



Virtual avatars as a new tool for human immunodeficiency virus prevention among men who have sex with men: a narrative review

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Background and Objective: Human immunodeficiency virus (HIV) continues to affect sexual and gender minorities, predominantly men who have sex with men (MSM). Stigma, medical mistrust, and apprehension towards discussing sexual health with one's medical provider are significant barriers in seeking or accessing preventive services. Those obstacles could be surpassed through novel digital and electronic health interventions, specifically with virtual avatar technology. Avatars are digital self-representative agents that are controlled with an interactive electronic device. Avatars allow for virtual self-immersion within infinitely customizable environments to practice skill building, fostering relationships and more, through an optional incognito approach. The objective of this narrative review is to examine recent uses of and developments in avatar technology, highlight the personalization attribute of this technology, and evaluate its strengths and limitations as a tool for HIV prevention among MSM.

Methods: We reviewed recent scientific literature generated by PubMed that use virtual avatar technology in HIV prevention and treatment among populations put at risk. Articles that met the inclusion criteria were then categorized on how the avatar technology was used.

Key Content and Findings: We identified eleven studies that met inclusion criteria. Avatar technology was found to create a comfortable environment for participants to address and discuss their sexual behaviors with less hesitation. Avatars can build rapport with populations put at high risk, creating an opportunity for reevaluation of their sexual behavior while assisting them in being able seek information, preventive services, or treatment for HIV or other sexually transmitted infections (STIs).

Conclusions: Given the increased use of digital technology in health and prevention, avatars might be useful in sexual health education and HIV prevention among populations put at risk. The benefits and potential in utilizing this technology for HIV prevention are highlighted.

Keywords: Virtual avatars; human immunodeficiency virus prevention (HIV prevention); electronic health (eHealth); mobile health (mHealth); telehealth

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Introduction

Men who have sex with men (MSM) continue to be the population most affected by human immunodeficiency virus (HIV) in the United States (US), accounting for two-thirds of all newly discovered infections each year (1). While highly effective pre-exposure prophylaxis (PrEP) (2,3) and post-exposure prophylaxis (PEP) (4) HIV prevention measures have been available for years in the US, these resources continue to be underutilized by MSM of color, particularly Black MSM, in comparison to white MSM (5,6). Disparities in knowledge and uptake of HIV PrEP and PEP can be attributed to both structural and cultural barriers, such as: stigma around HIV and HIV-related testing, racial and/or sexual identity discrimination, low perception of HIV risk, lack of culturally competent healthcare providers and settings, and lack of insurance coverage (7-16). To overcome such barriers, technological solutions may help link communities put at risk in the US to the effective HIV prevention services they need (17,18).

Technology-based HIV Interventions

Advances in telecommunication technologies, particularly the widespread dissemination of video call/conference software on smartphones, have allowed many HIV interventions to expand outside traditional brick-and-mortar facilities, and into the environments and *in situ* contexts of people's daily lives. The many technology-based interventions which have arisen can be usefully separated into typologies, including: (I) mobile health (a.k.a. "mHealth") options which seek to minimize technology or data usage requirements by utilizing relatively ubiquitous US telecommunication technologies, including short message service (SMS) text messaging or simple phone calls; (II) more data-intensive Internet-based, app-based, social media-based, or video conferencing-based electronic health (a.k.a., "eHealth") interventions which can offer a higher level of interactivity and/or technological sophistication; or (III) hybrid approaches which blend together elements of both mHealth and eHealth, depending on the needs of each intervention component and/or participant (19). In their systematic review of mHealth randomized control trials, Burns, Keating and Free (20) found that over 60% of participants preferred video-supported mobile surveys to paper surveys (21) while significantly increasing patient's desire to receive free, rapid HIV testing. For eHealth interventions, Schnall and colleagues' systematic review (22)

found that eHealth interventions provided short-term reduction of HIV risk behaviors and increased testing rates. In sub-Saharan Africa, Manby and colleagues' systematic review and meta-analyses (23) found that eHealth interventions were a low cost way of improving HIV management behaviors, but not in HIV prevention behaviors or outcomes overall. However, there is an imbalance of eHealth interventions that focus more on proximal solutions like, education and behavioral change, rather than distal obstacles like linkage to care, retention in care and adherence, particularly with PrEP (24).

Though it is ubiquitously considered the gold standard, "in-person" care suffers from several shortcomings for those embodying the intersection of multiple minority statuses, including innate medical mistrust and skepticism from participants, anticipated homonegativity and/or racial prejudice, and stigma or outright mistreatment based on self-reported sexual behaviors (15,25,26). In general, it is believed that telehealth solutions may disproportionately benefit minority populations (e.g., sexual and gender minorities of color, individuals that are non-English speaking or of low income) as they reduce logistical barriers to attendance (27,28), create the perception of increased privacy and safety (28), and allow potentially skeptical or mistrusting participants to feel more in control of their medical interactions (28). Unfortunately, while technology-based interventions allow for medical providers to engage with vulnerable populations more discreetly, concerns persist regarding long-term confidentiality/anonymity (i.e., due to the potential of data leaks), as well as the feasibility of remotely engaging people to deliver effective tailored HIV prevention/care (29-33). This discontinuity could be remedied by utilizing eHealth technology to make long-term benefits of PrEP uptake more relevant and appealing to an individual, which could in turn strengthen one's motivation. One solution which holds potential is the application of virtual avatar technology to HIV service provision.

