

Digital health innovation in HIV prevention and sexual health promotion: current applications and future prospects of mobile health and telehealth

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Abstract

Digital health is now a delivery strategy for HIV prevention and sexual health promotion, not simply a channel for health education. Mobile messaging, web-based testing, HIV self-testing (HIVST) support, mobile applications, social media recruitment, telehealth, tele-pre-exposure prophylaxis (PrEP), and chatbot-assisted workflows can reduce barriers related to stigma, distance, clinic capacity, and confidentiality. These tools also create an opportunity for primary HIV and sexually transmitted infection (STI) prevention before high-risk patterns are established, using positive, age-appropriate messages that support consent, healthy relationships, condom and vaccine uptake, timely testing, and informed prevention choices. This narrative review synthesizes evidence from trials, systematic reviews, implementation studies, and program evaluations, emphasizing quantitative outcomes and implementation limits. The most consistent benefits are seen for service actions with clear endpoints: HIVST, online STI testing, PrEP initiation through telehealth, and interactive text-message support for adherence. Effects are less consistent for sustained PrEP persistence, complex behavior change, linkage after reactive self-tests, and equity. Digital tools can improve access among men who have sex with men, adolescents and young adults, women, sex workers, and rural populations. Still, they can also reproduce inequities when privacy, cost, literacy, device access, legal vulnerability, and laboratory infrastructure are not addressed. Future systems should integrate prevention education and digital entry points with laboratories, pharmacies, clinicians, community navigators, human escalation, privacy governance, and equity monitoring. The field should now move from platform-centered pilots toward accountable hybrid sexual health systems.

Keywords: HIV prevention. Sexual health. Mobile health. Telehealth. HIV self-testing. Pre-exposure prophylaxis.

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Introduction

The global HIV response has a strong prevention portfolio but an uneven delivery system. In 2024, about 40.8 million people were living with HIV, and 1.3 million acquired HIV globally, with new infections concentrated in key populations and their partners.¹ Antiretroviral therapy (ART), pre-exposure prophylaxis (PrEP), HIV self-testing (HIVST), condom promotion, harm reduction, and long-acting prevention options have expanded what is technically possible.²⁻¹³ Yet many people who could benefit from testing, sexually transmitted infection (STI) screening, PrEP, contraception, partner services, or treatment do not enter or remain in care. Stigma, clinic distance, cost, inconvenient hours, privacy concerns, legal risk, and fragmented services continue to shape uptake.

Digital health is best understood as a service-delivery response to these gaps. A digital tool can function as a reminder, a private entry point, a kit-ordering system, a clinician visit, a peer-support channel, or a data layer for identifying missed follow-up. The World Health Organization has recommended selected digital interventions, including client-to-provider telemedicine and targeted digital communication, while warning that digital tools should strengthen health systems rather than replace them.¹⁴ HIVST guidance similarly supports expanded access when programs also provide confirmatory testing, linkage, and protection from social harm.¹⁵

In sexual health, privacy can be both a benefit and a risk. Ordering an HIV self-test online, receiving electronic STI results, or discussing PrEP through telehealth may reduce embarrassment and local stigma. The same digital trace can expose sexual orientation, sex work, HIV risk, pregnancy concerns, or medication use if messages, app icons, delivery packages, insurance claims, or platform data are seen by others. Digital interventions should therefore be assessed not only by uptake but also by safety, linkage, equity, and accountability.

This review synthesizes evidence on mobile health and telehealth in HIV prevention and sexual health promotion. It focuses on modalities, effectiveness across domains, implementation limitations, and future system design. The central argument is that digital sexual health interventions are most useful when they shorten a specific service transition, such as ordering a test, completing laboratory monitoring, reporting a result, initiating PrEP, or returning after missed follow-up. This framing is summarized in [figure 1](#). The layered structure separates digital modality from public health function: a mobile app, for example, may be used for education, test ordering, PrEP adherence, or linkage, and each

use should be judged by a different endpoint. The outer governance layer is also not peripheral. Privacy, equity, clinical safety, and cost determine whether a technically successful tool can be used safely by people who face stigma, criminalization, or limited access to conventional services.

