friends to help them get tested for HIV [mean (SD)=4.6/5 (0.8)] (data not shown).

Using a separate Likert scale ranging from 1 to 3, with 3 indicating high likelihood, participants reported being very likely to use the game to help with getting tested for HIV [mean (SD)=2.3/3 (0.9)], to get tested if the game determined their character's behavior to be high risk [mean (SD)=2.4/3 (0.9)], and to get tested if the game connected

them to an actual person [mean (SD)=2.4/3 (0.9)] (data not shown). Overall, both groups found the game highly acceptable and thought that it was possible to increase HIV testing by using interactive technologies such as videogames.

Discussion

Principal findings

This study aimed to determine the acceptability of using a life-and-dating simulation game that included HIV risk assessment to increase HIV testing among AYAs following an iterative process of development and refinement. AYAs in our study were similar to those in the U.S. in that they reported high levels of social media use (specifically Snapchat and Instagram)¹⁶ and frequent game play,¹⁷ often with unfettered access. They reported high levels of interest and acceptability and expressed enjoying games that were interactive, challenging, involved decision-making, and reflected the reality of their lives.

This study helps expand the limited research on the use of digital games to increase HIV testing among AYAs.^{25–29}

FIG. 3. Menu of sexual acts and condom use option.

Furthermore, the format presents an alternative to traditional behavioral interventions that may be time consuming, costly, and less accessible compared with a digital approach. For example, one intervention providing sexual health information to young transgender women involved six biweekly group sessions for 3 weeks lasting two and a half hours each in addition to one individual session.³⁵ While addressing a population at high risk for HIV, and while researchers did find acceptability and feasibility for their intervention, the intervention dose may be prohibitive.

The iterative process of game development and refinement demonstrated how collaboration between HIV researchers, gaming experts, and AYAs resulted in a game that is applicable to the population of interest while incorporating HIV prevention elements. AYAs shared important feedback concerning the game design, which allowed the developers to enhance its representation of their real-life experiences. They found aspects of the game to be realistic yet wanted to personalize certain elements of the game to increase its “playability.” Overall AYAs were excited about the game prototype

and supportive of the incorporation of the HIV risk element. Input from AYAs directed further game development by including several features that they proposed (additional locations and activities, inclusion of the CDC Risk Estimator, etc.). In general, AYAs were supportive of the revised version of the game, reporting that not only would they play it, but they would also get tested if their character were found to be at increased risk for HIV and use the game to locate HIV testing sites. Reasons for liking the game included its interactive nature and educational component. This suggests that integrating these two features, high-quality gameplay and HIV prevention messaging, may increase the popularity of the game, which could lead to more AYAs sharing the game with their friends through social media and possibly getting tested for HIV.

Limitations

There are several limitations to our study worth noting. Although common in qualitative research, the relatively small sample size of AYA focus group participants limits the

FIG. 4. Embedded CDC Risk Estimator and HIV testing locator. CDC, Centers for Disease Control and Prevention.

generalizability of the findings. Furthermore, the majority of our AYA participants identified as black or African American, and although the study population reflects the high burden of and risk for infection among these populations in the U.S. and DC region specifically, this may limit generalizability of findings to AYAs of other races or ethnicities. Similarly, the majority of AYA participants identified as heterosexual, which may limit the generalizability of the study's findings to youth of other sexual orientations. However, feedback from LGBTQ youth was considered during revisions to the game to make it more applicable and relatable to this population.

Conclusions

Study results suggest that a digital game to improve HIV testing is acceptable among youth who may be at increased risk for HIV infection. AYAs found the game fun and engaging as well as educational regarding the HIV risk associated with the actions of their game characters. The game addresses some existing barriers to testing^{12,13} by providing

HIV educational content, reducing stigma regarding sexual orientation, aiding in risk assessment, and confidentially facilitating access to HIV testing services, through the zip code locator. Since this small-scale pilot study cannot directly measure the impact on HIV testing, we intend to conduct an efficacy trial to determine whether access to the game through social media sites will lead to improved HIV testing and access to prevention methods such as condoms and pre-exposure prophylaxis among a cohort of youth at risk for HIV. During the trial, participants will be recruited primarily through social media and players will be able to share the game through social media to receive in-game virtual rewards. If the trial proves efficacious, in future iterations of the game, players will be able to share visual game content across social media channels. Spreading the game through social networks is important because AYAs use social media heavily¹⁶ and at risk AYAs are likely to be linked to other at risk AYAs, thus targeting the desired audience. Also, AYAs are more receptive to HIV information when it comes from a peer, as peers on social media are highly influential.^{36–38}

Thus, by using social media to expand the reach of the game, we aim to improve HIV knowledge, risk awareness, and HIV testing among AYAs at risk for HIV.