Avatar-based technologies

Avatars are digital self-representative agents which are controlled using an interactive electronic device (34). First created at National Aeronautics and Space Administration (NASA), avatars have helped facilitate people's interaction with the Internet and digital environments more broadly (e.g., video games, instructional materials), and even now are helping people get introduced to important digital spaces

where companies can create new, immersive means to reach customers and conduct business (35). Since their inception, avatars have evolved from mostly static 2-D figures used predominantly in instant messenger chat rooms to, in their most advanced forms, highly realistic artificial intelligence systems designed to facilitate and improve automated customer service interactions (36). Avatar technology has also shown great promise in its ability to more comfortably integrate people into digital environments, either through application within virtual reality, or with motion-sensor captured data (e.g., real-time control of 3-D avatars within computer, digital and virtual games) (36,37). Such integration is key as for example, major companies now use digital spaces not only as marketing and communication tools, but also to provide services to their customers in customizable virtual environments, with avatars facilitating the comfort of participants (38-45). In their meta-analysis and systematic review of interactive digital interventions (IDIs) for HIV prevention, Bailey and colleagues (46) found that IDIs can help increase knowledge and preventive behaviors, though this finding was nonsignificant when compared to face-to-face interventions. While this may imply that IDIs are ineffective in establishing behavior change, it is important to reframe IDIs to build rapport with medical providers to better aid in retention, but more importantly, linkage to care. Because of the developments in avatar software and smartphone capabilities, its expanded potential surpasses previous literature methods, and provides a refreshed opportunity for HIV prevention.

The therapeutic potential for avatar-based technologies becomes even clearer when one considers the “Proteus effect”, in which an individual’s behavior is said to be influenced by their avatar’s characteristics (47-49); a finding which both demonstrates the strength of allowing people to customize and create their own “idealized” avatars, and which also implies that use of an avatar can help facilitate a closer relationship between people and the technology they use. A further implication of the Proteus effect is that avatar technology could allow participants to create versions of themselves which can engage in behaviors (e.g., asking embarrassing HIV-related sexual questions, enrolling in HIV prevention intervention services) that might be too invasive, too scary, or too overwhelming to do in person. *Figure 1* shows an example of avatar customization. In using a self-representative digital figure to engage in behaviors they would not in person, people may then imitate prosocial or healthy behaviors into their own lives over time. Yee *et al.* (47) assessed the “Proteus effect” in two studies: one

focusing on how an avatar’s height or attractiveness affected how the character was utilized, and the second study assessed whether behaviors conducted while conducting the avatar could continue on in a face-to-face conversation. In their first study, they found participants that were represented by a more attractive avatar within a virtual reality setting stood closer to other avatars and self-disclosed more personal information than those with less attractive avatars, and that people with taller avatars acted more aggressively than people with shorter avatars (47). Their second study provided support that virtual behaviors could be mimicked and continued in face-to-face negotiations also (47). Overall, the researchers thus demonstrated how an avatar’s characteristics, not the real-life attributes of the person inhabiting the avatar, can influence actual behaviors and communication patterns (47).

Additional studies have further elucidated how avatars are able to influence a person’s behavior and/or self-ascribed attributes. Avatars can help increase overall self-expression, which is a key component in self-affirmation and behavior change (47,50). Avatars have thus found favor for use in therapeutic settings when addressing heavily stigmatized subjects (e.g., those with suicidal ideation and/or post-traumatic stress disorder), as well as in efforts to increase both self-care and self-efficacy in the management of chronic conditions (51-55). Avatars also may serve as effective mediums to aid in intervention delivery by helping participants better relate to information, including safe sexual practices. In Singapore, Kang and Kim (50) conducted two matched case control studies that evaluated how avatar customization can affect self-reflection, message derogation, or the belittling of the benefits of a health message, and processing health information (56). Both studies demonstrated that avatars, particularly customizable avatars, can provide a personalized medium where participants are: (I) more likely to invest in themselves; (II) may be less likely to experience negative emotions; and (III) can be more open-minded towards health information, all attributes that could support behavior change in a virtual environment.

