

Perceptions on HIV-related Comorbidities and Usability of a Virtual Environment as CVD Prevention Education in Sexual Minority Men with HIV: Formative Phases of a Pilot RCT

S. Raquel Ramos, Harmony Reynolds, Constance Johnson, Gail Melkus, Trace Kershaw, Julian Thayer, Allison Vorderstrasse

Submitted to: Journal of Medical Internet Research
on: February 13, 2024

Disclaimer: © The authors. All rights reserved. This is a privileged document currently under peer-review/community review. Authors have provided JMIR Publications with an exclusive license to publish this preprint on its website for review purposes only. While the final peer-reviewed paper may be licensed under a CC BY license on publication, at this stage authors and publisher expressly prohibit redistribution of this draft paper other than for review purposes.

Table of Contents

Original Manuscript..... 5

Supplementary Files..... 31

..... 31

..... 31

0..... 31

Perceptions on HIV-related Comorbidities and Usability of a Virtual Environment as CVD Prevention Education in Sexual Minority Men with HIV: Formative Phases of a Pilot RCT

S. Raquel Ramos^{1, 2, 3*} PhD, MBA, MSN, FNP, RN; Harmony Reynolds^{4, 5*} MD; Constance Johnson^{6, 7*} PhD, MS; Gail Melkus^{8*} EDD, ANP; Trace Kershaw^{2, 3*} PhD; Julian Thayer⁹ PhD, MA; Allison Vorderstrasse^{10*} DNSc, APRN

¹School of Nursing Yale University Orange US

²Center for Interdisciplinary Research on AIDS Yale University New Haven US

³School of Public Health Social and Behavioral Sciences Yale University New Haven US

⁴Department of Medicine Grossman School of Medicine New York US

⁵Cardiovascular Clinical Research Center NYU Langone Health New York US

⁶Czik School of Nursing The University of Texas Health Science Center Houston US

⁷School of Biomedical Informatics The University of Texas Health Science Center, Houston Houston US

⁸Rory Myers College of Nursing New York University New York US

⁹School of Social Ecology, Psychological Science University of California Irvine US

¹⁰Elaine Marieb College of Nursing University of Massachusetts Amherst Amherst US

* these authors contributed equally

Corresponding Author:

S. Raquel Ramos PhD, MBA, MSN, FNP, RN

School of Nursing

Yale University

400 West Campus Drive

Orange

US

Abstract

Background: Sexual minority men with HIV are at increased risk of cardiovascular disease (CVD) and have been underrepresented in intervention research and in clinical trials.

Objective: To explore patient's and HIV care experts' perceptions about HIV-related comorbidities and assess the usability and functionality of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV.

Methods: This two-phase study is part of a pilot clinical trial to test acceptability and feasibility of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV. We qualitatively explored HIV comorbidities of concern and conducted usability and beta testing of the virtual environment.

Results: In Phase 1, we found CVD risk factors included high blood pressure, heart attack, stroke, and diabetes. Cancer (prostate, colon, and others) was a common concern and so were the development of mental health conditions. In Phase 2, all participants completed the 12-item usability checklist with favorable feedback. Several themes emerged: 1) Mixed perceptions about health and HIV, 2) High risk for comorbid conditions, and 3) Virtual environment features. Sentiment resulting from beta-testing was favorable, but included constructive feedback for refinements that include diverse avatar representations.

Conclusions: We identified several comorbid conditions of concern and findings carry significant implications for mitigating barriers to preventative health screenings in Black and Latinx sexual minority men with HIV given the shared risk factors between HIV and related comorbidities. Highly rated aspects of the virtual environment were anonymity, the ability to meet other patients who identify as gay or bisexual with HIV, and accessibility to CVD prevention education. Critical end-user feedback from beta-testing suggested more options for avatar customization in skin, hair, body representation. We will apply these recommendations and others in our next step to formally test the virtual environment as a novel modality to extend the reach of CVD prevention education to minoritized individuals that have been underrepresented in advancements in health equity and in clinical trials. Clinical Trial: clinical trial (NCT04061915)

(JMIR Preprints 13/02/2024:57351)

DOI: <https://doi.org/10.2196/preprints.57351>

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

Please make my preprint PDF available to anyone at any time (recommended).

Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.

Only make the preprint title and abstract visible.

✓ **No, I do not wish to publish my submitted manuscript as a preprint.**

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✓ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**

Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain visible to all users.

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <http://www.jmir.org/>

Original Manuscript

Abstract

Background: Sexual minority men with HIV are at increased risk of cardiovascular disease (CVD) and have been underrepresented in behavioral research and in clinical trials.

Purpose: To explore perceptions about HIV-related comorbidities and assess the interest and usability of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV.

Methods: This is a 3-phase pilot randomized control behavioral trial. We report on formative phases 1 and 2 that informed virtual environment content and features using qualitative interviews, usability testing, and beta testing with 25 individuals. In Phase 1, 15 participants completed interviews exploring HIV-related illnesses of concern that would be used to tailor the virtual environment. In Phase 2, usability and beta testing were conducted with 10 participants to assess interest, features, and content.

Results: In Phase 1, we found CVD risk factors included high blood pressure, heart attack, stroke, and diabetes. Cancer (prostate, colon, and others) was a common concern and so were the development of mental health conditions. In Phase 2, all participants completed the 12-item usability checklist with favorable feedback within 30 to 60 minutes. Beta-testing interviews suggested: 1) Mixed perceptions about health and HIV, 2) High risk for comorbid conditions, 3) Virtual environment features were promising, and 4) need for diverse avatar representations.

Conclusions: We identified several comorbid conditions of concern and findings carry significant implications for mitigating barriers to preventative health screenings given the shared risk factors between HIV and related comorbidities. Highly rated aspects of the virtual environment were anonymity, meeting others who identify as gay or bisexual with HIV, validating LGBTQ+ images and content, and accessibility to CVD prevention education. Critical end-user feedback from beta-testing suggested more options for avatar customization in skin, hair, body representation. Our next phase will test the virtual environment as a new approach to advancing cardiovascular health equity in ethnic and racial sexual minority men with HIV.

Introduction

In the United States, cardiovascular disease (CVD) is the leading contributor to mortality and has been for over 100 years¹. Heart disease risk is especially prevalent among persons with human immunodeficiency virus (HIV).²⁻⁴ Antiretroviral therapy has increased life expectancy, permitting the link between HIV and premature onset CVD to come to light. Persons with HIV are 1.5 to 2 times more likely to develop CVD than HIV serostatus negative persons.⁴ This increase in CVD risk is similar to the increased risk of CVD due to diabetes.^{4,5} It is estimated that 78% of persons with HIV will have CVD by the year 2030.^{6,7}

