Original Research Article

Journal of the International Association of Providers of AIDS Care
Volume 24: 1-11

DOI: 10.1177/23259582251343669
journals.sagepub.com/home/jia
Sage

Healthcare Providers' Perspective on HIV Testing and Hypothetical mHealth-connected Linkage to Care Among Men who have Sex with Men (MSM) in South Carolina

Tony Brown, PhD[1], Prince Nii Ossah Addo, PhD[2], Monique J. Brown, PhD[2,3,4,5,6], Xiaoming Li, PhD[3,7], and Oluwafemi Adeagbo, PhD[8,9]

Abstract

Background: HIV continues to be an important public health concern in South Carolina (SC). However, an examination of providers' willingness to use mHealth technologies to address ongoing barriers to HIV care and prevention strategies, particularly among men who have sex with men (MSM) is currently lacking in SC. We therefore explored HIV care providers' perceptions of HIV testing and treatment uptake among MSM, and providers' willingness to use mHealth technology to address barriers to HIV testing and treatment in SC.

Methods: Between August and December 2021, we conducted semistructured virtual interviews with 10 HIV care providers recruited purposively based on their experience (2-11 years of service) providing HIV-related services to MSM in peri-urban ($n = 7$) and rural ($n = 3$) SC. The interviews were audio recorded, lasted 40–70 min, and were transcribed verbatim. The interview transcripts were analyzed inductively.

Results: Five themes emerged from the analysis: (a) challenges to HIV testing services; (b) concerns about HIV knowledge and status in the MSM community; (c) mixed feelings about HIV self-testing; (d) providers' perception of HIV treatment uptake and retention; and (e) potential of mHealth technology for the delivery of HIV care. Overall, participants reported limited resources, homophobia, medical mistrust, distance, medical costs, and HIV-related stigma as major barriers to HIV testing and treatment uptake in their localities (especially in rural areas). Particularly, they reported that MSM experience significant stigma associated with their sexual orientation and HIV.

Conclusions: Given barriers to care such as stigma and lack of access to care still impede MSM from receiving appropriate HIV services, mHealth-connected approaches could potentially address the barriers to HIV testing and care among MSM and improve their health outcomes. This is key to ending the HIV epidemic in SC and the United States by 2030.

[1]Department of Health Services, Policy, and Management, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[2]Department of Epidemiology and Biostatistics, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[3]South Carolina SmartState Center for Healthcare Quality, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[4]Rural and Minority Health Research Center, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[5]Office for the Study on Aging, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[6]Centre for Health Systems Research & Development, University of the Free State, Bloemfontein, SC, USA
[7]Department of Health Promotion, Education, and Behavior, Arnold School of Public Health, University of South Carolina, Columbia, SC, USA
[8]Department of Community and Behavioral Health, College of Public Health, University of Iowa, Iowa City, IA, USA
[9]Department of Sociology, Faculty of Humanities, University of Johannesburg, Johannesburg, South Africa

Corresponding Author:
Oluwafemi Adeagbo, Department of Community and Behavioral Health, College of Public Health, University of Iowa, 145 N Riverside Drive, Iowa City, IA 52242 Iowa City, IA, USA.
Email: oluwafemi-adeagbo@uiowa.edu

Keywords
mHealth, HIV testing, MSM, healthcare providers, qualitative

Received: 26 November 2024; revised: 26 March 2025; accepted: 30 April 2025

Introduction

HIV Epidemic in South Carolina

HIV continues to be an important public health concern in the United States, especially in the South.[1–3] According to the Centers for Disease Control and Prevention (CDC), the US South accounted for 52% of new HIV infections in 2021.[4] The Southern US also had the highest rates of HIV-related mortality and morbidity.[1] The disproportionate impact of HIV in the South has persisted. Factors associated with the disproportionate burden of HIV in the US South include high levels of HIV-related stigma, poverty, incarceration, sexually transmitted infections (STIs), racial/ethnic disparities, access to medical care, rurality, and southern culture.[1,2]

South Carolina (SC) is one of the southern states experiencing this high burden of HIV. According to a 2022 report from the SC Department of Public Health (DPH), the HIV epidemic in this primarily rural state disproportionately affects men and individuals of Black race/ethnicity.[5] Although individuals of Black race/ethnicity make up only 27% of the population, they accounted for 65% of the HIV prevalence and 55.4% of new HIV diagnoses in 2021.[5] The rate of HIV diagnosis among Black males is six times that of white males, and male-to-male sexual contact accounted for 85.9% of new HIV transmission among men in 2021.[6] Therefore, addressing the needs of the Men who have sex with men (MSM) population is important in SC's fight against the HIV epidemic.

Although there has been some reduction in the number of new HIV diagnoses in SC from 2018 to 2021, there is still much work to be done to meet the goal of ending the HIV epidemic in SC and the United States. Ending the HIV epidemic (EHE) is a federal initiative to end the HIV epidemic in the United States by 2030.[7] South Carolina is one of the priority states for the EHE initiative.[8] Ending the HIV epidemic in SC will require the provision of effective HIV prevention and treatment services, particularly for MSM. Therefore, the perspectives of HIV healthcare providers are crucial in addressing concerns with conventional and burgeoning testing methodologies.