Digital health modalities in HIV prevention and sexual health promotion

Digital modalities differ in technical burden, clinical scope, privacy risk, and dependence on the surrounding health system. Short message service (SMS) remains valuable because it is low-bandwidth and familiar. Weekly interactive SMS improved ART adherence and viral suppression in the *WeiTel Kenya1* trial, and weekly reminders improved adherence in another Kenyan trial, whereas daily generic reminders were less persuasive.^{16,17} These findings remain relevant because they show that light-touch communication can work when it is responsive and not excessive.

Mobile applications can support risk assessment, appointment scheduling, PrEP adherence, test ordering, secure messaging, and peer support. They allow more tailoring than SMS but also require smartphones, data plans, installation, updates, and sustained attention. The *P3* app produced a small short-term improvement in intracellular tenofovir-diphosphate adherence at 3 months but no sustained 6-month effect.¹⁸ The Thai youth PrEP app trial similarly showed high usability but no significant adherence difference at 3 or 6 months.¹⁹ These results caution against assuming that a youth-friendly interface alone solves adherence.

Web-based services can change service access more directly. In the *SH:24* trial, an online STI testing service with postal sampling and electronic results increased completed STI testing compared with clinic signposting: 50.0% versus 26.6%, with a risk ratio of about 1.87.²⁰ This was not only an educational intervention. It linked ordering, sampling, laboratory testing, result delivery, and referral. Its transferability depends on postal reliability, laboratory capacity, treatment access, and digital confidentiality.

HIVST is especially suited to digital delivery. Online ordering, mailed kits, instructional videos, reminders, result reporting, and navigation can reduce clinic barriers. The *eSTAMP* trial in US men who have sex with men (MSM) showed that internet-distributed HIV self-tests increased any HIV testing from 22.0% to 76.6% over 12 months and identified more new diagnoses.²¹ Reviews consistently show stronger evidence