The risk of HIV, and CVD as a comorbidity, disproportionately impacts Black and Latinx sexual minority men⁸ as they experience higher rates of HIV-related conditions, such as high blood pressure and diabetes⁹. CVD risk is intersectional and is exacerbated by social determinants and structural forces. When these multi-level stressors coalesce, they create barriers to education, safe neighborhoods, resources, and quality health care for those economically, racially, and ethnically marginalized. In sexual minoritized individuals, this is intensified and manifests in the forms of repeated experiences of racism, discrimination, homophobia, and violence^{10,11}. CVD risk is heightened by racism and discrimination^{10,11} and their persistent effects on allostatic load¹² and weathering¹³, (the ongoing, cumulative burden of stress that predisposes individuals to morbidity and mortality). Allostatic load has adverse impacts on the immune, cardiovascular, and metabolic systems over time¹⁴, which can increase stress responses and activate the hypothalamic-pituitary axis. This creates an increase in cortisol and other inflammatory markers resulting in physiological disruptions¹⁵ leading to cardio-metabolic and mental health morbidities¹⁶. Thayer and colleagues, identified a “*cardiovascular conundrum*” in which perpetual discrimination in Black^{10,17} and sexual minoritized individuals¹⁷ leads to both elevated systemic vascular resistance, which can heighten CVD morbidity and mortality risk, and higher vagally-mediated heart rate variability (HRV), typically associated with lower risk. Exposure to discrimination and racism lower HRV and may

elicit maladaptive coping mechanisms, such as rumination, which further lower HRV¹⁷⁻¹⁹. Racism and discrimination towards racial, ethnic, and sexual minoritized individuals have resulted in longstanding disadvantages towards achieving health equity. These are root causes of medical mistrust, are catalysts to avoiding care engagement²⁰, and reduce opportunities for CVD screening and preventative counseling²¹. A review examining non-pharmacologic behavioral interventions to prevent CVD in persons with HIV suggested that over the past decade, there has been an increase in behavioral CVD interventions²². However, the extant literature was limited in its representation of populations that continue to be disproportionately affected by low cardiovascular health²². Current research also identified the interplay between an individual's race, gender, and sexual orientation²³ that negatively affect health outcomes and further increase the risk of chronic conditions²⁴, creating a urgent need to mitigate health risk in disadvantaged, underserved and under-resourced populations.

Clinical research on behavioral and lifestyle interventions to prevent heart disease that are culturally salient and tailored are essential to mitigating CVD disparities in minoritized populations. The standard approach to prevention education has been conventional patient teaching within the clinical setting. However, the literature confirms the existence of an equity gap in who has access to timely²⁵, quality care²⁶ and who has access to engage in clinical trials^{27,28}. The health care and research enterprise has rapidly shifted towards ubiquitous computing as a common source of data collection for research (EHR, artificial intelligence, wearables, mHealth, process data via virtual environments and augmented reality, etc.)²⁹⁻³⁴. Behavioral research using virtual environments and/or augmented reality have been gaining in popularity³⁵⁻³⁸. Yet, the level of accessibility to this type of research has remained limited in diverse and marginalized populations. The novelty and relevance of technology-driven behavioral research has not been fully realized in low-income and urban communities where large numbers of minoritized individuals reside.

The American Heart Association has called for an increase in interventions that focus on enhancing cardiovascular health in underserved communities by addressing social determinates and

modifiable risk factors of CVD³⁹. Specifically, the AHA has called for more cardiovascular health interventions to be taken from the clinical setting into the community and community-serving programs. Community-based interventions are sought for their value in engaging individuals and families from disadvantaged or marginalized groups⁴⁰. This provides an exceptional opportunity to bridge the equity gap that currently exists, such that clinical interventions do not reach marginalized individuals at increased risk. In order to mitigate longstanding barriers to health equity and advance understanding about the social determinates that impede cardiovascular health and perceptions about other HIV-related comorbidities of concern, qualitative, community-engaged approaches are needed. To explore perceptions about HIV-related comorbidities and assess the usability and functionality of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV.

Methods

Study Design

This study is a 3-phase pilot randomized control behavioral trial. The purpose of the intervention is to test the acceptability and feasibility of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV. The protocol for the study is reported elsewhere³³ and is registered on clinicaltrials.gov (NCT04061915). Formative phases 1 and 2 informed virtual environment content and features using qualitative interviews, usability testing, and beta testing with 25 individuals. This paper reports on phases 1 and 2 that were necessary to inform the clinical trial in phase 3.

Participants

We wanted to better understand chronic illness health needs from the perspectives of both HIV health experts and also from individuals residing in the community. We partnered with two community-based organizations that provide supportive services to ethnic, racial, immigrant, and sexual minoritized individuals. The organizations were located in New York City and served many

individuals who are economically marginalized. We refer to “clients” of the community-based organization as study “participants.”

We engaged several experts in HIV care with clinical and community-health backgrounds. Eligibility criteria for the HIV care experts were: 1) engaged in healthcare or care services with persons living with HIV for at least 5 years, 2) any gender, 3) age 18+.

Participants were all adults and identified as being of ethnic or racial heritage. Eligibility criteria for participants were: 1) self-identify as gay or bisexual; 2) HIV serostatus positive; 3) ages 30 to 65; and 4) access to a laptop or desktop. Participants were ineligible if they: 1) identified as heterosexual, 2) were HIV negative, 3) had a history of heart attack, stroke, or cognitive impairment.

Recruitment

Prior to recruitment, we convened with administrators at the community-based organizations to discuss study objectives, approaches to data collections, described the types of data that would be collected, and outlined logistics to obtaining the data in ways that would be comfortable for the participants. Program managers and administrators from the community-serving organizations posted flyers and used word-of-mouth to provide information about the study. We worked with the community-serving organizations to contact individuals who conveyed interest in learning more about the study. Using Zoom, interested persons were screened, consented (if eligible) and enrolled. Verbal informed consent was obtained from all individuals who participated in the study. We provided a \$30 gift card as compensation for participation.

Ethical Considerations

The study was approved by the Yale University IRB 2000031403 in 2022, New York University Institutional Review Board in 2019, and the University of Texas Health Science Center at Houston in 2020.. All procedures performed in studies involving human subjects are in accordance with the ethical standards of the institutional and national research committee, the 1964 Helsinki Declaration and its later amendments, or comparable ethical standards. All study data were

deidentified to protect the identity of participants.

Study Procedures

Phase 1 and 2 were conducted using Zoom. Zoom is a HIPAA-compliant web and video conferencing platform that uses end-to-end encryption. During the interviews and focus groups, cameras were turned off. Only audio recordings using pseudonyms were used during data collection.

Phase 1 Qualitative Interviews

Phase 1 data were collected from June 2021 to May 2022 with a total of 15 participants. The purpose of Phase 1 was to learn about health concerns that were important to participants and use that information to tailor the content and design of the virtual environment, which would be piloted in phase 3. Our interview questions were derived from an open-ended interview guide. The interview guide included five-questions, with probes for clarity. An example question was, “Tell me about any medical conditions, other than HIV, that you are concerned about?” Example questions from the guide were reviewed with the program manager at the community-serving organization to ensure the language and content were appropriate for their clients. To ensure participant accessibility and convenience, semi-structured interviews and focus groups (for participants who preferred to have an in-person, group interview at their community-serving organization) were conducted. Prior to starting the focus groups, ground rules were established for respect and confidentiality of information shared. The first author (SRR), an academic researcher, had a preexisting relationship with the community-based organizations and facilitated qualitative data collection. For both semi-structured interviews and focus groups, pseudonyms were created prior to the interviews to maintain anonymity. After the interviews were completed, we used the data to embed the virtual environment with content that was reported as important, relevant, and culturally salient.

Phase 2 Usability and Beta-testing

After we had embedded the virtual environment with content from Phase 1, we conducted usability and beta testing. Data for Phase 2 was collected from August 2022 to October 2022 with a

total of 10 participants. A 12-item usability checklist (Figure 1) was developed and pilot tested by members of the study team. The purpose of the usability checklist was to conduct a task analysis to assess practical functionality of the virtual environment.