Acknowledgments

The authors would like to thank the providers and staff at Children's National Medical Center, the administrators of the participating community-based organizations and other organizations from which youth were recruited, and all of the youth who participated in this study.

Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Author Disclosure Statement

D.G., a PI on the grant, has a stake in Media Rez consistent with the policy on Small Business Innovation Research.

Funding Information

Research reported in this publication was fully supported by the National Institutes of Health Eunice Kennedy Shriver National Institute of Child Health and Human Development under award number R43HD088332.

References

- Centers for Disease Control and Prevention. HIV Surveillance Report: Diagnoses of HIV Infection in the United States and Dependent Areas, 2016. 2017. <https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-report-2016-vol-28.pdf> (accessed December 16, 2018).
- Centers for Disease Control and Prevention. Vital Signs: HIV infection, testing, and risk behaviors among youths—United States. *MMWR* 2012; 61:971–976.
- District of Columbia Department of Health HIV/AIDS Hepatitis, STD, and TB Administration. Annual Epidemiology & Surveillance Report APPENDICES—Data through December 2017. 2018. https://dchealth.dc.gov/sites/default/files/dc/sites/doh/publication/attachments/Appendix%20A_v07252018.pdf (accessed December 16, 2018).
- District of Columbia Department of Health HIV/AIDS Hepatitis, STD, and TB Administration. Annual Epidemiology & Surveillance Report—Data through December 2017. 2018. https://dchealth.dc.gov/sites/default/files/dc/sites/doh/publication/attachments/AR%20report%202018_v072518_FINAL.pdf (accessed December 16, 2018).
- Goyal MK, Witt R, Hayes KL, et al. Clinician adherence to recommendations for screening of adolescents for sexual activity and sexually transmitted infection/human immunodeficiency virus. *J Pediatr* 2014; 165:343–347.
- Van Handel M, Kann L, Olsen EO, et al. HIV testing among US high school students and young adults. *Pediatrics* 2016; 137:e20152700.
- Committee on Pediatric AIDS, Emmanuel PJ, Martinez J. Adolescents and HIV infection: The pediatrician's role in promoting routine testing. *Pediatrics* 2011; 128:1023–1029.
- Rakhmanina N, Messenger N, Phillips G, et al. Factors affecting acceptance of routine human immunodeficiency virus screening by adolescents in pediatric emergency departments. *J Adolesc Health* 2014; 54:176–182.
- Turner SD, Anderson K, Slater M, et al. Rapid point-of-care HIV testing in youth: A systematic review. *J Adolesc Health* 2013; 53:683–691.
- Haines CJ, Uwazuo K, Zussman B, et al. Pediatric emergency department-based rapid HIV testing: Adolescent attitudes and preferences. *Pediatr Emerg Care* 2011; 27:13–16.
- Swenson RR, Hadley WS, Houck CD, et al. Who accepts a rapid HIV antibody test? The role of race/ethnicity and HIV risk behavior among community adolescents. *J Adolesc Health* 2011; 48:527–529.
- Kurth AE, Lally MA, Choko AT, et al. HIV testing and linkage to services for youth. *J Int AIDS Soc* 2015; 18(Suppl 1):19433.
- Minnear TD, Gilmore B, Arnold SR, et al. Implementation of and barriers to routine HIV screening for adolescents. *Pediatrics* 2009; 124:1076–1084.
- Dimmitt Champion J, Harlin B, Collins JL. Sexual risk behavior and STI health literacy among ethnic minority adolescent women. *Appl Nurs Res* 2013; 26:204–209.
- Mavedzenge SN, Luecke E, Ross DA. Effective approaches for programming to reduce adolescent vulnerability to HIV infection, HIV risk, and HIV-related morbidity and mortality: A systematic review of systematic reviews. *J Acquir Immune Defic Syndr* 2014; 66 Suppl 2:S154–S169.
- Anderson M, Jiang J. Teens, Social Media & Technology 2018. Pew Research Center, Internet and Technology. 2018. www.pewinternet.org/2018/05/31/teens-social-media-technology-2018 (accessed December 16, 2018).
- Enah C, Moneyham L, Vance DE, et al. Digital gaming for HIV prevention with young adolescents. *J Assoc Nurses AIDS Care* 2013; 24:71–80.
- Hightow-Weidman LB, Muessig KE, Bauermeister JA, et al. The future of digital games for HIV prevention and care. *Curr Opin HIV AIDS* 2017; 12:501–507.
- Li TM, Chau M, Wong PW, et al. Evaluation of a Web-based social network electronic game in enhancing mental health literacy for young people. *J Med Internet Res* 2013; 15:e80.
- Schott G, Hodgetts D. Health and digital gaming: The benefits of a community of practice. *J Health Psychol* 2006; 11:309–316.
- Bailey BW, McInnis K. Energy cost of exergaming: A comparison of the energy cost of 6 forms of exergaming. *Arch Pediatr Adolesc Med* 2011; 165:597–602.
- Lukhele BW, Musumari P, El-Saaidi C, et al. Efficacy of mobile serious games in increasing HIV risk perception in Swaziland: A randomized control trial (SGprev Trial) research protocol. *JMIR Res Protoc* 2016; 5:e224.
- Fiellin LE, Hieftje KD, Pendergrass TM, et al. Video game intervention for sexual risk reduction in minority adolescents: Randomized controlled trial. *JMIR* 2017; 19:e314.
- Winskell K, Sabbem G, Akelo V, et al. A smartphone game-based intervention (Tumaini) to prevent HIV among young Africans: Pilot randomized controlled trial. *JMIR Mhealth Uhealth* 2018; 6:e10482.
- Mustanski B, Parsons JT, Sullivan PS, et al. Biomedical and behavioral outcomes of Keep It Up!: An eHealth HIV Prevention Program RCT. *Am J Prev Med* 2018; 55:151–158.
- Pendergrass TM, Hieftje KD, Duncan LR, et al. *A Pilot Intervention to Encourage HIV Testing and Counseling Among Minority Adolescents*. In Proceedings of Technology, Mind, and Society, Washington, DC, April 5–7, 2018.