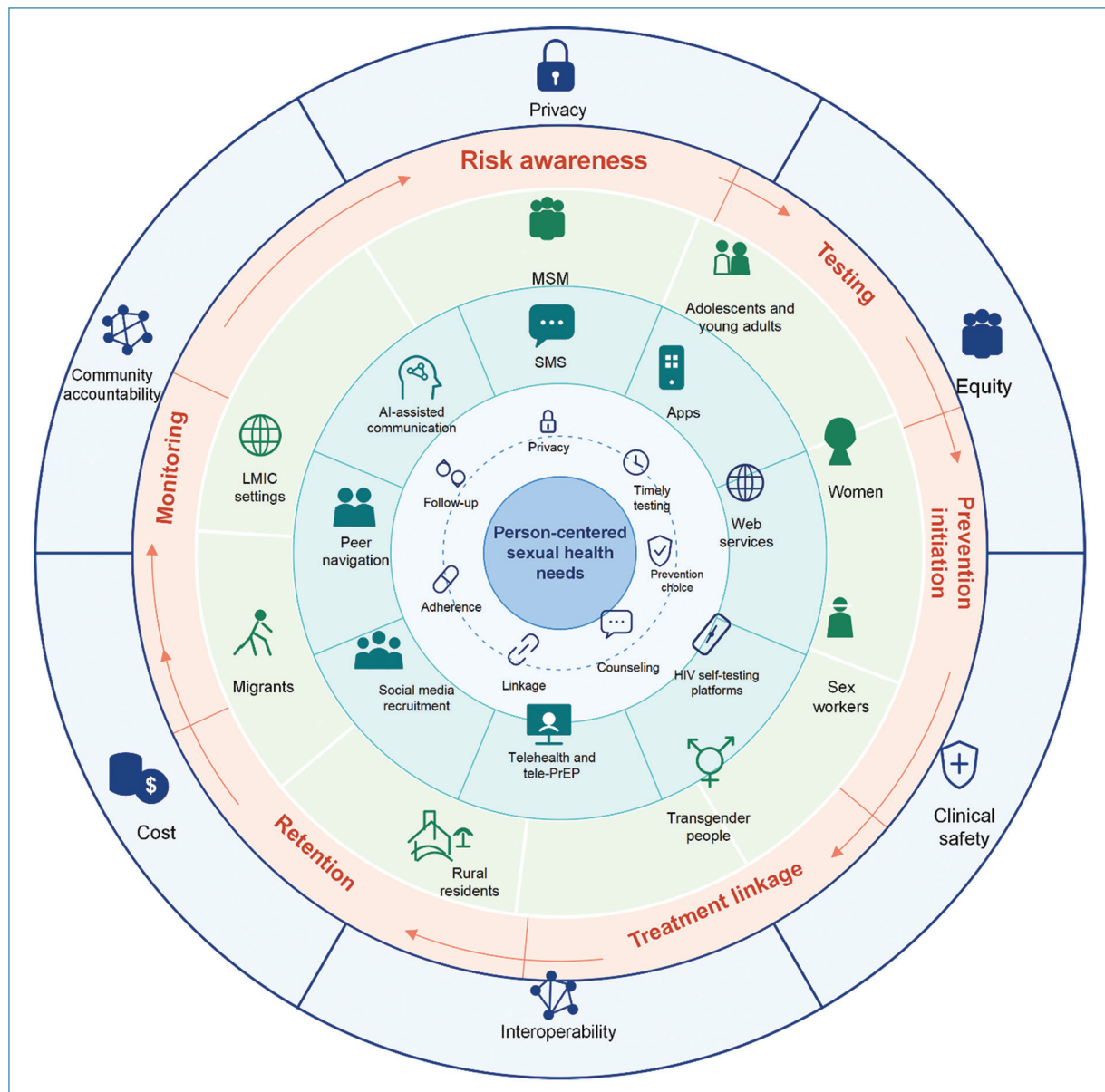


Figure 1. Conceptual circle diagram for digital health innovation in HIV prevention and sexual health promotion.

for testing uptake than for linkage after a reactive result.²²⁻²⁶ Digital HIVST programs are therefore strongest when kit delivery is paired with active linkage.

Telehealth and tele-PrEP extend digital health into clinical care. They can combine phone, video, asynchronous review, electronic prescribing, laboratory coordination, and medication delivery. Iowa TelePrEP demonstrated that a public-health-partnered telehealth model could reach rural and small-city users, with 127 unique patients served and about 62% active at 6 months.²⁷ Large commercial tele-PrEP cohorts have shown national scale; one US online company included

162,422 users and represented about 20.9% of US PrEP use in 2024.²⁸ Scale, however, does not by itself prove equity, retention, or clinical quality.

Social media, geosocial networking applications, and crowdsourced campaigns are often used for recruitment and demand creation. In a Blued app trial in China, app-based risk assessment and tailored feedback increased HIV testing frequency, with 2.51 versus 1.72 tests per person-year.²⁹ A stepped-wedge crowdsourcing trial among Chinese MSM increased HIV testing during intervention periods, with a risk ratio of 1.43, and increased HIVST with a risk ratio of 1.89.³⁰ These approaches