Example checklist items included: 1) “Customize your avatars hair, skin, clothes, and shoes,” and 2) “Use the microphone to say hello to others in the virtual environment.” Participants were tasked with moving through all 12 items, which would convey they were able to navigate all areas, engage with features, and customize their avatar. After usability testing, we conducted beta testing, which comprised of several questions to assess: 1) avatar customization, 2) functionality and features, 3) quest content, 4) educational health content. We also asked for any additional feedback for tailoring of virtual environment content prior to initiation of the clinical trial. In Phase 3, we will test the new content that is embedded and assess outcomes on usability and acceptability.

Data Analysis

Qualitative data were analyzed using content analysis in NVivo version 12. Content analysis is an established set of step-wise techniques used in qualitative research to identify, code, describe, and assign themes to open-ended narrative. In qualitative research, data is contextual and focused on maximizing understanding of the phenomenon under study and not necessarily on fixed sample size. Three coders analyzed the data (SRR, LC, MOB) and discrepancies were resolved through discussion until consensus was reached. Data saturation was achieved after 15 Phase 1 participants were interviewed and there were no new emerging data^{41,42}. In Phase 2 usability testing, metrics of content navigation and duration of time to completion using the 12-item checklist were tracked. Beta-testing qualitative data were pooled and common themes were assigned thematic categories to contextualize the findings using representative quotes.

Measures of Rigor for Qualitative Data

Reliability was demonstrated by providing a detailed description and rationale for the study

purpose, participant sampling approach and the role of the researchers and study team⁴³. Dependability was ensured through using consistent approaches to data collection, such as a prespecified interview guide.⁴⁴ Validity was assessed by checking for accuracy or credibility of the findings through member checking and peer debriefing^{43,45}. Debriefings were held with the study team following data collection to strengthen the validity of data interpretations and not leave them subject to recall.⁴³ Transferability⁴⁴ of our study findings may be applicable, to diverse and marginalized populations who are at risk of comorbid conditions Standards for Reporting Qualitative Research (SRQR) was used to report findings⁴⁶.

Results

Sample Characteristics

We collected qualitative data about health concerns outside of HIV from 11 participants who are clients at the community-based organizations. Their characteristics are presented in Table 1.

Table 1. Phase 1 Qualitative Interview Participant Characteristics (n=11)

Characteristics	
Race/Ethnicity, No. (%)	
African American (Non-Hispanic/Latinx)	5 (45)
Latinx	4 (36)
Mixed Race Ethnicity / Biracial	2 (18)
Age	
(M=32.27, SD=3.04)	
Highest Level of Education	
Masters Degree	N/A
Bachelors Degree	2 (18)
Some College or Associates Degree	2 (18)
HS Diploma or GED	7 (64)

^a HIV care expert (n=4) not included in table due to small n. Their characteristics are narrated in the results section.

Overall, sixty-four percent reported duration in years from diagnosis with an average of 8 years (SD

4.88). This sample characteristics of participants with HIV are representative of those who have been historically underrepresented in clinical trials and experience the greatest health inequities.

Four participants were HIV care experts with clinical and community-health backgrounds including: one holistic advanced practice nurse practitioner with a Master's degree and five years of experience; one access to care specialist with a Bachelor's degree and five years of experience; one community health educator with a Master's degree and 15 years of experience; and one HIV senior program director with a Bachelor's degree and six years of experience. All four HIV care experts identified as being from an ethnic or racial minoritized background. These individuals were highly trusted by participants. Their engagement during phases 1 and 2 facilitated open lines of communication from our participant with HIV sample, which added to the quality of the data.

The Phase 2 sample consisted of 10 participants, which aligned with published recommendations for conducting user testing^{47,48}. Forty-five percent (n=5) of persons with HIV, had participated in the Phase 1 qualitative interviews as prospective end-users for the subsequent clinical trial to test virtual environment acceptability and feasibility. Educational attainment ranged from 11th grade to Bachelor's degree.

The five HIV care experts had backgrounds in medicine and community-health. There was overlap of one HIV care expert having participated in the Phase 1 qualitative interview. HIV care experts had completed a college level education ranging from an Associate's degree up to Doctor of Medicine degree.

Phase 1 Focus Group and Semi-structured Interviews

Qualitative data collection for each interview took 60 to 90 minutes. Nine semi-structured interviews and one focus group were conducted with six participants (four HIV care experts with clinical and community-health backgrounds and two participants with HIV who were receiving services from the community-based organizations). Prior to the focus group, participants requested a program manager be a part of the group since some participants with HIV were new to participating

in research. The program manager contributed ease during the group, which resulted in a robust discussion about HIV comorbidities of concern. Phase 1 resulted in a total of 84 pages of transcribed data.

Theme 1: Mixed Perceptions about Health and HIV

Overall, the majority (60%) of participants with HIV believed their health to be “decent” to “really healthy.” They conveyed being very in-tune with their health issues and that having a diagnosis of HIV was really the catalyst for being more cognizant about their health behaviors. Four (40%) participants were diagnosed with HIV in the last five years and had mixed perceptions regarding how they perceived their overall health. Some of the sentiments conveyed about health perceptions were due to the effects of acquiring HIV during the COVID pandemic.

“I think me testing positive...being diagnosed with HIV...have helped me open up my mind and tell myself now it’s time to get your health in order...not just your physical health, but your mental health as well....I’ve changed my diet trying to eat healthier, drink healthier, trying to exercise more to help with my physical health, my mental health. Sometimes depending on the weather, instead of taking transportation somewhere I walk just to get a little bit of exercise; or when the weather is warm out, I’ll bring out my bike and I’ll go bike riding around the city just for the exercise.” – Pseudonym: Eric

“..overall, I feel pretty healthy..I want to live a good long healthy life with the least amount of complications as possible. So yes, if there is ever something, I go to my doctor for, and he’s like, hey, you need to fix this – I’m already on it. For example, like for vitamin D, I think it was my vitamin D, it was really low, and I said okay. Right after the visit, I went right to the store bought those vitamins, started taking those. Three months later, we did my blood work, he’s like, oh, you’re good. I said, thanks.” – Pseudonym: Roman

“I got diagnosed [with HIV] during the beginning of COVID, like in March...It’s been a process, so to speak, because I would’ve expected for me to be a ho [promiscuous] and then get it [acquire HIV]. But I trusted somebody, you know, that was supposed to be mine and he fell in love with somebody else that was positive. To even know that he got [HIV] positive, and yeah, that’s what, to me, the whole world went...you know issues. Because, I have trust issues already as a person, you know. People show their true colors. It’s common for people to have trust issues after you go through a very traumatic situation.” – Pseudonym Arai

“My diagnosis was actually August of 2020, so almost two years. It was a shock. This is on the period of now COVID, and then this happening.. This has been a journey in that...from receiving my diagnosis to now has been...as a person also of color, trying to find the right physician that has listened to my needs and my concerns. Living with a compromised immune system especially because of everything, post-diagnosis...it’s been one of those things where I have had to...I’ve had...I felt dismissed in the beginning. I’ve had some concerns as related to other health issues related to diagnosis. So, I’ve had it where some providers have thought I was being a little overly

anxious, so they dismissed my concerns or they spoke down to me. At the time until I spoke to other friends, I would have stayed [in care with the same provider] with it because part of it were issues were...maybe financially or economic reasons...I just didn't have the access to get a better physician. So, I'm stuck with what was familiar with even when I didn't feel like most of my concerns and medical needs were met. It took some time to navigate that and go out of my comfort or familiarity and then seek out providers who assess my needs. Even if they were a little bit further geographically than I was used to, that overall my experience with them would be a little bit better than what I was already getting." – Pseudonym Zoe

Three of the HIV care experts also conveyed mixed perceptions about health-related behaviors (Table 2) resulting from HIV diagnosis in newly diagnosed young people when compared to persons who have had HIV for an extended duration.