- (TechMindSociety'18). New York, NY: ACM, 1 page. <https://doi.org/10.1145/3183654.3183675>.
27. Gilliam M, Jagoda P, Jones IB, et al. Embedded game design as a method for addressing social determinants of health. *Am J Sex Educ* 2018; 13:378–398.
 28. Mejia CM, Acland D, Buzdugan R, et al. An intervention using gamification to increase human immunodeficiency virus and sexually transmitted infection screening among young men who have sex with men in California: Rationale and design of stick to it. *JMIR Res Protoc* 2017; 6:e140.
 29. Kachur R, Mesnick J, Liddon N, et al. *Adolescents, Technology and Reducing Risk for HIV, STDs and Pregnancy*. Atlanta, GA: Centers for Disease Control and Prevention; 2013. <https://www.cdc.gov/std/life-stages-populations/adolescents-white-paper.pdf>
 30. Abroms LC, Leavitt LE, Van Alstyne JM, et al. A motion videogame for opioid relapse prevention. *Games Health J* 2015; 4:494–501.
 31. Castel AD, Qasmieh S, Greenberg D, et al. Digital gaming to improve adherence among adolescents and young adults living with HIV: Mixed-methods study to test feasibility and acceptability. *JMIR Serious Games* 2018; 6:e10213.
 32. Krueger R, Casey M. *Focus Groups: A Practical Guide for Applied Research (4th ed.)*. Thousand Oaks, CA: Sage; 2009.
 33. Charmaz K. *Grounded Theory*. In: Smith J, ed. *Qualitative psychology: A practical guide to research methods*. Thousand Oaks, CA: Sage; 2007.
 34. Centers for Disease Control and Prevention. HIV Risk Reduction Tool. <https://wwwn.cdc.gov/hivrisk/estimator.html> (accessed December 16, 2018).
 35. Garofalo R, Johnson AK, Kuhns LM, et al. Life skills: Evaluation of a theory-driven behavioral HIV prevention intervention for young transgender women. *J Urban Health* 2012; 83:419–431.
 36. Tome G, Matos M, Simoes C, et al. How can peer group influence the behavior of adolescents: Explanatory model. *Glob J Health Sci* 2012; 4:26–35.
 37. Karakos H. Positive peer support or negative peer influence? The role of peers among adolescents in recovery high schools. *Peabody J Educ* 2014; 89:214–228.
 38. Silva K, Shulman EP, Chein J, et al. Peers increase late adolescents' exploratory behavior and sensitivity to positive and negative feedback. *J Res Adolesc* 2016; 26:696–705.

Address correspondence to:

Brittany Wilbourn, MPH

Department of Epidemiology

The Milken Institute School of Public Health

The George Washington University

950 New Hampshire Avenue Northwest

Suite 500

Washington, DC, 20052

E-mail: blewis1@gwu.edu