Avatar use in the U.S. has proliferated in recent years and will likely continue to do so as virtual reality environments and the “meta-verse” become ever more commonplace within daily life as over 96% of Americans now own a smartphone (57). To best reflect this expansion of avatar capabilities, this narrative review focuses on literature generated between 2017 and 2022. While the field of HIV prevention is broad, this narrative review focuses primarily

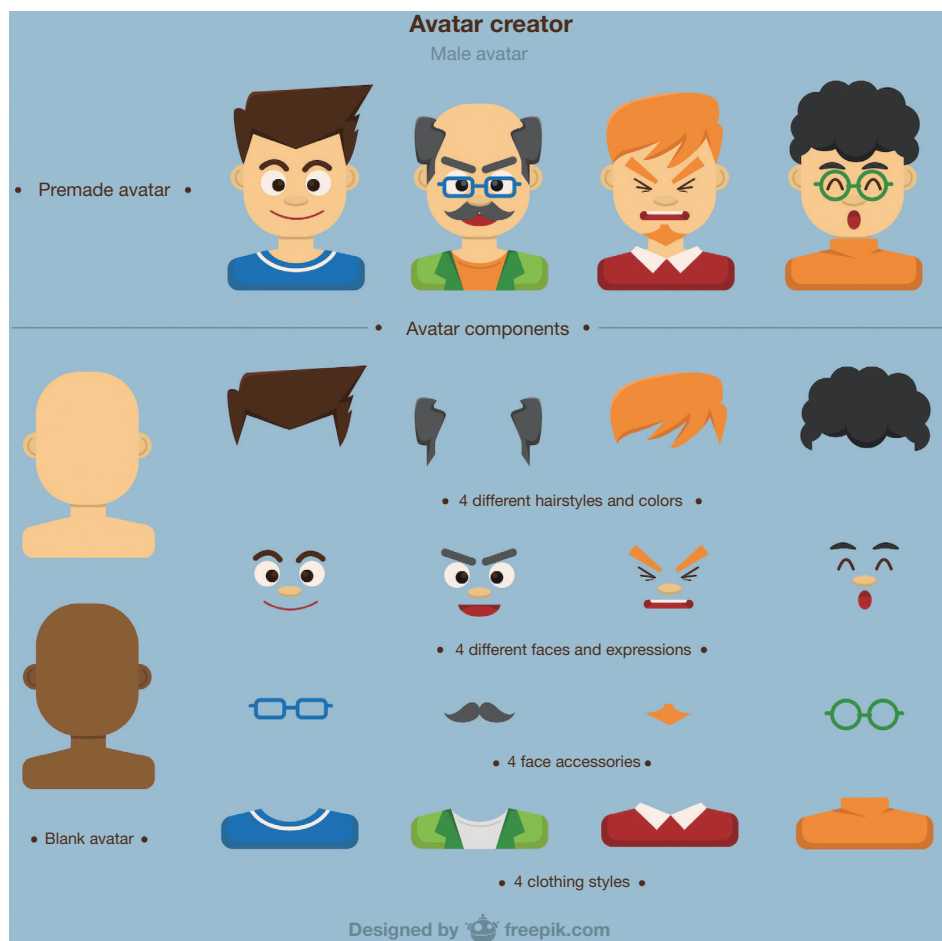


Figure 1 Example of avatar customization.

on the potential of utilizing avatar technology towards distal obstacles, like linkage to care and retention, as most eHealth/mHealth interventions focus on behavior change or education. In this narrative review, we aim to: (I) examine recent uses of and developments in avatar technology; (II) highlight the personalization attribute of this technology; and (III) evaluate its strengths and limitations as a potential tool for HIV prevention among MSM. We present this article in accordance with the Narrative Review reporting checklist (available at <https://mhealth.amegroups.com/article/view/10.21037/mhealth-22-33/rc>).

Methods

We searched PubMed to find scientific literature which used virtual avatar technology in HIV prevention and treatment, as well as sexual health education. Our search strategy is described in *Table 1*. Studies were included if: (I) there was

mention of *HIV prevention, avatar, human, or agent* in the abstract or title; (II) an avatar or embodied agent was used in the intervention delivery; (III) addressed a population put at risk for HIV acquisition, and how what was learned can be tailored to others; (IV) avatar technology actively involved participants; and (V) the intervention itself focused on an aspect of the HIV care continuum (e.g., treatment as prevention, prevention overall, and testing). Studies were excluded if: (I) there was no mention of at least one of the following terms: HIV prevention, avatar, human or agent in the abstract or title; (II) the intervention delivery did not include the use of an avatar or embodied agent; and (III) the studies were in another language besides English.

Articles that met the inclusion criteria were then categorized based on the usage of the avatar technology, including: improving antiretroviral therapy adherence (ART), both as prevention for individuals without HIV and as treatment for people living with HIV; training