Reiterated, HIV disproportionately affects MSM across the United States with high prevalence in the South.[9] MSM are 83% times likely to be infected with HIV than heterosexual men due to individual, interpersonal, and structural risk factors.[10,11] HIV testing is crucial to halting the persistent HIV transmission in MSM. Particularly, MSM residing in the US South, especially those living in rural regions, may experience specific access barriers to HIV services and health systems issues such as systemic racism.[9] Previous studies have reported that common factors inhibiting the uptake of HIV testing among MSM were concerns about stigma, confidentiality, and inconvenience associated with clinic-based testing.[9,12,13] Specifically, HIV-related stigma is a major barrier inhibiting MSM access to HIV testing, prevention, or treatment in the South.[9,14,15] Past studies reported that MSM were less likely to access HIV testing service, pre-exposure prophylaxis (PrEP), and less likely to reveal their sexual identity and sexual behaviors to health providers due to stigma.[16–19] Notably, HIV testing is low among MSM (especially African American and Hispanic MSM) and innovative approaches such as HIV self-testing (HIVST) have been demonstrated to address some barriers such as health system mistrust and stigma that impede of HIV testing uptake among priority populations.[20,21] Furthermore, HIVST has been evidenced as a vital approach for increasing the uptake and frequency of HIV testing among key populations, such as MSM.[22] The private and convenient nature of HIV self-testing helps overcome structural and individual (fear of stigma and discrimination) barriers to HIV testing among key populations.[23–26] Also, research has shown that the frequent use of HIVST may encourage regular testing and potentially facilitate linkage to care.[21] Despite the potential of HIVST, studies have revealed that it is not sufficient to link users to further HIV care, such as antiretroviral therapy (ART) or pre-exposure prophylaxis (PrEP).[25,27] A recent global systematic review and meta-analyses found that HIVST interventions alone did not increase linkage to care, to ART or PrEP.[27] HIV self-testing could, therefore, support the HIV prevention efforts in South Carolina by reaching those less likely to participate in conventional HIV testing methods.

Mobile Health (mHealth) Connected Apps for HIV Testing and Care

Studies reviewing the utility and preference for HIV self-testing among MSM have identified various challenges with the testing methodology, including a failure to provide appropriate follow-up for counseling and results, preference, and a potential delay in linkage to care.[25,28] However, mHealth-connected interventions (text messaging and mobile applications) have been shown to address

many of these issues by increasing the likelihood of follow-up for counseling and results, as well as improving acceptability among MSM in the United States.[21,28–31] There is a significant growth in the use of mHealth to decentralize access to healthcare services. Several studies (including reviews) have reported the use of mHealth interventions, such as text messaging or social media, to support disease management (eg diabetes) and ART.[32–34] mHealth interventions are complicated and need to involve prospective users and healthcare professionals in their development to increase the uptake of interventions using mobile electronic devices, such as mobile phones, to deliver healthcare services and circumvent unintentionally worsening health inequity.[35,36] Past studies highlighted the potential of combining HIVST and mHealth interventions to increase HIV testing among high-risk MSM in the United States.[12,29,37] For instance, three randomized controlled trials conducted among MSM that employed mHealth interventions reported a significant increase in HIV testing among participants in the intervention group compared to the control group.[14–16] Another study reported that MSM found mHealth interventions for HIV testing were preferred over conventional self-testing, as well as determining that the duration of follow-up was appropriate.[25] Similarly, literature on mHealth interventions aimed at supporting HIV treatment adherence reported improvements in viral load, CD4+ count, pill count, and self-reported adherence to treatment via mHealth interventions.[17–19]

Furthermore, there is strong evidence showing that getting people living with HIV (PLWH) into treatment and helping them remain on treatment to achieve viral suppression is an effective way of controlling the further spread of HIV.[38,39] Several challenges make it difficult for MSM to engage and remain in HIV care. However, studies have shown that mobile health applications (mHealth) can support MSM along the HIV treatment cascade and help them to successfully engage in every step of the cascade, particularly from HIV testing[30,40] to treatment adherence.[41,42] Although mHealth has the potential to reduce barriers to HIV preventive strategies, some studies have reported that MSM are wary of using mHealth interventions due to confidentiality concerns, risk of HIV stigma, and data safety.[24,43] Thus, despite its potential to decentralize care and support HIV testing, research has shown that mHealth interventions should be integrated with other interventions as it is insufficient to overcome some barriers to HIV testing and care services at fixed clinics.[34] An examination of providers' willingness to use novel approaches that seek to address ongoing barriers to HIV care and prevention strategies is currently lacking in SC. To provide needed HIV services to MSM in SC, it is important to gain a better understanding of SC's current HIV situation, the barriers and facilitators of HIV care and treatment services, as well as opportunities for expanding HIV services to reach this priority population. This study, therefore, explored HIV care providers' views of HIV testing and treatment uptake among MSM, as well as providers' willingness to use mHealth technology to overcome existing barriers to HIV testing and treatment in SC.

Methods

Sampling and Description of Participants

Ten (6 males and 4 females) healthcare providers (aged 24-40 years) were recruited purposively based on their experience (2-11 years of service) providing HIV-related services to MSM in peri-urban ($n = 7$) and rural ($n = 3$) SC. Five participants identified as heterosexual, while the other five identified as gay men. Eight of the providers identified as non-Hispanic Black, one identified as Hispanic Asian, and the other biracial. The interviewer (TB) has years of experience working in community-based settings in South Carolina as well as for the state health department. Through professional networking channels and word of mouth, the interviewer identified HIV service providers who had experience working with MSM in SC. None of the participants had any prior knowledge about the study and researchers except for the principal investigator's (PI) contact information (email address and office telephone number) in the recruitment materials.

Eligibility

To be eligible for the study, the participants must have provided HIV/STI-related services for at least a year prior to the interview to MSM, including HIV testing, HIV care, pre-exposure prophylaxis (PrEP), and STI screenings in either clinical or nonclinical settings in SC. The sample is representative of both clinicians and nonclinicians and specifically includes peer navigators, community health workers, Ryan White case managers, administrators of community-based organizations (program managers), nurses, and an infectious disease physician. All the program managers in our study provide care (HIV testing, STI screening, medication adherence, or case management) alongside their administrative roles.