Table 2. HIV Care Expert Selected Utterances about Client health-related behaviors

Theme	Utterances (HIV Care Experts)
Mixed Perceptions	<p><i>"..people who are living with HIV tend to be more adherent to taking their medications, you know, as prescribed, simply because they want to achieve undetectable viral load. And in addition, in my opinion, they tend to be a little more healthier than people who are not living with HIV."</i> – HIV Care Expert Pseudonym: Tyler</p> <p><i>"..people that have been already living with HIV for many, many years, they are more conscious about how to take care about themselves, the ways of getting HIV or any other comorbidities, how to take care of themselves. But, I am not very sure that evolves with young people to take care of their issues, their conditions in the same way even though we have more information right now, and more access to treatment. I think that the attitude is a little bit different."</i> – HIV Care Expert Pseudonym: Lloyd</p> <p><i>"I've noticed that over my experience with patients, people with HIV is that there are ebbs and flows, and it depends on where they are in their life and how they perceive their HIV. I do notice that younger folks sometimes think about it like, I have to take this from now until forever for my HIV, and it becomes overwhelming for them at times. I do find that the ones who are diagnosed years ago tend to be more stabilized with their ideas and their thoughts about HIV, and being able to keep them adherent to medication and so forth."</i> – HIV Care Expert Pseudonym: Eric</p>

Theme 2: High Risk for Comorbid Conditions

Participants with HIV perceived they were susceptible to other illnesses as a result of having HIV, stemming from environmental conditions, such as diabetes and asthma, respectively. They spoke about lung function and the effects of the weather on their breathing. Cardiovascular disease and CVD risk factors were consistently expressed concerns in relation to HIV and health, including hypertension, heart attack, stroke, and diabetes. Additional well-described comorbidities of HIV, such as kidney, and liver disease were also identified by participants as important. Cancer (prostate,

colon, and others) was a common concern among participants. Participants with HIV also voiced concerns about mental health conditions. Participants conveyed:

“I heard that sometimes complications can come with, you know living with HIV, like cancer and other health problems that can come up, that I’m not really...I’m not aware of all of them. But I don’t know; cancer is just something that I thought that could be. And especially too, with heart problems or you know, different things like that... Heart attacks, strokes, palpitations, all kinds of stuff.” – Pseudonym: Kori

“I have high blood pressure, so I take high blood pressure medicine. I also have asthma, so I usually have a pump just in case. That’s pretty much it.” – Pseudonym: Ralph

“Cancer is a concern for me because it runs in my family. It’s something that’s kind of, I guess is hereditary. We’ve lost a lot of family members due to that. So, for people who probably have hereditary illnesses or diseases that run in their family, that should be of concern to them..” – Pseudonym: Omar

“I don’t know why, but colon cancer, and that’s not it, because I remember hearing someone talk about it, and I was just like, this can really happen! I never knew that.” – Pseudonym: Roman

The HIV care experts described chronic disease and mental health conditions that were affecting participants (Table 3), such as anxiety and depression due to the stress of living with HIV, and for some, HIV comorbidities.

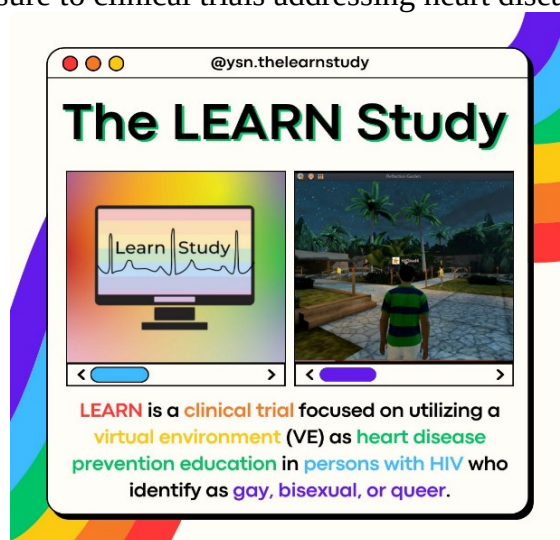
Table 3. HIV Care Expert Selected Utterances about their Clients Risk for Comorbid Conditions

Theme	Utterances (HIV Care Experts)
High Risk for Comorbid Conditions	<p><i>“I’ve dealt with a lot of diabetes and hypertension dominating those areas. And, I deal with a lot of patients who are HIV positive and diabetes, and like the secondary factor that is a big concern to them...They haven’t learned yet...most of the people say that they’ve not learned what are the best options, as far as nutrition, to take care of their diabetes on top of their HIV. So, they’re focused on what they should or should not be eating.”</i> – HIV Care Expert Pseudonym Eric</p> <p><i>“..but another health issue that still didn’t come out. And it’s about liver disease. The</i></p>

	<i>population that I work with that are mostly over 45 to 50-years old, this sort of thing has developed. And, in the different part of the body or even cirrhosis, even those these people do not drink any alcohol, okay. So, I feel that it's another point to keep in mind."</i> – HIV Care Expert Pseudonym Lloyd
High Risk for Mental Health Conditions	<p><i>"I know we're talking a lot about more physical, although I do think depression is physical too. But, more physical illnesses, but depression is probably the, really, most common one I've heard about, you know, being either diagnosed with depression or anxiety disorder."</i> – HIV Care Expert Pseudonym Eric</p> <p><i>"I work with people who become, at least clinically depressed after their diagnoses. I was going to say that earlier as well. So, there may not actually be like a physical thing, but it certainly can develop into a physical thing, as someone falls into, I guess, a deep depression. Or, like they have these drug induced psychosis and stuff like that, which is quite possible for an HIV induced psychosis as well, you know, because you were recently, you know, diagnosed, that can kick up some things in that person that may have not necessarily been focused on earlier or identified earlier."</i> – HIV Care Expert Pseudonym Tyler</p>

Theme 3: Virtual Environment Features

We tested out features of the virtual environment, such as avatar customization, quests, and navigation to various districts (Figure 1). There was excitement around the privacy and anonymity of the platform, and avatar customization of the skin tone, hair color, and clothing. Participants were excited about the potential of meeting other participants who identified as gay or bisexual who were living with HIV. Information within the virtual environment was deemed interesting, engaging, and supportive of their identity. Participants commented about naming the bookstore after Marsha P. Johnson and the representation of pictures and content that were validating to race and ethnicity. Overall, accessibility of the virtual environment to ethnic and racial sexual minority men with HIV, who have not had prior exposure to clinical trials addressing heart disease prevention, was deemed as appealing.