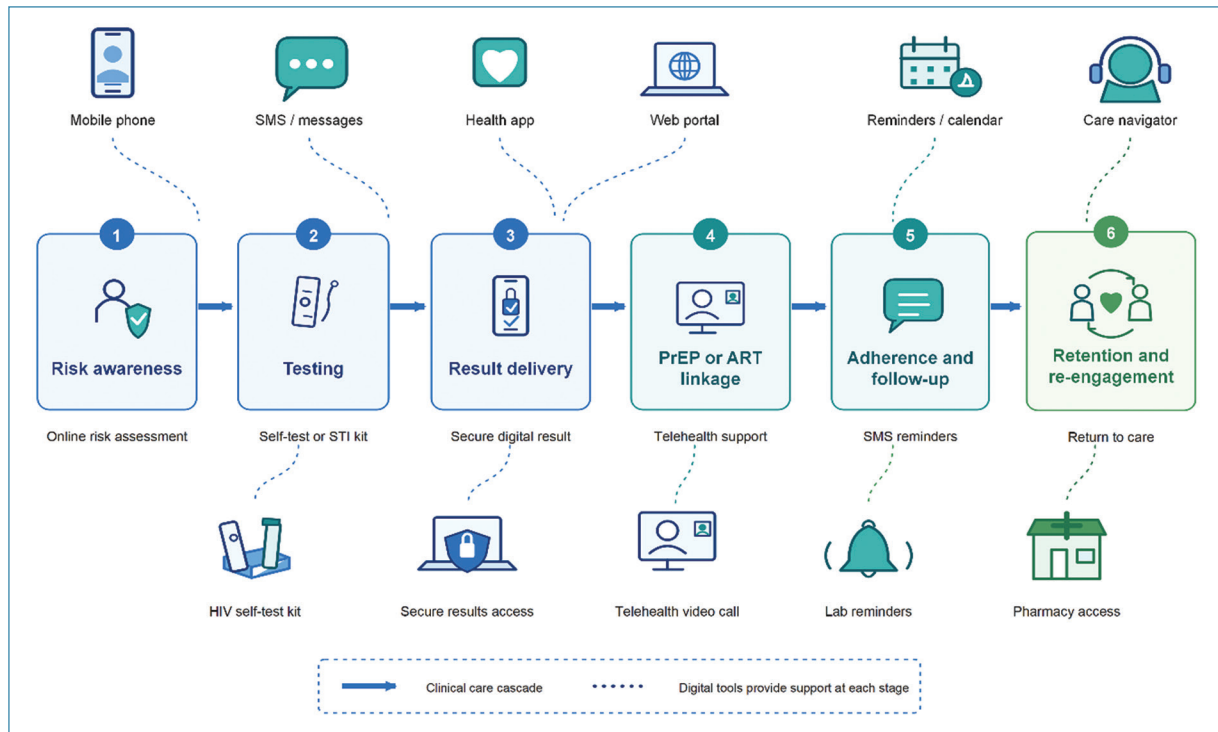


Figure 2. Digital enhancement of the HIV prevention and sexual health care cascade.

show how community language and platform context can shape uptake.

AI-assisted risk communication and chatbots are newer. Their most defensible near-term role is narrow support: answering common questions, guiding HIVST steps, triaging low-complexity needs, and routing users to human help. In a Hong Kong randomized trial among MSM, chatbot-supported HIVST was non-inferior to human-administered online support for HIVST uptake and improved counseling support among users.³¹ This result supports bounded automation, not replacement of clinicians or counselors.

The cascade framing in figure 2 clarifies why digital interventions should not be evaluated with a single generic outcome. A tool that increases HIVST ordering may still fail if results are not reported or if reactive results do not lead to confirmatory testing. Similarly, tele-PrEP may improve initiation while leaving laboratory monitoring, STI screening, or persistence unresolved. The cascade view therefore links intervention design to measurable transitions and helps prevent overinterpretation of early uptake.

The quantitative evidence in table 1 shows why broad claims about “mHealth” are not useful. Effects are largest when digital tools remove a direct logistical barrier,

and effects are smaller or less durable when interventions try to change complex behavior through education alone. The table also shows a clear contrast between access-oriented and adherence-oriented interventions. Online STI testing, eSTAMP, PrEPTECH, and Blued produced relatively direct changes in testing or PrEP initiation because the digital component removed a specific access barrier. App-based PrEP adherence interventions produced more mixed results because adherence depends on medication access, perceived risk, side effects, follow-up, and life circumstances. High acceptability is not enough: SmartLink was technically feasible but did not overcome linkage barriers after HIV diagnosis, whereas PositiveLinks appeared stronger because it was embedded in a responsive clinic team.

Evidence of effectiveness across key intervention domains

HIV testing and HIVST

The strongest evidence is for HIV testing. HIVST addresses privacy, convenience, and stigma, and digital platforms can add ordering, instructions, reminders,