Data Collection

After the verbal informed consent was taken and audio-recorded, virtual (with Zoom technology) semistructured interviews were conducted (August–December 2021) with a purposive sample of 10 HIV care providers (24-40 years old) ranging from peer navigators to infectious disease physicians in SC. The interviews were conducted by a trained graduate research assistant (TB) fluent in English and skilled in qualitative data collection under the guidance of the study PI (OA). TB (Black male) was a doctoral student at the time

of the study, and OA (Black male) obtained a PhD in Sociology and has over a decade of experience conducting both qualitative and quantitative research. OA and TB had previous research experience with HIV providers and LGBTQIA+ persons and did not consider their gender or sexual orientation had any significant impact on participant recruitment or the interviews. The interviews were between only the interviewee and the interviewer, audio-recorded and lasted between 40 and 70 min (55 min on average). We opted for virtual interviews to adhere to COVID-19 precautions. Participants were asked about their general experience with their employment and their perspectives on the following themes and their impact in the MSM community: HIV testing, antiretroviral use and retention in care, PrEP uptake and utilization, COVID-19, telehealth, HIV self-testing, and a hypothetical mHealth-connected HIV self-testing technology. Participants were provided with adequate information about the study, and they were allowed to ask questions for clarification prior to their involvement in the study. This study was reviewed and approved by the Institutional Review Board of the University of South Carolina (Reference no: Pro00113232). Also, the reporting of this study conforms to the consolidated criteria for reporting qualitative research (COREQ) checklist.[44]

Data Analysis

The interviews were transcribed verbatim into text in English by Otter.ai and all identifying information were removed from the transcripts to protect confidentiality. The principal investigator (OA) reviewed the transcriptions for quality control, ensuring that no identifiable information was present in the final transcripts. The interview transcripts were coded manually and iteratively by two researchers (OA and TB) skilled in qualitative research methods. Emerging themes were identified and analyzed. We created a provider codebook informed by the interview guide, extracting perspectives related to the identified themes. The thematic analysis was guided by the six steps (ie, familiarization; coding; generating themes; reviewing themes; defining and renaming; and reporting) recommended by Braun and Clarke.[20] Notably, despite our recruitment efforts to recruit more healthcare professionals, only 10 were available and participated in the study. The 10 providers were sampled purposively based on the interviewer's experience working in community health organizations and the state government. The interviewer fostered these professional relationships prior to conducting the study. The providers were sampled in part due to their skillsets and work experience but also their lived experience in these communities. Lastly, due to time constraints, other potential providers were not available during the interviews. However, data saturation was reached with the analysis of 10 participants as recommended by Francis and colleagues.[45]

Results

Health providers who participated in the study had varying levels of experience (2-11 years of service) (Table 1). The HIV care providers' perspective was centralized on five main themes: (1) Challenges to HIV testing services; (2) Concerns about HIV knowledge and status in the MSM community; (3) Mixed feelings about HIV self-testing; (4) Providers perception of HIV treatment uptake and retention; and (5) Potential of mHealth for the delivery of HIV care. These perspectives were based on their experiences treating MSM and/or how they perceived other providers' impressions of the themes. The providers discussed multifold barriers and facilitators regarding these themes, many of which were expressed throughout multiple themes (Supplemental Table 1). We define the acronyms used in the result section as follows: participant (P), age (eg, 40 years), male (M), female (F), rural areas (R), and urban areas (U).

Challenges to HIV Testing Services

Throughout the interviews, many of the providers discussed HIV being highly represented in rural areas, along with the perceived consequences of stigma impacting those areas. These rural communities, many of which are considered healthcare deserts, lack the resources to provide HIV care services at a high capacity. Due to this lack of resources and accessibility, providers have had to be creative in providing HIV care services to the MSM community, as described by one participant:

> … It forces us to be a little bit more creative and think outside the box, hmm. Because we're in a rural area, in a sense, you have to think of how they're kind of like, get where they're at, and put yourself in those spaces. So, it's causing us to be more creative… (P06, 36, F, R)

Stigma in these areas greatly hinders HIV testing initiatives. As stated by a participant,

> We're developing our ability to test and we're finding it very difficult in this area because of stigma. So, there's a lot of stigma. There are a lot of barriers, especially as we go farther into the rural areas. Like I mentioned that one of my areas in the County … and that's almost a healthcare desert. But it's really difficult to get people to test in those areas. (P04, 40, F, U)

Concerns About HIV Knowledge and Status in the MSM Community

Many of the providers believe that a large swath of the MSM population in their area was unaware of their HIV status. As a result of stigma, lack of health literacy, and lack of resources, this group continues to be made

Table 1. Participant Characteristics of HIV Providers ($n = 10$).

Characteristic	*N* (%)
Age, years (mean, range)	34 (24-40)
Years of service (mean, range)	6 (2-11)
Gender	
Female	4 (40)
Male	6 (60)
Race/Ethnicity	
Asian, Hispanic	1 (10)
Biracial, non-Hispanic	1 (10)
Black/African American, non-Hispanic	8 (80)
Sexual identity	
MSM[a]	5 (50)
Heterosexual	5 (50)
Urban/Rural workplace	
Peri-urban	7 (70)
Rural	3 (30)
Employment position	
Community health worker	2 (20)
Infectious disease physician	1 (10)
Peer navigator	1 (10)
Program manager	5 (50)
Nurse	1 (10)

[a]MSM = men-who-have-sex-with-men.

vulnerable to HIV. Many of the antiquated notions of being diagnosed with HIV still exist:

> They're still great, great myths and theories that, first of all, HIV is a punishment. HIV is a gay man's disease. I've had one individual even tell me that when they tested positive, they had a family member, in so many words to tell them that, pretty much that's what they get, like, for being gay, like HIV is the gay man's punishment. So, for that reason, a lot of people are very resistant. They're very resistant to testing and knowing the status and whatever. (P07, 32, M, R)

A provider recounted recently having patients who believed that an HIV diagnosis was still a death sentence. There were many misconceived sentiments about HIV transmission and acquisition that the providers continually combat: "[fear that] I don't just have HIV, I have AIDS. And I'm gonna die. Like in the next year" (P01, 33, M, U)

Another perspective provided on HIV testing relates to social marketing and community outreach to MSM. Providers conveyed the need for continual community engagement with the MSM community to diminish structural barriers and medical mistrust. Specifically, the media in which these entities attempt to reach the population may not be effective or efficient in their purpose. The following excerpt captures this sentiment:

> I believe the government isn't doing what it needs to do to say that they're helping us stop the [HIV] pandemic. Yes, thank you for doing that big brother. Round of applause for you. But you're not actually taking that step with us to do that. It's only promoted, like, on a commercial, like, maybe once a day, twice a day. That's not enough. You don't promote it on the radio, like, I don't hear it on one or 104.7 or, or anything like that. The only time … is during Pride, really. Because that's just said, and they only do it on the gay apps…. Facebook as well. (P08, 24, M, U)

Overall, participants believe that addressing stigma and concerns about confidentiality and privacy and cultivating effective outreach efforts are paramount to increasing HIV testing in MSM populations across SC.

Mixed Feelings About HIV Self-Testing

HIV self-testing (HIVST) was discussed with the providers to gauge their perspectives while detailing the facilitators and barriers. The providers had very mixed reviews on using HIV self-testing in HIV prevention. Four of the providers believed that it was an additional tool in the toolkit of HIV prevention. This group expressed that HIVST has a role in diminishing barriers to HIV testing, such as issues with confidentiality, transportation, and stigma. One of the providers likened it to COVID-19 self-testing in that individuals would know their status and feel empowered. They stated, "people were empowered and still knew their status" (P10, 35, M, U)

Five of the providers disliked the idea of HIVST, particularly the providers with medical case management backgrounds. Although they reported that HIVST has the potential to reduce the previously mentioned barriers to HIV testing, they were concerned about the aftermath of the test. They described a scenario where an individual would have a positive test result using the self-test kit but would have no one to support them in that moment. Those with prior experience with individuals receiving an HIV diagnosis spoke of their clients' range of emotions after receiving their status. They felt it would be detrimental for their clients to receive it in that way:

> So, my background prior to this was in medical case management. So, the social service side of me have some reservations, personal reservations to someone who self-tests. Because I think there's a whole social aspect that happens, if someone has a positive result, I'm afraid of them having that positive result, and not being in the best mind frame at that time (P04, 40, F, R)

Disparity in access to HIVST kits is also a concern for some providers. While governmental and agency-funded programs supply HIVST kits across the state of SC for free per the consensus of the providers, individuals can still purchase the kits from a private retailer. Individuals

receiving kits from a government or agency-funded program may have to go through an approval process, causing a lag in time in receipt of the kit. Conversely, if an individual can afford the costs of a test kit at a retailer, they could buy as many as they prefer. One of the providers gave a scenario of a disparity in the availability of HIVST kits:

> It boils down to cost and education. So, you'll have that engineer who makes I don't know how much ever an engineer makes, lives in a nice house. Could have a stack of 20 test kits, whether it's over the counter or his provider just sends them, and he can afford to get them because he has insurance … it's not people of color [that can afford]…. We somehow have to figure out how to get past the disparities (P05, 40, F, U)

Providers Perception of HIV Treatment Uptake and Retention

The providers' perspective on antiretroviral therapy (ART) usage and retention in care for MSM was similar to that of HIV testing. They reiterated the impact of stigma, racial and gender-discordant staffing, and lack of access to medical services in rural areas. However, new themes were discussed in these conversations, such as ART injectables and Undetectable = Untransmittable (U = U) as advancements that have improved accessibility to HIV treatment. A representative quote from a participant describing their challenges reaching the MSM community:

> And for those who we've tested in the past, even prior to me coming here, and those who have been identified in the past, they're not interested in care in this community, they would rather drive an hour to care, because they're afraid of the stigma that's attached to it…It is hard to penetrate the community to gain the trust of the MSM community in these areas, because it's so small, everyone knows, everyone belongs to … faith is a big thing down here, their faith community … their church. And, you know, that's what I've been hearing a lot. Well, people from my church work there, and I don't want my name in your database (P04, 40, F, R)

Some providers not only mentioned that some HIV care providers are inexperienced in providing specialized treatment to PLWH, but that some of these providers and their clinics contribute to perceived feelings of stigma from patients. This sentiment was also paired with providers making assumptions about individual patients' susceptibility to HIV based on implicit biases:

> But that's not the culture of providers is more so like, I'm looking at you, you know, you work on Wall Street, your lawyer, your doctor, your teacher, whatever, I don't think you need an HIV test. For whatever reasons, I think some of it may just come from providers, maybe with their comfort, or you know, their perceptions and what services they think you may need (P03, 38, F, U)

Conversely, advancements in HIV treatment and care, such as ART injectables and Undetectable = Untransmittable (U = U), have changed the perception of living with HIV. The ART injectables assist in minimizing potential barriers for some patients who possibly struggle with adherence to a daily tablet. The respondents provided the following excerpts about U = U and ART injectables:

> It's an amazing thing, U = U (Undetectable = Untransmittable) and it takes away [fear] because I do have HIV positive folks who have not had sex since their diagnosis … [their] fear is like I don't want to do this to anybody else ever. So that [U = U] is so helpful for the mental health and the well-being of these positive patients who can't get out there and then for my heterosexual couples and trying to get kids and stuff, this is like amazing (P05, 40, F, U)