Features	Key Activity Examples
1. Avatar	<ul style="list-style-type: none"> • Customize avatar • Engage anonymously with other participants
2. Quests	<ul style="list-style-type: none"> • Build knowledge about chronic illness prevention • Test knowledge • Earn tickets to customize avatar
3. Districts	<ul style="list-style-type: none"> • Lobby (Pharmacy and Bookstore #1) • Plaza (Fitness Center, Clothing Store, Bookstore #2) • Food Court (Restaurant, Grocery, Farmers Market) • Reflection Garden (Tranquil area)
4. Nurse-led health sessions*	<ul style="list-style-type: none"> • Virtual or video presentations focusing on heart health
5. Technical Support*	<ul style="list-style-type: none"> • Instructional guidebook on virtual environment use • Videos to enhance use of virtual environment • Online newsletter

Figure 1. Virtual environment features that will be accessible to individuals enrolled in the clinical trial

Note* Nurse led health sessions and technical support were not part of Phases 1 and 2.

Participants conveyed:

*“I don’t even think I could add anything else. I think just within itself I feel like it would be amazing because it’s so different. **Say maybe somebody wants information or wants to meet other people to discuss things, sometimes it can be nerve wracking or sometimes people aren’t ready to really put themselves out there like that. So, I think with having the avatar and having different spaces, like the library and the relaxation area is good because you could be who you would want to be with the avatar.** So, you’re comfortable to really put yourself out there. I think the concept is really good because some people aren’t as up front. It’s like **they still get to maintain their sense of privacy, but also get to interact with other people and get more knowledge** and stuff about things. Yes, I think it’s great the way it is.”* - Pseudonym: Ralph

*“I think that [privacy/anonymity] is important for **the simple fact that that people do enjoy their privacy.** I would say that’s great, because **I’m someone who plays online a lot, and I never am giving out my real name.** So, it’s always, this is my gamer tag, and if you want to chat, we can talk on this court where it makes things more private. You don’t have my number, but you can message me on there..”* – Pseudonym: Roman

*“I would love that [to use a VE as heart disease prevention], and honestly, for me, like I said, I’m very much a hands-on person. I love the idea of the experiencing new things. So, **you had me at, you know, the start of the [VE platform] pictures.**”* Pseudonym: Arai

“..I think that giving tips to us, how to take care of ourselves, better care of ourselves to prevent

certain illnesses. *I think it should be information about the type of foods to eat, you know vitamins, different tips of how to keep ourselves, you know, healthy.*” – Pseudonym: Kori

HIV care experts had favorable sentiment about the virtual environment. They focused on nutrition, avatar diversity, engagement with others, and pushing the envelope to extend the virtual environment to new areas in preventative screenings (Table 4).

Table 4. HIV Care Expert Feedback on Beta Testing the Virtual Environment
Utterances (HIV Care Experts)

*“I liked the avatar. I liked how it was easy to change to whether I wanted to be male or female. **Skin tone is important** wanted to wear something short, something long, it gave the options. So, it wasn't limited to just I have to be a girl or have to be a boy.....And I think that the areas are very colorful. **The Reflection area, it looked like a Tiki bar. So it makes you want to meet with people. So it's a good, it's visually appealing to say; hey, let's meet here...Some people are very uncomfortable talking about health messages or their own personal. But if you have an avatar and your avatar can ask questions, or a text box where questions pops up and you're in a group, and they're now competing with another group, it may be better to get messages coming from the avatar.**” – HIV Care Expert Pseudonym Emma*

*“..I definitely liked the areas. I think all the areas was nice. I think the game was well-developed. However, I think maybe **avatars should be maybe a little more reflective of the people using the games. Also, I think that... And I know that you guys are working on that this is something that you guys are working on. But changing the menu options and the pharmacy things, the things that people actually use.... I think it's definitely something that we would use with our clients. It's easy to navigate. The information is there. I mean I work with a lot of people who are undocumented. They have a hard time understanding English. The visual aspect of it is great. It is also something that we can use to keep our clients on track. So if we were able to customize it, I would customize it to questions that reflect the communities that we serve. Like, have you been taking your medication the past five days?** - HIV Care Expert Pseudonym Sequan*

*“For example, talking about aging with HIV. How does that look? The other comorbidities that can accompany HIV as well. As we get older, we have so many things that can... We are not as potent as we used to be when we were younger. So we are confronted with other comorbidities. And plus, HIV adds into that as well. So how does that look? So what are the other problems that we may have? **Also the screenings, what screenings are recommended based on particular times of your life? For example, the males doing their colonoscopy on time? It's recommended to do it at 45 now. It used to be 50. Are you receiving sexual vaccines? For example, you have Shingrix that protects you against Shingles. Will you have to take that a second time? For example, you have vaccines against pneumonia, and flu shots. And also, cognition. As we get older, you can have cases of dementia. You can have isolation. How do you meet other people of your age? How do you socialize? There are other things that can... I mean if you want to really push it to the limit, there are so many things that you can identify that can also make a difference.**” – HIV Care Expert Pseudonym Mario*

*“**I think that's a good use for it [the virtual environment], just being able to look at the calories and the ingredients in certain food items** and such. But also, what I think my favorite part was the gym and the health tips. So like in terms of basic, how much water intake you should have in a day, and information walking. I think one of the things it talked about was how to select a shoe and how to do things like that, for exercise. These are questions that people don't think about until they have to think about it. And so going there and finding that information I think is helpful. – HIV Care Expert Pseudonym Kayla*

*“**So by adding those varieties of cuisine, for example, like Italian, Caribbean, it's a way you're helping the person to manage their diet.**” – HIV Care Expert Pseudonym Kayla*



different choice, if they ever get a chance in the real life. For example, there is a food that you might not know about. And presenting it to you in the virtual, it's all right. I mean they might be more willing to try this. And also if you used to have something about like a food, now that you have the facts, would you want to try it? So I think that's going to be pretty helpful.

HIV Care Expert Pseudonym Porter

Phase 2 Usability and Beta Testing

All 10 participants were able to complete all 12 action items on the checklist (Figure 2).

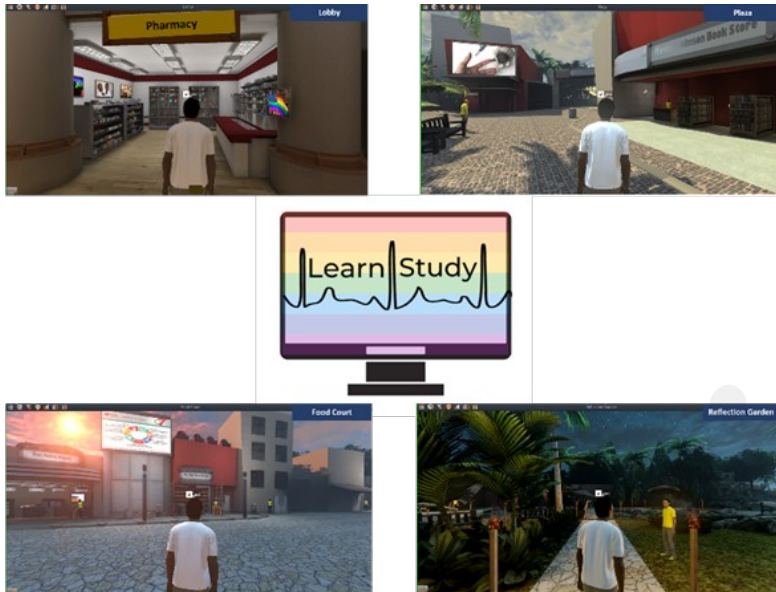
Virtual Environment Usability Checklist

- ☐ Use your avatar to walk and turn (arrow keys or A, W, S, D keys), run + up arrow (hold down shift key), and jump (ctrl key)
- ☐ Use the map to enter a different district ( symbol in upper left corner of screen)
- ☐ Use the microphone to say hello to others in the virtual environment (hold down Z)
- ☐ Read the nutrition information for 3 items in the food court menu
- ☐ Read about 2 different items in the pharmacy
- ☐ Speak with an avatar with an exclamation point over its head and complete a quest
- ☐ Sit on a bench or chair (click on chair to sit), and stand back (click on chair to stand)
- ☐ Hear the running water in the reflection garden
- ☐ Click on a link for a book from the bookstore
- ☐ Hear the music in the gym
- ☐ Click on a announcements board in the lobby and watch it change messages
- ☐ Customize your avatar's hair, skin, clothes, and shoes (Go to Game Options Menu  symbol in the upper left corner of screen > Character Customization)