Table 1 Search strategy summary

Items	Specification
Date of search	January 2022 to June 2022
Databases and other sources searched	PubMed Central
Search terms used	"Avatar AND mHealth", OR "avatar HIV prevention", OR "avatar HIV", OR "HIV gamification" OR "eHealth avatar" OR "HIV prevention interactive computer based intervention" OR "avatar human"
Timeframe	January 2017–July 2021
Inclusion and exclusion criteria	<p>Inclusion criteria:</p> <ol style="list-style-type: none"> 1. Studies mentioned HIV prevention, avatar, virtual avatar, human or agent in the abstract or title; 2. Avatar or embodied agent was used in the intervention delivery; 3. Not limited to a specific population put at risk for HIV acquisition, more so draw from what was learned and how it could be tailored for additional populations; 4. HIV prevention went beyond traditional eHealth/mHealth approaches (e.g., SMS messaging) show more of a lively integration of avatars; 5. Intervention focused on addressing some aspect of HIV care continuum (e.g., treatment, prevention, testing) <p>Exclusion criteria:</p> <ol style="list-style-type: none"> 1. Studies did not mention HIV prevention, avatar, virtual avatar, human or agent in the abstract or title; 2. Studies utilized technology that did not include the use of an avatar or embodied agent in the intervention delivery; 3. Language restricted to English only
Selection process	One author (GAOP) conducted selection
Any additional considerations	<p>Articles that met the inclusion criteria were then categorized based on the usage of the avatar technology, including:</p> <p>Improving antiretroviral therapy adherence, both as prevention for individuals without HIV and as treatment for people living with HIV;</p> <p>Training medical residents;</p> <p>Educating participants on sexual health;</p> <p>Addressing medical distrust in the community;</p> <p>Assessing the overall efficacy of messaging through avatar technology</p>

HIV, human immunodeficiency virus; SMS, short message service.

medical residents; educating participants on sexual health; addressing medical mistrust; and assessing the overall efficacy of interventions applied through avatar technology.

Results

After initial screening and eligibility assessment, 11 publications were identified and included in this narrative review (58–68). All studies are summarized and

included in *Table 2*.

Use of avatars in ART adherence in HIV prevention and treatment

We identified one literature review (58), one qualitative study (59), one prospective pilot study (60), one study proposal (61), and one cross-sectional study (62), which incorporated avatars in both HIV prevention and as

Table 2 Description of studies and statistical results

Study	Country	Avatar usage	Population	Findings
Hightow-Weidman <i>et al.</i> , 2017 (58)	USA	Highlighted two interventions (e.g., Epic Games, and HMP) that showed how gamification can help with HIV prevention and treatment	Epic Allies focused on young MSM and transgender women who have sex with men; both populations are living with HIV	Avatars helped develop social connections; there were increases in viral suppression and ART adherence, but recruitment issues and application troubles limit ability to determine whether the app intervention was successful or not
Dworkin <i>et al.</i> , 2018 (59)	USA	Avatar embodied agent mobile phone intervention supported by theory	Young African American MSM living with HIV (n=16)	5/5 FG welcomed the intervention; participants advocated for stronger safeguard measures for privacy and against stigma (5/5 FG); Male avatars accepted, but welcome female versions; additional illustrations were added to improve communication
Dworkin <i>et al.</i> , 2019 (60)	USA	My Personal Health Guide, an avatar embodied agent mobile phone intervention supported by theory	Young African American MSM living with HIV (n=43)	ART pill count adherence (>80%) increased from 62% to 88 % (P=0.05); significant changes occurred in knowing what viral load, CD4 count and if food needs to be taken with the medicine (P=0.05)
Ahonkhai <i>et al.</i> , 2021 (61)	Nigeria	PEERNaija, an Android-based mHealth application w/ gamification to promote ART adherence	Adolescents and young adults living with HIV	This tool was developed to help establish behaviors for ART adherence among AYA living with HIV; various features were included, including medication reminds, avatar selection for privacy, and chat feature to promote interactions
Bond and Ramos, 2019 (62)	USA	PEP and PrEP for Women, an avatar-led, eHealth video that uses storytelling to address various topics, including HIV risk, and initiation of PEP/PrEP	African American women (n=116)	91 women watched the video in its entirety; 89% (81/91) rated the video as good or better; 97% (88/91) reported they would take PEP if needed; 76% (69/91) would take PrEP; 91% (83/91) would recommend PrEP to another woman; 5 variables predicted a high rating for the video: (I) no current drug use (P=0.004); (II) using condoms in the last 3 months (P=0.03); (III) higher household income (P=0.03); (IV) lower education attained (P=0.005); (V) less sexually abused as an adult (P=0.004)
Gannon <i>et al.</i> , 2020 (63)	USA	MyPEEPS, a smartphone app focusing on sexual health education and HIV prevention	Adolescent sexual minority young men, aged 19 to 25	Participants found the app to be usable; expressed that this could benefit those that live in a different geographical region, who do not have much sexual experience, or lived experiences; resonated with information on gender/sexuality, but recommended privacy measures for comfort
Canidate and Hart, 2017 (64)	USA	Observing how avatars are chosen when seeking HIV/AIDS information on the Internet	Patients or public health workers (n=1,119)	Participants selected avatars with close resemblance to own likeness; low avatar diversity resulted in more White-presenting avatars being chosen; it is suggested a White female avatar be available as it was preferred by this study; no data available in identifying what responses corresponded to patients or public health workers

Table 2 (continued)

Table 2 (continued)