Testimonial from another provider shows that injectable ART could potentially facilitate HIV treatment uptake and retention:

> The HIV injection once a month, and you know, that's huge now, because, you know, I've had all the clients that I work with another issue, call me and be like, how do I get this injection? You know, because pill fatigue is real. So, people, you know, they tired of taking a pill every day, and it's nice to have that feeling of normalcy, I can go in once a month and you know, taking injections, I think that's a game changer (P04, 40, F, R)

Potential of mHealth for the Delivery of HIV Care

The providers were asked for their impressions of a hypothetical mHealth technology that links clients using HIV self-testing kits to medical or nonmedical care. The technology was described as a mobile application that allowed two-way communication between the provider and the user to discuss questions or issues with performing the test, interpreting the result, and reporting the test results back to the data-secure client portal. Compared to typical HIV self-testing, using mHealth-connected HIV testing was perceived to have many benefits. The providers highlighted the benefits of ensuring confidentiality, continuity of care, comfortability, ease in interpreting results, and two-way communication in patient care using the technology. They also reported that MSM would use this product, citing comfortability while completing it in privacy. They added that this type of technology would be useful in rural areas, particularly in reaching and engaging MSM in these communities with healthcare deserts:

> I think that will probably be really good. If there was an app like that, they will be able to flag the provider, and even give

> the option to the client, whoever is taking the test. They're like, hey, you know, this is who you can reach out to, you can reach out to for medical advice, or for just advice period in regard to HIV (P01, 33, M, U)

However, some providers discussed barriers to using the technology for their clients. These potential barriers include access to high-speed internet, the ability to reach vulnerable populations that may not be tech-savvy or older populations, and medical mistrust:

> Most use [would be] in our white population, we [would] see less use in the black population, because there's a lot of distrust in the healthcare system, especially putting your information in something I don't see, I don't think we will see much use, if at all, with the Hispanic population (P04, 40, F, R)

When asked to describe how other providers would receive the proposed technology, several providers said that they would be interested. There is much interest in using the technology due to its ability to create two-way communication between patient and provider and automatically collect test results. Conversely, some traditionalists do not trust using mHealth technologies or telehealth to treat their patients:

> I think people who sit on the fence about it, I feel like some of us are very traditional, like me, in my thinking sometimes where I'm like, I prefer to see person face to face. And I feel like there are some people who are more forthcoming and moving forward with technology (P01, 33, M, U)

Some had concerns about client's data security and suggested that there must be staffing capacity to handle mHealth program in clinical settings:

> I would say the biggest thing is just making sure that everybody's record stays anonymous, stay confidential, and that no identities are at risk of being or being exposed (P09, 28, M, U)

> It can feel frustrating, just tracking all of the people with the, you know, making sure all of this is correct. Are you the right person who took the test? Are you the right person who reported it, you know, it can feel like a lot of work. But it has to be a person who the goal and the mission of the project and be able to wait it out is stick through every barrier that comes through. So, I will say that a good bit of healthcare professionals that I have been in tune with, or engage with, we will probably be okay with it (P06, 36, F, R)

Finally, the providers were asked to describe the most important features to be considered when developing the mobile application. Some providers mentioned that educational videos could be posted in the app for individuals wanting to learn more about HIV, STIs, PrEP, and other related topics. They also suggested the app has a backend tracking mechanism to log communication, appointment setups and reminders, referrals, test results, medication refills, and other activities. This tracking would allow for data transfers to other electronic medical records (EMR). It was suggested that the test results be scanned using a QR code or barcode for the results to be viewed. This mechanism could help with reporting patient results back to the provider:

> If it showed their results and their previous results, and upcoming appointments and the providers…And if it was on there, and I can see that. And if I get PrEP that would also be on there too. Yeah, like that would be that would work. (P08, 24, M, U)

The mHealth technology could potentially address many of the barriers to traditional HIV care testing. The providers believed that other providers would use the product if afforded the proper resources to implement the program fully.

Discussion

This study presents findings regarding HIV care providers' perspectives of HIV testing and treatment uptake among MSM as well as their (providers') willingness to use mHealth technology to address the ongoing barriers to HIV testing (including HIVST) and treatment in SC. Overall, participants reported limited resources, homophobia, medical mistrust, distance, medical costs, and HIV-related stigma as major barriers to HIV testing and treatment uptake in their localities (especially in rural areas). They reported that MSM experience significant stigma associated with their sexual orientation and HIV. According to the providers, an HIV diagnosis is seen as a 'punishment' or 'death sentence' for gay people in some environments. In fact, some participants believe that most gay and bisexual men in their environment are unaware of their HIV status due to the prevalence of HIV stigma. This finding corresponds to the findings of other studies conducted among MSM in the Southern and Midwestern United States.[9,13,46] Participants highlighted the need for ongoing innovations in HIV care and prevention strategies that address the significant barriers to care that some MSM experience, such as stigma and lack of access to care. They emphasized that community-based organizations and governmental entities should be more creative in reaching the MSM community.[9,46]

Furthermore, our study participants had mixed feelings about the potential of HIVST in increasing the number of MSM knowing their HIV status. Half of the providers interviewed had concerns about HIV self-testing, such as

individuals neglecting to report positive test results, potential lost to follow-up, inaccurate results, and not having a supportive structure established for those with positive test results. While the current implementation of HIV self-testing may provide more individuals with a convenient method to know their HIV status, some providers felt it could lead to a furtherance of disconnected and out-of-care individuals. They highlighted that HIV service providers offer a supportive structure to those with positive test results by delivering and explaining the results as well as providing appropriate linkage to care in a conventional setting. These findings reflect previous studies in HIV care, which show that building a trusting and caring relationship with clients engenders positive therapeutic outcomes.[13,47] Also, the lack of appropriate and timely linkage to care after a reactive test result may increase the number of new infections.[20] Despite the concerns, US studies have found HIVST to improve HIV testing, especially among priority populations like MSM due to its privacy and confidentiality.[20,21,23,48]