Please see FAQ's for further information and tips

Figure 2. 12-item usability checklist

The reflection garden was the most enjoyed area by participants because it was the most serene. The fitness center received the most feedback for needing more equipment so that it was more realistic. The duration of time to completion of the checklist ranged 30 to 60 minutes. Those with more



technology experience were able

Figure 3. LEARN Virtual Environment 4 Districts (Lobby, Plaza, Food Court, Reflection Garden)

to navigate the checklist faster. Information within the virtual environment was deemed interesting, engaging, and supportive of their identity. Participants commented about naming the bookstore after Marsha P. Johnson and the representation of pictures and content that were validating to race and ethnicity (Figure 3). Overall, feedback from the usability and beta-testing of the virtual environment was favorable, but also contained constructive feedback for representation and diversity.

Selected utterances from the beta-testers included:

“I think the names [of the stores/restaurants] are really creative. And I like how some of them pay homage [to historical LGBTQ+ leaders] I think you guys can get creative with the graphics on these graphics here, because you've got a bookstore called the Marsha B. Johnson Bookstore. So it'd be nice if you could have maybe pictures of her on the slides, or historical figures on the slides. That would be cool. Yeah. That's pretty much it. I would just add that.” – Pseudonym: Justin

“Gay's Anatomy! I'm dying. I'm so down with this game. This is really cute. Okay.... Marsha P. Johnson Bookstore? Marsha P? Come on, honey. Stonewall and all, girl!..But the avatars, they need to be able to customize the body, too. Like make them bigger, if they want them to be bigger. Or make them skinnier if they want them to be skinnier. Because some people might come on something like this not just for the information, but like I said, to meet other people and maybe talk to other people. And I feel like they should be able to emulate themselves in this world like however they

want.” – Pseudonym: Beta4

“I would change the texture of the hair [on the avatars] and have more options of the shoes and colors of pants. His [the avatar] hair is more like one of them Backstreet Boys hair. What about curly? What about afro? What about braids” – Pseudonym: Felix

“I would be more interested in the trivia, simply because I can learn something new. And it’s easy to figure out, because I get explanations on why I’m right or wrong. And if I have questions about something, I can always go to a different section and be informed about my questions.”– Pseudonym: Silver

Discussion

The purpose of this study was to explore perceptions about HIV-related comorbidities and assess the usability of a virtual environment as CVD prevention education in Black and Latinx sexual minority men with HIV. We found that perceptions of health among participants were mixed and based on life context. Those who perceived their health in a positive light were motivated to practice enhanced health behaviors such as enhancing physical activity, medication adherence, and following clinician health recommendations, as a result of acquiring HIV. Negative sentiments towards health perceptions were reported due to personal relationships, being diagnosed with HIV during COVID-19, and economic social determinants that limited accessibility to LGBTQ+ health care specialists. Cancer was identified as a predominant illness of concern. There is an increased risk of cancers, other than AIDS-defining illnesses, among people with HIV and concern may be due to reported heredity factors as well as potential risk due to shared cancer-related risk factors. In a recent study by Bell and colleagues, CVD was associated with higher incidence of cancer, especially in persons with atherosclerotic CVD⁴⁹, which carries significant implications for mitigating barriers to preventative health screenings and raises considerations for cancer and multimorbidity in Black and Latinx sexual minority men with HIV.

With regard to the virtual environment, all participants, except one, were enthusiastic. We believe hesitancy in the remaining participant, was related to not having prior access or experience to evolving technologies, and unfamiliarity with the premise of using a virtual environment.

Participants with HIV were particularly open to the use of a virtual environment because they would assume the identity of an avatar, with a pseudonym, and would meet others who had shared characteristics and health goals. Participants were pleased about the potential to learn with others who were a part of the study, which is an important consideration in behavioral interventions as individuals build community around shared life experiences. We found the participants were interested and found the content desirable because we named the bookstore after Marsha P. Johnson (a Black, transgender woman who was a pioneer and activist for gay and transgender rights), included positive visualizations of ethnic and racial sexual minority men, queer love, and pride. This was important to validate and affirm the existence of the participants. These types of visualizations are uncommon in public areas of the United States and are banned in certain states. Providing a virtual environment that celebrates ethnic and racial LGBTQ+ individuals and legacy activists was deemed as acceptable and wanted.

HIV care experts are trusted individuals who worked with the community and have keen insights into their needs, challenges, and opportunities to enhance cardiovascular health. Their lived and professional experiences working with ethnic, racial, and sexual minoritized individuals enhanced our understanding about the intersectionality of race, ethnicity, HIV serostatus, and CVD risk in relation to community needs.

Prevention of comorbidities in persons with HIV is complicated due to historic and ongoing barriers to health equity in health care and research²⁰ that disproportionately target racial and ethnic, sexual minority, and other marginalized populations¹¹. CVD prevention is also challenging because individuals are required to become proficient in a variety of lifestyle behaviors to enhance cardiovascular health and to incorporate these into their everyday lives⁵⁰. Our study findings suggested favor towards the use of a virtual environment as CVD prevention education in ethnic and racial sexual minority men with HIV. These findings are in alignment with a 2019 survey conducted by the AARP (formerly called the American Association of Retired Persons), suggesting that 50% of

African American and 42% of Latino persons ages 50+ played video games^{51,52}. The two prominent reasons for engaging in video game play was for entertainment and to maintain mental sharpness^{51,52}. Moreover, other studies have used virtual environments (defined as 3D computerized environments with avatars), for risk reduction in adolescents^{53,54}, diabetes self-management^{37,55}, and cardiac rehabilitation⁵⁶, yet none have focused on CVD prevention in persons with HIV. Recommendations from a systematic review identified the need for future research on gamification for CVD prevention to include: 1) larger sample sizes; 2) experimental designs; 3) objective measures; 4) and incorporate behavior change frameworks⁵⁷. Our qualitative study, used to inform our future clinical trial³³, directly responds to the need to develop novel, widely applicable strategies to address cardiovascular health equity using a virtual environment for individuals from a variety of minoritized racial/ethnic groups with HIV, particularly those who might otherwise lack access to clinical trial research.