Study	Country	Avatar usage	Population	Findings
Shafii <i>et al.</i> , 2019 (65)	USA	Interactive computer-based intervention on sexual health promotion, pregnancy, and STI prevention that was delivered by a physician avatar	Males and females, aged 14–24, recruited at a public health STI clinic (n=272)	No statistical significance, but at 3-month follow-up, the intervention arm (n=130) reported 33% lower rates of unprotected vaginal sex, and 20% fewer sex partners in comparison to the control arm (N=142); after adjusting for self-reported history of transactional sex, unprotected sex, there were significant lower rates of unprotected sex among females (P=0.01)
Winskell <i>et al.</i> , 2018 (66)	Sub-Saharan Africa	Tumaini, a narrative-based, interactive game, which uses avatars to help the participant connect to the material	Young Kenyans aged 11–14 (n=60)	From baseline to postintervention, there were significant increases in survey scores among the intervention arm (mean 8.03, SD 4.46) when compared with the control arm (mean 2.23, SD 3.88) ($t_{58}=-5.38$, $P<0.001$). Additionally, the intervention arm showed significant gains 6 weeks postintervention in both knowledge (mean 3.80, SD 2.37) and self-efficacy (mean 2.03, SD 1.83) when compared with the control arms (mean 0.80, SD 2.14; mean 0.63, SD 1.20) ($t_{58}=-5.14$, $P<0.001$; $t_{58}=-3.50$, $P<0.001$) respectively
Ramos <i>et al.</i> , 2019 (67)	USA	Utilizing eHealth technology (e.g., virtual environments and avatars) to build rapport with sexual minority populations of color	2 examples presented: Diabetes LIVE & avatar-led eHealth videos on PrEP and PEP	Findings are consistent with the aforementioned Bond and Ramos article
Frasca <i>et al.</i> , 2019 (68)	USA	A curriculum, delivered by virtual avatar patients and practiced on actual patients, on how to collect sexual history and discuss HIV prevention care	Internal medicine residents (n=34)	Quantitative results (19/34): significant increase in a resident's confidence and comfort in discussing PrEP from 10.5% to 84.2% ($P<0.001$), and in discussing safe sexual practices with LGBTQ patients, increasing from 26.3% to 100.0% ($P<0.001$). Qualitative results: residents were more comfortable and confident using a patient's preferred pronouns as well (5/9), learning new skills (5/9), and practicing dialogue in a safe, virtual environment (9/9). The training was found to be more in-depth than that offered in medical school (5/9) and was found to be relevant and engaging (9/9). Trainees recommended that the material could be strengthened by having more variety in patient backgrounds (8/9)

HMP, healthMpowerment; HIV, human immunodeficiency virus; MSM, men who have sex with men; ART, antiretroviral therapy; FG, focus groups; AYA, adolescents and young adults; PEP, post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; AIDS, acquired immunodeficiency syndrome; STI, sexually transmitted infection; SD, standard deviation; LGBTQ, lesbian, gay, bisexual, transgender, queer.

treatment. A theme uniting these studies was that through the personalization of an avatar a patient may be more easily able to invest themselves in what they consider a more authentic representation of themselves, thus allowing for improved intervention outcomes.

Preliminary findings suggest avatar technologies show

promise for application among people living with HIV. In their review, Hightow-Weidman and colleagues (58) showcased how gamification using avatars is a useful strategy to improve motivation to receive HIV-related services, particularly among youth living with HIV. They demonstrate that gamification can improve participants'

capacity to overcome challenges while providing feedback and positive reinforcement, promoting social connectivity, all within an entertaining format (58). One example mentioned is *Epic Allies*, a smartphone app which uses gamification to increase engagement with HIV care and ART uptake among young MSM living with HIV. In this application, avatars were used to foster social connection while also rewarding personal achievements with digitized medals (58). Overall, both the intervention and control arms had increases in viral suppression and ART adherence, but issues with the application limit the conclusion that the application itself improved health outcomes (69). Avatars were also used in the virtual reality-based video game *Tough Talks*, which was designed to allow young MSM living with HIV to practice disclosing their status to potential sex partners in a safe, confidential, and digitized setting (58). After a feasibility pilot, 11 young MSM living with HIV reported having higher self-efficacy to disclose their status, though this was not significant (58,70).

Additional studies have demonstrated the efficacy of delivering information to populations living with HIV using an avatar-based medium. Dworkin and colleagues conducted focus groups to develop a mobile phone app to help promote ART medication adherence and retention among African American MSM living with HIV (59). This qualitative study found that the use of an avatar was acceptable among all surveyed participants, though they raised some concerns of stigma and privacy on intervention efficacy, resulting in the researchers strengthening the app and participants' comfort level (59). Participants also highlighted the importance of being able to customize the avatar, especially in the ability to embody the agent during interactions and more readily understanding new information (59). Overall, the avatar was helpful in presenting a relatable medium that was effective in informing, motivating, and promoting health behaviors (59). Dworkin and colleagues later conducted a prospective pilot study among young African American MSM living with HIV (n=43) (60). With a 3-month pre-post design, the researchers found that ART adherence significantly increased from 62% to 82% (60). The app user interface was found to be acceptable, and though non-significant, health literacy and self-efficacy increased as well (60).