Our study found that HIV care providers generally showed strong support for the development and use of mHealth technology that provides effective two-way communication between clients and providers to HIV care services following HIVST. Providers reported that mHealth-connected technologies would likely minimize barriers to care while addressing conventional HIV self-testing concerns. This finding is consistent with reports from prior studies.[21,28,49] A pilot randomized controlled trial conducted in the United States reported 100% HIV testing among MSM who used the eTEST app to support HIVST.[21] The eTEST app enabled HIV counsellors to track HIV self-kit mailed to participants in order to provide relevant support (including counselling and referrals to sexual health services) to anyone who opened the HIVST kit.[21] Similarly, a comprehensive literature review by LeGrand and colleagues reported multiple studies examining mHealth interventions that support HIV self-testing among MSM in the United States.[28] They found that mHealth interventions increased access to HIV self-testing and addressed many of the barriers pertaining to linkage, confidentiality, and stigma.[28] Other studies outside of the United States reported similar findings. An mHealth intervention program aimed at promoting oral HIV self-testing among MSM in China reported higher HIV testing rates compared to those who did not receive the intervention.[40] Another study conducted among MSM in Thailand reported a preference for online pretest counseling among individuals taking an HIV test for the first time.[50] Healthcare providers in the study used mobile phones and laptop computers to provide HIV counseling to some study participants, highlighting the possibility of expanding HIV testing and care using mHealth.[50] As telehealth has become a staple in many of the providers' daily operations since the COVID-19 pandemic, mHealth-connected technology could potentially utilize an established paradigm to operationalize the service, particularly in resource-limited settings.

Finally, there were some limitations to this study. The use of purposive sampling and a limited sample size may restrict the generalizability of the qualitative findings to other states or regions. However, the participants' experiences (especially those who identified as MSM) provided a unique perspective on the potential acceptability of an mHealth intervention among both providers and the MSM population. Additionally, some findings presented in this paper were based on a hypothetical mHealth intervention described to participants, rather than an evaluation of an actual app. Therefore, further research is needed to assess real-world acceptability and usage once the app is developed and implemented. Despite these limitations, a key strength of this study is that some providers' perspectives were informed not only by their extensive work experience in delivering care to MSM in South Carolina but also by their own lived experiences as gay men.

Conclusions

Participants in our study were aware of the barriers (eg, costs, distance, access, homophobia, and stigma) inhibiting the effective delivery and uptake of HIV testing and treatment by the MSM community in SC. Although they were excited about the idea of using HIV self-testing kits and mHealth intervention to decentralize HIV care in SC, some of them (especially those with a medical case management background) had mixed feelings about HIVST. Some providers were worried about disparity in access to HIVST kits and the unwillingness of some MSM to link to care after HIV diagnoses. Also, some providers were concerned that older populations, those with little or no digital literacy or those without access to high-speed internet may not benefit from the intervention. Given barriers to care such as stigma and lack of access to care still impede MSM from receiving appropriate HIV services, mHealth-based approaches could potentially address the barriers of HIV testing and linkage to care, thereby improving their health outcomes. This is key to ending the HIV epidemic in SC and the United States by 2030.

Acknowledgments

The authors are grateful to the manuscript's anonymous reviewers and the study participants. We are also thankful to Shakeem Jenkins, Bobby Rogers, and Joni Zwemer for study coordination.

ORCID iDs

Tony Brown https://orcid.org/0009-0004-3481-7905
Prince Nii Ossah Addo https://orcid.org/0000-0001-5859-

2983
Xiaoming Li https://orcid.org/0000-0002-5555-9034
Oluwafemi Adeagbo https://orcid.org/0000-0003-1462-9275

Ethical Considerations

This study was reviewed and approved by the Institutional Review Board of the University of South Carolina (Reference no: Pro00113232). The data were collected with the informed consent of the participants. All the researchers including interviewers received adequate training on research ethics such as confidentiality and voluntary participation. We ensured confidentiality at all levels of the research process and no participants' identifying information was used in any of our reports or presentations. Participants were provided with adequate information about the study, and they were allowed to ask questions for clarification prior to their involvement in the study. This study conforms to the ethical guidelines and standards of the University of South Carolina.

Consent to Participate

Verbal informed consent to participate was obtained and audio-recorded before the interview. Aldo, verbal permission to audio-tape the qualitative interviews was obtained from the participants and all data were kept secured in a password-protected computer.

Consent for Publication

Participants provided written and verbal consent for data collection and for publishing collected data under the protocol approved by the Institutional Review Board of the University of South Carolina (Reference no: Pro00113232).

Informed Consent

Participants provided verbal informed consent and inclusion of their de-identified data for publication. The informed consents were verbal and audio-recorded with the consent of the participants to limit human interactions and to adhere to COVID-19 precautions.

Author Contributions

OAA conceived the research idea. OAA and XL contributed to the research design. OAA and TB facilitated data collection. OAA, TB, and PA conducted the data analysis. OAA, TB, and PA drafted the manuscript, and all authors critically revised the manuscript. OAA supervised the entire review process.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Advanced Support Program for Innovative Research Excellence-I (ASPIRE), University of South Carolina, Columbia, United States (Grant no: 115400-21-56809).

Declaration of Conflicting Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The research was funded by the University of South Carolina Office of the Vice President for Research.