Limitations

First, although our sample size was in alignment with qualitative guidelines, small sample sizes limit generalizability. However, the diverse participant sample and inclusion of HIV care experts provided insights about perceived CVD, other comorbid risks, and potential for a virtual environment as a behavioral CVD prevention modality. This type of data has not been captured in previous studies from an exclusive participant sample of economically marginalized, ethnic and racial sexual minority men with HIV. Second, using qualitative methods we are unable to demonstrate causality⁵⁸. However, we followed established criteria for ensuring rigor during data collection⁵⁸ and obtained over 80 pages of qualitative data. A strength of qualitative data collection was the ability to gain high-quality contextual insights and details into HIV comorbidities of concern and assess usability and verbal reactions about the virtual environment, which would not be obtainable using survey methods. Third, recruitment bias is a potential limitation. We minimized recruitment bias by adhering to our prespecified inclusion criteria.

Conclusions

We identified several comorbid conditions of concern and findings carry significant implications for mitigating barriers to preventative health screenings in Black and Latinx sexual minority men with HIV given the shared risk factors between HIV and related comorbidities. Highly rated aspects of the virtual environment were anonymity, the ability to meet others who identify as gay or bisexual with HIV, validating LGBTQ+ inclusive images and content, and accessibility to CVD prevention education. Critical end-user feedback from beta-testing suggested more options for avatar customization in skin, hair, body representation. We will apply these recommendations and others in Phase 3 to formally test the virtual environment in the subsequent clinical trial.

References

1. Martin SS, Aday AW, Almarzooq ZI, et al. 2024 Heart Disease and Stroke Statistics: A Report of US and Global Data From the American Heart Association. *Circulation*.
2. Tsao CW, Aday AW, Almarzooq ZI, et al. Heart disease and stroke statistics—2023 update: a report from the American Heart Association. *Circulation*. 2023;147(8):e93-e621.
3. Feinstein MJ, Bahiru E, Achenbach C, et al. Patterns of cardiovascular mortality for HIV-infected adults in the United States: 1999 to 2013. *The American journal of cardiology*. 2016;117(2):214-220.
4. Losina E, Hyle EP, Borre ED, et al. Projecting 10-year, 20-year, and lifetime risks of cardiovascular disease in persons living with human immunodeficiency virus in the United States. *Clinical Infectious Diseases*. 2017;65(8):1266-1271.
5. Althoff KN, McGinnis KA, Wyatt CM, et al. Comparison of risk and age at diagnosis of myocardial infarction, end-stage renal disease, and non-AIDS-defining cancer in HIV-infected versus uninfected adults. *Clinical Infectious Diseases*. 2015;60(4):627-638.
6. Smit M, Brinkman K, Geerlings S, et al. Future challenges for clinical care of an ageing population infected with HIV: a modelling study. *The Lancet infectious diseases*. 2015;15(7):810-818.
7. Hsue PY, Waters DD. Time to recognize HIV infection as a major cardiovascular risk factor. In. Vol 138: Am Heart Assoc; 2018:1113-1115.
8. Diaz CL, Shah NS, Lloyd-Jones DM, Khan SS. State of the nation's cardiovascular health and targeting health equity in the United States: a narrative review. *JAMA cardiology*. 2021;6(8):963-970.
9. Caceres BA, Ancheta AJ, Dorsen C, Newlin-Lew K, Edmondson D, Hughes TL. A population-based study of the intersection of sexual identity and race/ethnicity on physiological risk factors for CVD among US adults (ages 18–59). *Ethnicity & health*. 2020:1-22.
10. Thayer JF, Carnevali L, Sgoifo A, Williams DP. Angry in America: Psychophysiological responses to unfair treatment. *Annals of Behavioral Medicine*. 2020;54(12):924-931.
11. Caceres BA, Streed Jr CG, Corliss HL, et al. Assessing and addressing cardiovascular health in LGBTQ adults: a scientific statement from the American Heart Association. *Circulation*. 2020;142(19):e321-e332.
12. McEwen BS, Stellar E. Stress and the individual: Mechanisms leading to disease. *Archives of internal medicine*. 1993;153(18):2093-2101.

13. Geronimus AT. The weathering hypothesis and the health of African-American women and infants: evidence and speculations. *Ethnicity & disease*. 1992;207-221.
14. Seeman TE, Singer BH, Rowe JW, Horwitz RI, McEwen BS. Price of adaptation—allostatic load and its health consequences: MacArthur studies of successful aging. *Archives of internal medicine*. 1997;157(19):2259-2268.
15. Duong MT, Bingham BA, Aldana PC, Chung ST, Sumner AE. Variation in the calculation of allostatic load score: 21 examples from NHANES. *Journal of racial and ethnic health disparities*. 2017;4:455-461.
16. Fazeli PL, Waldrop-Valverde D, Yigit I, et al. An exploratory study of correlates of allostatic load in older people living with HIV. *Journal of acquired immune deficiency syndromes (1999)*. 2020;83(5):441.
17. Hill LK, Thayer JF. The autonomic nervous system and hypertension: ethnic differences and psychosocial factors. *Current cardiology reports*. 2019;21:1-9.
18. Hill LK, Hoggard LS, Richmond AS, Gray DL, Williams DP, Thayer JF. Examining the association between perceived discrimination and heart rate variability in African Americans. *Cultural Diversity and Ethnic Minority Psychology*. 2017;23(1):5.
19. Williams DP, Joseph N, Hill LK, et al. Stereotype threat, trait perseveration, and vagal activity: evidence for mechanisms underpinning health disparities in Black Americans. *Ethnicity & health*. 2019;24(8):909-926.
20. Ramos SR, Warren R, Shedlin M, Melkus G, Kershaw T, Vorderstrasse A. A framework for using eHealth interventions to overcome medical mistrust among sexual minority men of color living with chronic conditions. *Behavioral Medicine*. 2019;45(2):166-176.
21. Muncan B. Cardiovascular disease in racial/ethnic minority populations: illness burden and overview of community-based interventions. *Public health reviews*. 2018;39(1):1-11.
22. Ramos SR, O'Hare OM, Colon AH, et al. Purely Behavioral: A Scoping Review of Nonpharmacological Behavioral and Lifestyle Interventions to Prevent Cardiovascular Disease in Persons Living With HIV. *Journal of the Association of Nurses in AIDS Care*. 2021;32(5):536-547.
23. Fredriksen-Goldsen KI, Simoni JM, Kim H-J, et al. The health equity promotion model: Reconceptualization of lesbian, gay, bisexual, and transgender (LGBT) health disparities. *American Journal of Orthopsychiatry*. 2014;84(6):653.
24. Ramos SR, Lardier Jr DT, Opara I, et al. Intersectional effects of sexual orientation concealment, internalized homophobia, and gender expression on sexual identity and HIV risk among sexual minority men of color: A path analysis. *The Journal of the Association of Nurses in AIDS Care*. 2021;32(4):495.
25. Caraballo C, Ndumele CD, Roy B, et al. Trends in racial and ethnic disparities in barriers to timely medical care among adults in the US, 1999 to 2018. Paper presented at: JAMA Health Forum2022.
26. Commodore-Mensah Y, Loustalot F, Himmelfarb CD, et al. Proceedings from a National Heart, Lung, and Blood Institute and the Centers for Disease Control and Prevention workshop to control hypertension. *American journal of hypertension*. 2022;35(3):232-243.
27. Entrup P, Garcia S, Hall OT. Bilingual Care in Clinical Trials—Understanding the Need for Expanded Research in Latino Communities. *JAMA Network Open*. 2023;6(5):e2314860-e2314860.
28. Turner BE, Steinberg JR, Weeks BT, Rodriguez F, Cullen MR. Race/ethnicity reporting and representation in US clinical trials: a cohort study. *The Lancet Regional Health—Americas*. 2022;11.
29. Khera R, Butte AJ, Berkwits M, et al. AI in Medicine—JAMA's Focus on Clinical Outcomes, Patient-Centered Care, Quality, and Equity. *JAMA*. 2023.
30. Dhingra LS, Shen M, Mangla A, Khera R. Cardiovascular Care Innovation through Data-