Currently, similar work is being conducted in Sub-Saharan Africa, which bears approximately 85% of the world's adolescents and young adults living with HIV (61). Ahonkhai and colleagues developed *PEERNaija*, which is founded on peer-based mHealth ART adherence interventions and is intended to improve fostering ART

adherence behaviors throughout the app experience (61). For this study proposal, avatars will be used to immerse participants in the app experience through extensive customization options (61). It is hoped that these features will improve perceived social support and supportive accountability (61).

Avatar-based interventions can help additional populations put at risk for HIV understand the benefits of preventive measures, like engaging in PrEP. For example, Bond and Ramos created an avatar-led health video on PrEP and PEP to inform Black women (n=116), ages 18 to 61, about these HIV preventive measures (62). The researchers measured the perceived acceptability, feasibility and preference of such a format after collecting demographic and sexual behavior information (62). The video was highly rated by most participants, demonstrating again the utility of avatars for creating a comfortable and aesthetically acceptable medium for providing HIV-related information and other resources (62). Thematic analysis highlighted that the avatar-led video was relatable to the women and educational in an entertaining manner (62). Overall, this study provided evidence that incorporating embodied avatars within an educational video helped foster education about preventive measures, especially those that may not have had much exposure to such manners (62). In summary, the use of customizable and/or representative avatars can aid in the comprehension of important HIV prevention/treatment topics while also empowering an individual's perceptions of self-efficacy.

The effect of avatars on sexual health education

We identified one evaluation (63), one observational study (64), and two randomized control pilot studies (65,66) that observed how avatars were utilized in sexual health education.

For MSM, Gannon and colleagues utilized avatars in the *MyPEEPS* smartphone app, which provided both HIV prevention and sexual health education [i.e., information on HIV and sexually transmitted infection (STI)s, condom usage] to adolescent sexual minority young men (63). Participants used the app and were later interviewed to self-report their app experience, as well as being asked to complete usability questionnaires (63). Participants found the app to be useful, especially in providing basic sexual health knowledge (63). They also reported that the avatar helped make the information salient while also relatable for young MSM (63). Avatar customization also helped provide

a culturally relevant aesthetic experience for participants, which was supported by appropriate language used by the avatar. Overall, the app experience and features were reported to be relatable and relevant to taking care of one's sexual well-being (63).

Avatars have also proven fruitful in promoting sexual education among the general public. An observational study conducted by Canidate and Hart (64) investigated patterns of avatar selection, from a small assortment of various ethnicities and gender, among participants (n=1,119) as they sought information on HIV and acquired immunodeficiency syndrome (AIDS) on the internet. Users self-reported their age, gender and ethnicity/race. It was found that participants selected an avatar that matched their own likeness, especially one's ethnicity (e.g., 65.5% of Black participants chose a Black avatar, 52.5% of White avatars chose a White avatar) (64). Using these findings, the authors then inferred that participants may be more comfortable receiving information from an avatar based on their likeness rather than a healthcare provider that may not have the same likeness (64). In a separate pilot randomized controlled study conducted by Shafii and colleagues (65), participants (n=272) between 14 to 24 years of age were randomized into either a computer-based intervention (n=130) arm or a control arm (n=142). Baseline demographics and sexual history were collected via computer-assisted self-interviews along with urine samples for STI testing. Within the intervention arm, participants could select one of three interfaces to engage with the computer program: a static male physician avatar, a female physician avatar based on images as if interacting with a patient, and text-based responses only. Based on their baseline sexual history, participants received tailored feedback on their protective and risky sexual behaviors. Participants were then asked by the avatar what they'd like to discuss further: STI/HIV and male condom use, or birth control use and unintended pregnancy. These two options were self-ranked in perceived importance and confidence in consistently enacting the behavior. The avatar then inquired: (I) why the selected category was important; (II) what perceived barriers exist towards conducting that behavior; and (III) what skills and information could increase self-efficacy. After the intervention, participants were encouraged to identify a risky sexual behavior and to create a goal on changing that behavior. Ultimately at follow-up, there were no significant changes among the intervention arm, yet participants did report lower rates of unprotected vaginal sex and fewer sex partners (65). These studies show that avatars can

help create a comfortable environment for patients to reflect on their behaviors while setting goals for change. Additionally, each of these studies highlights the potential importance of allowing participants to self-pace themselves in exploring sexual health information without any pressure to immediately process and enact a behavior immediately (64,65); avatars may help with the self-pacing process, as they encourage exploration and self-actualization in a digital environment.