Data Availability Statement

The qualitative data analyzed for this manuscript are not publicly available. However, the corresponding author can make the data available upon reasonable request.

Supplemental Material

Supplemental material for this article is available online.

References

1. Reif SS, Whetten K, Wilson ER, et al. HIV/AIDS in the southern USA: A disproportionate epidemic. *AIDS Care*. 2014;26(3):351–359.
2. Reif S, Safley D, McAllaster C, Wilson E, Whetten K. State of HIV in the US deep south. *J Community Health*. 2017;42(5):844–853.
3. Control CfD, Prevention. HIV in the United States by Region: HIV Incidence. CDC website. Published May. 2022. August 11, 2022;3. https://www.cdc.gov/hiv/statistics/overview/incidence.html. Accessed October 9, 2023.
4. CDC. Fast Facts: HIV in the United States. May. 2024;14. https://www.cdc.gov/hiv/data-research/facts-stats/index.html. Accessed June 28, 2024.
5. Control SCDoHaE. HIV, AIDS, STD Data and Reports. 2024. Accessed June 28, 2024. https://scdhec.gov/hiv-aids-std-data-reports
6. AIDSVu. South Carolina. 2024. Accessed October 12, 2024. https://aidsvu.org/local-data/united-states/south/south-carolina/
7. Fauci AS, Redfield RR, Sigounas G, Weahkee MD, Giroir BP. Ending the HIV epidemic: A plan for the United States. *Jama*. 2019;321(9):844–845.
8. HIV.gov. Priority Jurisdictions: Phase I. Accessed October 12, 2023. https://www.hiv.gov/federal-response/ending-the-hiv-epidemic/jurisdictions/phase-one
9. Adeagbo O, Harrison S, Qiao S, Li X. Pre-Exposure prophylaxis (PrEP) uptake among black men who have sex with men (BMSM) in the southern U.S. *Int J Environ Res Public Health*. 2021;18(18):9715.
10. Mouhanna F, Castel AD, Sullivan PS, et al. Small-area spatial-temporal changes in pre-exposure prophylaxis (PrEP) use in the general population and among men who have sex with men in the United States between 2012 and 2018. *Ann Epidemiol*. 2020;49:1–7.
11. Hess KL, Hu X, Lansky A, Mermin J, Hall HI. Lifetime risk of a diagnosis of HIV infection in the United States. *Ann Epidemiol*. 2017;27(4):238–243.
12. Huang E, Marlin RW, Young SD, Medline A, Klausner JD. Using grindr, a smartphone social-networking application, to increase HIV self-testing among black and latino men who have sex with men in Los Angeles, 2014. *AIDS Educ Prev*. 2016;28(4):341–350.