Table 1. Representative digital HIV prevention and sexual health interventions

Study/year	Population/ setting	Modality	Comparator	Sample	Key quantitative outcome	Main limitation	References
WelTel Kenya1, 2010	Adults on ART, Kenya	Weekly two-way SMS	Standard care	538	Adherence 62% versus 50%; viral suppression 57% versus 48%	ART context, not PrEP-specific	16
Pop-Eleches, 2011	Adults on ART, Kenya	Weekly SMS reminders	No SMS	431	Weekly SMS improved adherence; daily SMS less useful	Older ART context	17
SH: 24, 2017	Adults in London	Online STI testing	Clinic signposting	2072	STI testing 50.0% versus 26.6%; RR about 1.87	Requires postal and laboratory capacity	20
eSTAMP, 2020	US MSM	Online mailed HIVST	Online information	2665	Any HIV testing 76.6% versus 22.0%	Linkage less complete	21
HIVST meta-analysis, 2017	Mixed populations	HIVST	Standard testing	5 RCTs	HIVST increased uptake and frequency	Linkage outcomes variable	23
Digital HIVST review, 2021	Global	Digital HIVST supports	Varied	46 studies	Acceptability often 77-97%	Heterogeneous designs	26
Updated digital HIVST review, 2025	Global	Digital HIVST supports	Varied	55 studies	Sensitivity 92.9-100%; specificity 96.8-99.9%	Inconsistent linkage metrics	22
Blued trial, 2023	MSM in China	App risk assessment	Standard app information	9280	Tests/person-year 2.51 versus 1.72; IRR 1.32	Platform- specific exposure	29
Crowdsourcing trial, 2018	MSM in China	Community- designed digital campaign	Conventional message	1381	HIV testing RR 1.43; HIVST RR 1.89	Cluster design	30
Keep It Up!, 2018	Young MSM, US	Online prevention program	Attention control	901	Reduced selected STI/risk outcomes	Behavioral endpoints vary	32
MyPEEPS Mobile, 2022	Adolescent MSM, US	Mobile prevention app	Delayed intervention	763	Reduced condomless anal sex at 3 months	Later effects less consistent	33
FSW SMS HIVST, 2019	Female sex workers, Kenya	SMS- supported HIVST	Standard outreach	220	HIVST uptake increased	Shared phone privacy risk	34
FSW HIVST, 2017	Female sex workers, Zambia	Peer HIVST plus follow-up	Standard services	965	Recent testing increased	Not purely digital	35
FSW HIVST, 2017	Female sex workers, Uganda	Direct HIVST plus phone support	Facility collection	> 1000	Direct provision improved testing	Result interpretation concerns	36
Partner HIVST, 2016	Kenyan women and partners	Secondary HIVST plus follow-up	Invitation letter	600	Male partner testing increased	Social harm monitoring needed	37

(Continues)

Table 1. Representative digital HIV prevention and sexual health interventions (*continued*)

Study/year	Population/setting	Modality	Comparator	Sample	Key quantitative outcome	Main limitation	References
PrEPmate/EPIC, 2018	Young MSM, US	Two-way SMS PrEP support	Standard care	121	Retention 86% versus 71%; adherence 72% versus 57%	Small trial	38
P3, 2025	Young SGM, US	Gamified PrEP app	Control app	246	3-month adherence difference + 0.13; no 6-month effect	Engagement decay	18
Thai PrEP app, 2022	Young MSM/ TGW, Thailand	PrEP app plus services	Services alone	200	No significant adherence difference at 3 or 6 months	App use declined	19
HealthMindr-PrEP, 2025	Gay and bisexual MSM, US	PrEP uptake app	Study-progress app	657 planned	PrEP initiation HR 1.64 among participants with baseline indications	Underpowered for subgroup effects	39
PrEPTECH, 2024	Young MSM/ TGW, US	Tele-PrEP	Referral	229	PrEP initiation 89.4% versus 42.9%; retention 85.3% versus 51.5%	Laboratory workflows still needed	40
Iowa TelePrEP, 2019	Rural/ small-city users, US	Public tele-PrEP	Program evaluation	186 referrals	127 patients served; about 62% active at 6 months	Observational	27
MISTR, 2025	US online PrEP users	Commercial tele-PrEP	No comparator	162422	67.3% retained after year 1; 36.1% uninsured	Selection and quality measures	28
Chatbot HIVST, 2025	MSM, Hong Kong	Chatbot HIVST support	Human online support	531	HIVST uptake 81.2% versus 85.7%; counseling 91.2% versus 62.6%	Escalation needed	31
PositiveLinks, 2018	People with HIV, US	Clinic-linked app	Standard care	77	Improved retention and viral suppression	Small single-site cohort	41
SmartLink, 2019	Newly diagnosed adults, South Africa	Smartphone linkage app	Standard counseling	278	No clear linkage improvement	Clinic barriers persisted	42

SMS: short message service; ART: antiretroviral therapy; STI: sexually transmitted infection; HIVST: HIV self-testing; PrEP: pre-exposure prophylaxis; MSM: men who have sex with men; TGW: transgender women; RCT: randomized controlled trial.

result reporting, and linkage. eSTAMP is a benchmark because it increased testing and new diagnoses among internet-recruited MSM over 12 months.²¹ The limitation is also instructive: testing was measured better than downstream linkage. This pattern appears across reviews, which generally find stronger evidence for uptake than for confirmatory testing, PrEP referral, or ART initiation.^{22,23,25,26}

HIVST evidence from women and sex workers shows that digital and peer-supported models must be designed for safety. SMS-supported HIVST among female sex workers in Kenya improved uptake, while peer

distribution in Zambia and Uganda expanded testing in settings where clinic-based services can be stigmatizing.³⁴⁻³⁶ Secondary distribution by women to male partners increased partner testing, but programs must monitor intimate partner violence and coercion.³⁷

The chatbot trial in Hong Kong adds a newer implementation lesson. Automated support can match human online support for HIVST uptake when the task is narrow, the workflow is scripted, and escalation is available.³¹ It should not be generalized to unsupervised AI counseling for complex risk, reactive results, distress, sexual violence, or legal concerns.