Additionally, Winskell and colleagues (66) utilized *Tumaini*, a theory-centered, empirically based smartphone application among young Kenyans (n=60), ages 11 to 14 years, who were evenly allocated into the intervention and control arms (n=30, respectively). This randomized control pilot study tested the effectiveness of *Tumaini* in increasing age and condom use at one's first sexual encounter. *Tumaini* consisted of 12 hours of gameplay with a "choose your own adventure" approach, allowing participants to explore the 40 possible endings for the game. Avatar customization was part of the process, allowing participants to better relate to health information while exploring different viewpoints as they were also required to play avatars of both sexes along with one character living with HIV to promote empathy and challenge negative norms (66). These features formed the intervention arm while the control arm still received sex education, but from their family, school and/or peers instead of *Tumaini*. Participants later completed a survey on their behaviors at baseline, post interventions, and after 6 weeks postintervention. There were no significant differences in baseline scores between the groups. However, overall, from baseline to postintervention, there were significant increases in survey scores among the intervention arm [mean 8.03, standard deviation (SD) 4.46] when compared with the control arm (mean 2.23, SD 3.88) ($t_{58}=-5.38$, $P<0.001$). Additionally, the intervention arm showed significant gains 6 weeks postintervention in both knowledge (mean 3.80, SD 2.37) and self-efficacy (mean 2.03, SD 1.83) when compared with the control arms (mean 0.80, SD 2.14; mean 0.63, SD 1.20) ($t_{58}=-5.14$, $P<0.001$; $t_{58}=-3.50$, $P<0.001$) respectively. Qualitative survey analyses showcased that the app's information was relevant and appealing, and that the intervention itself: (I) was entertaining; (II) left participants wanting to play more; and (III) would be recommended to friends to experience. *Tumaini's* use of interactive narratives immerse participants in problem-solving situations in simulating cognitive and behavioral learning by exploring protective and risky behavioral choices in a safe and virtual environment (66); avatars were likely a critical part of this

immersive process. As with the study done by Shafii and colleagues, this study helped participant set goals, how to enact them, and how to overcome anticipated challenges (65,66).

These studies showcase that avatars, when applied in a smartphone or web-based format, can be effective in encouraging precautions towards potentially risky behaviors.

Overcoming medical mistrust via avatars

We identified one framework proposal (67) and one curriculum evaluation (68) that present promising themes to help improve culturally competent care towards sexual and gender minority populations.

Ramos and colleagues (67) developed a stepwise, multi-construct framework which proposes using eHealth technology to help overcome medical distrust among sexual minority men of color living with chronic conditions. This framework focuses on five constructs to help with building rapport: adoption and usage, anonymity, co-presence, self-disclosure, and social support (67). One example presented is utilizing virtual environments to help with diabetes self-management and support. Another study focused on avatar-led eHealth videos that were made to increase knowledge of both PEP and PrEP, which has been effective as demonstrated by Bond and Ramos (62). Results from the diabetes example found that participants developed strong social bonds, and that over time, both disclosure of sensitive information and overall support increased. As for the avatar-led videos, results found that the information was relevant, and could help a client find prophylactic treatment if needed (67).

Avatars can also educate medical professionals to provide more culturally competent care. Frasca and colleagues (68) created a medical curriculum to train residents (n=34) on how to conduct inclusive sexual history taking and HIV prevention care among lesbian, gay, bisexual, transgender, queer (LGBTQ) patients, and additional communities put at risk through online virtual patient cases. After training with virtual avatar patients, these skills were then applied under directly supervised clinical care. Participating residents completed pre-self-assessment surveys (26/34), post-self-assessment surveys (22/34), any additional post-surveys on the training modules, and/or were interviewed (9/34). There were 19 matched pre-post surveys. Quantitative results (19/34) showed a significant increase in a resident's confidence and comfort in discussing PrEP from 10.5% to 84.2% ($P<0.001$), and in discussing safe sexual practices with LGBTQ patients, increasing from 26.3% to 100.0%

($P<0.001$). Qualitative analyses showed that residents were more comfortable and confident using a patient's preferred pronouns as well (5/9), learning new skills (5/9), and practicing dialogue in a safe, virtual environment (9/9). The training was found to be more in-depth than that offered in medical school (5/9) and was found to be relevant and engaging (9/9). Trainees recommended that the material could be strengthened by having more variety in patient backgrounds (8/9). This training could help providers provide more competent care as experts recommend that LGBTQ and sexual health curricula continue beyond one's time at medical school (71). This study helps show that virtual patients can help teach sexual history taking, the distribution of PrEP, and risk reduction counseling, which all strengthen HIV care and prevention.

Both studies highlight that eHealth technology can help nurture a relationship with medical providers when addressing chronic conditions like HIV/AIDS. In return, providers can practice their skills with virtual patients to then incorporate them into a brick-and-mortar facility to change how patients may interpret their experience. Overall, avatars present the opportunity for both providers and patients to communicate effectively and comfortably.

Discussion

We conducted a narrative review on the use of avatar technology on HIV prevention. We found 11 English-language publications which fit the inclusion criteria. Our findings suggest that avatars may promote the transmission of health information to populations put at high risk for HIV acquisition, as well as provide a medium for participants to comfortably reflect on and disclose their sexual behaviors. HIV prevention encompasses many factors, including treatment as prevention and prophylactic measures, yet there is not much focus on addressing distal issues like linkage to care and retention, which can be aided by integrating avatars. Previously, among the LGBTQ community more broadly, mHealth and eHealth interventions, and telemedicine more amply (72), have successfully been applied to the areas of STI testing, hormone replacement therapy, reproductive care, and HIV prevention (72-74). In particular, eHealth interventions can be effective in reducing risky sexual behaviors among MSM (e.g., unprotected anal intercourse, multiple sex partnerships, and infrequent HIV testing) when incorporating features like tailored strategies, personalized feedback, and computer-mediated communications (75).