13. Adeagbo O. Barriers and facilitators to pre-exposure prophylaxis uptake among black/African American men who have sex with other men in Iowa: COM-B model analysis. *Ther Adv Infect Dis.* 2024;11:20499361241267151.
14. Bauermeister JA, Meanley S, Pingel E, Soler JH, Harper GW. PrEP awareness and perceived barriers among single young men who have sex with men. *Curr HIV Res.* 2013;11(7):520–527.
15. Smith DK, Van Handel M, Grey J. Estimates of adults with indications for HIV pre-exposure prophylaxis by jurisdiction, transmission risk group, and race/ethnicity, United States, 2015. *Ann Epidemiol.* 2018;28(12):850–857. e9.
16. Dunville R, Harper C, Johns MM, et al. Awareness and willingness to use biomedical prevention strategies for HIV among sexual and gender minority youth: Results from a national survey. *J Adolesc Health*. 2021;68(1):199–206. doi:10.1016/j.jadohealth.2020.05.032
17. Arrington-Sanders R, Morgan A, Oidtman J, Qian I, Celentano D, Beyrer C. A medical care missed opportunity: Preexposure prophylaxis and young black men who have sex with men. *J Adolescent Health*. 2016;59(6): 725–728.
18. Frye V, Nandi V, Egan J, et al. Sexual orientation-and race-based discrimination and sexual HIV risk behavior among urban MSM. *AIDS Behav.* 2015;19(2):257–269.
19. Garofalo R, Mustanski B, Johnson A, Emerson E. Exploring factors that underlie racial/ethnic disparities in HIV risk among young men who have sex with men. *J Urban Health.* 2010;87(2):318–323.
20. Wray TB, Chan PA, Klausner JD, et al. Etest: A limited-interaction, longitudinal randomized controlled trial of a mobile health platform that enables real-time phone counseling after HIV self-testing among high-risk men who have sex with men. *Trials*. 2020;21(654):1–13.
21. Wray TB, Chan PA, Simpanen E, Operario D. A pilot, randomized controlled trial of HIV self-testing and real-time post-test counseling/referral on screening and preventative care among men who have sex with men. *AIDS Patient Care STDS.* 2018;32(9):360–367.
22. Witzel TC, Eshun-Wilson I, Jamil MS, et al. Comparing the effects of HIV self-testing to standard HIV testing for key populations: A systematic review and meta-analysis. *BMC Med.* 2020;18(381):1–13.
23. Figueroa C, Johnson C, Verster A, Baggaley R. Attitudes and acceptability on HIV self-testing among key populations: A literature review. *AIDS Behav.* 2015;19(11):1949–1965.
24. Badru OA, Adeagbo OA. The perception of HIV self-testing and willingness to use mHealth for HIV prevention among black men who have sex with men in Iowa, United States: A qualitative study. *Digital Health*. 2024;10:20552076241302250.
25. Wray T, Chan PA, Simpanen E, Operario D. eTEST: Developing a smart home HIV testing kit that enables active, real-time follow-up and referral after testing. *JMIR Mhealth Uhealth.* 2017;5(5):e6491.
26. Katz DA, Cassels SL, Stekler JD. Replacing clinic-based tests with home-use tests may increase HIV prevalence among Seattle men who have sex with men: Evidence from a mathematical model. *Sex Transm Dis.* 2014;41(1):2–9.
27. Adeagbo OA, Badru OA, Nkfusai CN, Bain LE. Effectiveness of linkage to care and prevention interventions following HIV self-testing: A global systematic review and meta-analysis. *AIDS Behav.* 2024;28(4):1314–1326.
28. LeGrand S, Muessig KE, Horvath KJ, Rosengren AL, Hightow-Weidman LB. Using technology to support HIV self-testing among MSM. *Curr Opin HIV AIDS.* 2017;12(5):425–431.
29. Rosengren AL, Huang E, Daniels J, Young SD, Marlin RW, Klausner JD. Feasibility of using grindr™ to distribute HIV self-test kits to men who have sex with men in Los Angeles, California. *Sex Health.* 2016;13(4):389–392.
30. Sullivan PS, Driggers R, Stekler JD, et al. Usability and acceptability of a Mobile comprehensive HIV prevention app for men who have sex with men: A pilot study. *JMIR Mhealth Uhealth.* 2017;5(3):e26. doi:10.2196/mhealth.7199
31. Maksut JL, Eaton LA, Siembida EJ, Driffin DD, Baldwin R. A test of concept study of at-home, self-administered HIV testing with web-based peer counseling via video chat for men who have sex with men. *JMIR Public Health And Surveillance*. 2016;2(2):e6377.
32. Zhao Y, Zhu X, Pérez AE, et al. MHealth approach to promote oral HIV self-testing among men who have sex with men in China: A qualitative description. *BMC Public Health*. 2018;18(1146):1–8.
33. Déglise C, Suggs LS, Odermatt P. Short message service (SMS) applications for disease prevention in developing countries. *J Med Internet Res.* 2012;14(1):e1823.
34. Adeagbo O, Kim H-Y, Tanser F, et al. Acceptability of a tablet-based application to support early HIV testing among men in rural KwaZulu-natal, South Africa: A mixed method study. *AIDS Care*. 2021;33(4):494–501.
35. Ospina-Pinillos L, Davenport T, Diaz M, et al. Using participatory design methodologies to co-design and culturally adapt the spanish version of the mental health eClinic: Qualitative study. *J Med Internet Res.* 2019;21(8):e14127.
36. Adeagbo O, Herbst C, Blandford A, et al. Exploring people's candidacy for mobile health–supported HIV testing and care services in rural KwaZulu-natal, South Africa: Qualitative study. *J Med Internet Res.* 2019;21(11):e15681.
37. Elliot E, Rossi M, McCormack S, McOwan A. Identifying undiagnosed HIV in men who have sex with men (MSM) by offering HIV home sampling via online gay social media: A service evaluation. *Sex Transm Infect.* 2016;92(6):470–473.
38. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med.* 2011;365(6):493–505.
39. Rodger AJ, Cambiano V, Bruun T, et al. Sexual activity without condoms and risk of HIV transmission in serodifferent

couples when the HIV-positive partner is using suppressive antiretroviral therapy. *Jama*. 2016;316(2):171–181.
40. Zhu X, Zhang W, Operario D, et al. Effects of a mobile health intervention to promote HIV self-testing with MSM in China: A randomized controlled trial. *AIDS Behav.* 2019;23(11):3129–3139.
41. Dworkin MS, Lee S, Chakraborty A, et al. Acceptability, feasibility, and preliminary efficacy of a theory-based relational embodied conversational agent mobile phone intervention to promote HIV medication adherence in young HIV-positive African American MSM. *AIDS Educ Prev.* 2019;31(1):17–37.
42. Hightow-Weidman L, Muessig K, Knudtson K, et al. A gamified smartphone app to support engagement in care and medication adherence for HIV-positive young men who have sex with men (AllyQuest): Development and pilot study. *JMIR Public Health And Surveillance*. 2018;4(2): e8923.
43. Shrestha R, Fisher C, Wickersham JA, et al. Privacy and confidentiality concerns related to the use of mHealth apps for HIV prevention efforts among Malaysian men who have sex with men: Cross-sectional survey study. *JMIR Format Res*. 2021;5(12):e28311.
44. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): A 32-item checklist for interviews and focus groups. *Int J Qual Health Care.* 2007;19(6):349–357.
45. 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.
46. Gessner M, Bishop MD, Martos A, Wilson BD, Russell ST. Sexual minority people's perspectives of sexual health care: Understanding minority stress in sexual health settings. *Sexuality Res Soc Policy*. 2020;17(4):607–618.
47. Wood TJ, Koester KA, Christopoulos KA, Sauceda JA, Neilands TB, Johnson MO. If someone cares about you, you are more apt to come around: Improving HIV care engagement by strengthening the patient–provider relationship. *Patient Prefer Adherence.* 2018;12:919–927.
48. Frye V, Nandi V, Paige MQ, et al. TRUST: Assessing the efficacy of an intervention to increase HIV self-testing among young black men who have sex with men (MSM) and transwomen. *AIDS Behav.* 2021;25(4):1219–1235.
49. Free C, Phillips G, Felix L, Galli L, Patel V, Edwards P. The effectiveness of M-health technologies for improving health and health services: A systematic review protocol. *BMC Res Notes.* 2010;3(250):1–7.
50. Phanuphak N, Anand T, Jantarapakde J, et al. What would you choose: Online or offline or mixed services? Feasibility of online HIV counselling and testing among Thai men who have sex with men and transgender women and factors associated with service uptake. *J Int AIDS Soc.* 2018;21(S5): e25118.