- Driven Discoveries in the Electronic Health Record. *The American Journal of Cardiology*. 2023;203:136-148.
31. Johnson AE, Routh S, Taylor CN, et al. Developing and implementing an mHealth heart failure self-care program to reduce readmissions: randomized controlled trial. *JMIR cardio*. 2022;6(1):e33286.
 32. Dunn J, Runge R, Snyder M. Wearables and the medical revolution. *Personalized medicine*. 2018;15(5):429-448.
 33. Ramos SR, Johnson C, Melkus G, et al. Cardiovascular Disease Prevention Education Using a Virtual Environment in Sexual-Minority Men of Color With HIV: Protocol for a Sequential, Mixed Method, Waitlist Randomized Controlled Trial. *JMIR Research Protocols*. 2022;11(5):e38348.
 34. Vorwerg S, Stamm O, Mueller-Werdan U. Movement training in augmented reality for older adults with essential hypertension: a qualitative study determining training requirements. *Games for Health Journal*. 2020;9(6):436-445.
 35. Johnson C, Feinglos M, Pereira K, et al. Feasibility and preliminary effects of a virtual environment for adults with type 2 diabetes: pilot study. *JMIR research protocols*. 2014;3(2):e3045.
 36. Ruggiero L, Moadsiri A, Quinn LT, et al. Diabetes island: preliminary impact of a virtual world self-care educational intervention for african americans with type 2 diabetes. *JMIR Serious Games*. 2014;2(2):e3260.
 37. Vorderstrasse AA, Melkus G, Pan W, Lewinski AA, Johnson CM. Diabetes LIVE (Learning in Virtual Environments): Testing the efficacy of self-management training and support in virtual environments (RCT Protocol). *Nursing research*. 2015;64(6):485.
 38. Stamm O, Vorwerg S, Haink M, Hildebrand K, Buchem I. Usability and Acceptance of Exergames Using Different Types of Training among Older Hypertensive Patients in a Simulated Mixed Reality. *Applied Sciences*. 2022;12(22):11424.
 39. Lloyd-Jones DM, Allen NB, Anderson CA, et al. Life's Essential 8: Updating and Enhancing the American Heart Association's Construct of Cardiovascular Health: A Presidential Advisory From the American Heart Association. *Circulation*. 2022;10.1161/CIR.0000000000001078.
 40. Ramos SR, Fraser M, Araya F, et al. Community-engaged Intervention Mapping for CVD-prevention in Black and Latinx Sexual Minority Men with HIV in New York City: Protocol for A Web-based Mixed Method Study. *JMIR Research Protocols*. 2022.
 41. Sandelowski M. Sample size in qualitative research. *Research in nursing & health*. 1995;18(2):179-183.
 42. Francis JJ, Johnston M, Robertson C, et al. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology and health*. 2010;25(10):1229-1245.
 43. Creswell JW, Creswell JD. *Research design: Qualitative, quantitative, and mixed methods approaches*. Sage publications; 2017.
 44. Speziale HS, Streubert HJ, Carpenter DR. *Qualitative research in nursing: Advancing the humanistic imperative*. Lippincott Williams & Wilkins; 2011.
 45. Creswell JW, Poth CN. *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications; 2016.
 46. O'Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. *Academic medicine*. 2014 Sep 1;89(9):1245-51.
 47. Valacich J, George J, Hoffer J. *Essentials of systems analysis and design*. Prentice Hall Press; 2014.
 48. Hertzog MA. Considerations in determining sample size for pilot studies. *Research in nursing & health*. 2008;31(2):180-191.

49. Bell CF, Lei X, Haas A, et al. Risk of cancer after diagnosis of Cardiovascular Disease. *JACC: CardioOncology*. 2023.
50. Riegel B, Lee CS, Dickson VV. Self care in patients with chronic heart failure. *Nature reviews cardiology*. 2011;8(11):644-654.
51. AARP. Gaming Gains. *AARP Spotlights* 2020; https://www.aarp.org/content/dam/aarp/research/surveys_statistics/technology/2020/hispanics-video-games-trends.doi.10.26419-2Fres.00328.004.pdf. Accessed July 24, 2021.
52. AARP. Gaming - more than just entertainment. 2020; https://www.aarp.org/content/dam/aarp/research/surveys_statistics/technology/2020/african-american-video-games-trends.doi.10.26419-2Fres.00328.003.pdf.
53. Fiellin LE, Kyriakides TC, Hieftje KD, et al. The design and implementation of a randomized controlled trial of a risk reduction and human immunodeficiency virus prevention videogame intervention in minority adolescents: PlayForward: Elm City Stories. *Clinical Trials*. 2016;13(4):400-408.
54. Fiellin LE, Hieftje KD, Pendergrass TM, et al. Video game intervention for sexual risk reduction in minority adolescents: randomized controlled trial. *Journal of medical Internet research*. 2017;19(9):e8148.
55. Vorderstrasse A, Melkus GD, Feinglos M, et al. Virtual environment for diabetes self-management education and support: Preliminary RCT outcomes. *Circulation*. 2017;136(suppl_1):A17519-A17519.
56. Brewer LC, Kaihoi B, Zarling KK, Squires RW, Thomas R, Kopecky S. The use of virtual world-based cardiac rehabilitation to encourage healthy lifestyle choices among cardiac patients: intervention development and pilot study protocol. *JMIR research protocols*. 2015;4(2):e4285.
57. Davis AJ, Parker HM, Gallagher R. Gamified applications for secondary prevention in patients with high cardiovascular disease risk: A systematic review of effectiveness and acceptability. *Journal of Clinical Nursing*. 2021.
58. Raskind IG, Shelton RC, Comeau DL, Cooper HL, Griffith DM, Kegler MC. A review of qualitative data analysis practices in health education and health behavior research. *Health Education & Behavior*. 2019;46(1):32-39.

Acknowledgements:

This study was funded by the National Heart, Lung, and Blood Institute K01HL145580 and the Yale Fund for Lesbian and Gay Studies (PI: Ramos). The funding organizations had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

We acknowledge and thank our community partners and study participants for their engagement and feedback during the phases of data collection. We also would like to thank Maame-Owusua Boateng MPH and Lauren Chin MPH for their assistance with data analysis; Lauren Chin MPH and Harry Kim RN BSN for their assistance with usability checklist pilot testing.

Data Availability Statement:

The data presented may be available upon reasonable request to the corresponding author.

Use of Artificial Intelligence:

AI or AI-assisted tools were not used in drafting any aspect of this manuscript.



Supplementary Files

Untitled.

URL: <http://asset.jmir.pub/assets/0f258872c8200aa0d0f54935c75592ce.docx>

Untitled.

URL: <http://asset.jmir.pub/assets/7b789ff11e9ec0600b4a15590d4ea068.docx>

Untitled.

URL: <http://asset.jmir.pub/assets/dc3e46448a01c7f895dfb190e9bafdc5.docx>