Utilizing avatars in HIV prevention provides an opportunity to establish safe sexual behaviors while overcoming key obstacles in care. Avatars provide a convenient and discreet manner to be able to address sensitive and stigmatized topics, while empowering an individual with information and improving their self-efficacy to engage in preventive measures or treatment. Adapting avatar technology towards HIV prevention and treatment alongside sexual education may prove to be beneficial to establish both proximal and distal effects for care.

While current eHealth interventions have helped expand access to HIV care and treatment, there remains a need to reinforce and adapt avatar-based technology for more widespread public adoption. First, identifying how and where exactly to present avatar-based consultation or advice would be essential to determine its efficacy towards vulnerable populations. It is recommended that this technology be adapted to communities that are affected by stigma in sexual healthcare; in doing so, a participant could utilize the anonymity from the avatar to feel more comfortable in disclosing sex behaviors, and in turn, having better tailored care. Our study shows that avatars present an easily accessible and understandable user interface for populations to interact with and can also identify technological preferences among different populations as shown by the included studies.

Second, avatars present the opportunity to overcome stigma and hesitation in seeking and engaging in HIV and STI care and education. When considering the “Proteus effect” and its findings, role-playing with a custom avatar can help orient a participant’s attitude, abilities and overall cognitive skills towards health information and preventive behaviors. The visual components along with scenario-based learning can help participants recognize the applicability of learned skills into their *modus vivendi*, or way of living. Within a controlled virtual environment, the increased anonymity participants experience through avatars can help patients disclose more information than they would to a medical provider, providing an opportunity to enhance and better tailor one’s care as well. Overall, it is possible that a participant could surpass the threshold to rely on virtual settings to then manifest and apply these skills face-to-face. As one’s behavior may change, this condition can provide a more consistent evaluation whenever a patient is seeking care without the hesitation of a medical professional’s input or anticipated critique. This is key, especially in settings where LGBTQ-identifying or competent providers may be scarce, and which may affect important factors like linkage

to care, adherence, and most importantly, retention.

Third, the nearly infinite customizability of avatars presents the opportunity for patients to not only personalize their own avatars but could be more effective than face-to-face consultations. With computer-based interventions, interventions can be delivered accurately, with minimal human error (65). Additionally, there are fixed costs for both software and hardware, with feasible revisions and improvements to be done to a virtual system (65). Practically, avatars could implement feedback quicker than a person would and reduce any resistance towards change among providers and researchers.

Fourth, though this is not covered in our review, we feel it is important to note that avatars may be more cost effective for both consumers and providers. Currently, telemedicine is covered by private and public insurance companies (76). Integrating avatars into telemedicine could be beneficial for participants who prefer remote services while also strengthening privacy while encouraging patient behavior disclosure. For businesses, avatars cost less to implement and manage, while providing accurate information and lively engagement with clients as well (77). As shown in this study, avatars can educate clients on prevention or management of their behaviors in various topics, which could be helpful to target multiple subjects and condense that information into an avatar that can effectively communicate with information seekers. Physicians can also utilize avatars to learn how to better provide competent and holistic care towards sexual and gender minorities in taking sexual history and overall behaviors.

Finally, avatars present the opportunity to help community partners, public health services, and researchers to adapt existing sexual health services and resources. In including avatars in outreach, it may present a more enticing opportunity for hard-to-reach communities and communities of color to better engage with these resources to highlight any existing obstacles and how providers can better tailor care interventions, messaging, and overall care to those in need. This insight could be effective in reducing overall incidence and prevalence of HIV and STI rates throughout communities put at risk.

While avatar technology has potential for integration into HIV and STI treatment and prevention, there remain some important caveats and limitations. First, our focus was primarily on how avatars were used, which incorporated various communities of different demographics, serostatus, and countries, each with their own respective outcomes. While the results themselves may not be generalizable

to all communities, it does highlight the potential for applying avatar-based technologies across a broad array of populations and communities put at risk. Second, avatar usability and acceptability were not the main target of outcomes but was rather a component in how a study was being conducted or as a medium for an intervention. Future studies should emphasize the use of avatars and overall efficacy in targeting a specific health behavior in prevention. Third, not all the studies were empirically tested as some were either frameworks or study proposals. The few studies that were conducted did not all have significant results but gave some indication as to the direction of how the research may go. Fourth, some of our reviews had small sample sizes, which may influence the results, and may change with a bigger sample size. Finally, while our review did include studies from other countries, it did not necessarily include studies that were in their native language beyond English, limiting further analyses into avatars.

Conclusions

Overall, the studies included in our review show that integrating avatars in HIV prevention, alongside sexual health education can help reduce risk behaviors among communities put at risk. Such an integration of avatar technology in HIV prevention can help educate and empower vulnerable communities to better manage their sexual health, while reducing their likelihood for HIV infection and other STIs in the US.

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Footnote

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