STI testing and broader sexual health promotion

Digital sexual health services often work best when they provide a complete pathway rather than advice alone. SH:24 increased completed STI testing because the intervention linked online ordering, postal self-sampling, laboratory processing, electronic results, and treatment referral.²⁰ Similar models can preserve clinic capacity for symptomatic patients, PrEP initiation, complex counseling, and safeguarding. Their effectiveness depends on reliable delivery, laboratory systems, treatment access, and user privacy.

Digital behavior-change interventions show more variable results. Keep It Up! and MyPEEPS Mobile reduced selected sexual risk outcomes, but effects differed by endpoint and follow-up period.^{32,33} Earlier systematic reviews of digital sexual health promotion reached a similar conclusion: knowledge and service-use outcomes are easier to shift than durable sexual behavior, STI incidence, or pregnancy-related outcomes.⁴³⁻⁴⁵ This variability is expected. Ordering a test is a discrete action; changing condom use, partner communication, or sexual network behavior is more socially embedded.

Digital programs should pair accurate, regularly updated information with direct access to combined HIV and STI testing rather than treat knowledge as the endpoint. Surveillance trends can diverge: Spanish data documented a broad post-pandemic STI rebound, while a Catalan primary-care analysis found that HIV diagnoses remained below 2019 levels as several other STI diagnoses recovered or increased.^{46,47} These ecological trends do not establish that PrEP causes STI increases; they instead support integrated prevention, repeat testing based on exposure and guidelines, and clear communication that PrEP prevents HIV but not other STIs. Programs should also address chemsex (sexualized drug use before or during sex) without judgment. Digital screening can ask confidentially about substances, injection practices, consent, condom use, PrEP or post-exposure prophylaxis, and recent testing, then connect users to combined HIV/STI testing, drug-interaction advice, harm-reduction services, mental health care, and human support.^{48,49}

The 2022 mpox outbreak further showed that risk communication should focus on exposure patterns rather than sexual identity. In the Valencia case series, almost all patients were men and MSM, and recent condomless sexual contact was common.⁵⁰ During an active outbreak, digital services can provide symptom

and exposure guidance, vaccine eligibility and booking, testing and isolation instructions, partner notification support, and practical advice on temporarily reducing new or multiple partners.⁵¹ Messages should name relevant sexual-network risks clearly while avoiding stigmatizing labels, because stigma can deter testing and disclosure.

AI-assisted HIVST support

Chatbot-supported HIVST belongs in the testing evidence base, but it should be discussed separately from both online STI testing and broad AI risk communication. The Hong Kong trial used a bounded comparison with human-administered online support, which makes it more informative than uncontrolled chatbot acceptability studies.³¹ Its main lesson is that automation can support a narrow workflow when escalation and outcome measurement are built in.

PrEP uptake, adherence, and persistence

PrEP is a demanding test for digital health because it requires eligibility assessment, HIV testing, renal and STI monitoring, prescribing, medication access, adherence, and follow-up. Digital tools can improve some steps but not all. PrEPmate/EPIC improved retention and adherence among young MSM, but it was small.³⁸ P3 showed a short-term biomarker signal that did not persist at 6 months.¹⁸ The Thai PrEP app trial showed no significant adherence difference at 3 or 6 months despite high usability.¹⁹ HealthMindr-PrEP suggested a higher PrEP initiation rate among users with baseline indications, although estimates remained imprecise.³⁹ These findings suggest that app engagement is not equivalent to pharmacologic coverage.

Tele-PrEP has stronger evidence for access and initiation. PrEPTECH increased PrEP initiation from 42.9% to 89.4% and retention from 51.5% to 85.3% over 180 days.⁴⁰ Iowa TelePrEP reached rural users who otherwise had limited local access.²⁷ MISTR demonstrated large national reach but also raises questions about selection, affordability, laboratory completion, and long-term quality.²⁸ The broader PrEP continuum literature shows that awareness, initiation, adherence, persistence, and re-engagement are distinct steps, and losses at one step cannot be inferred from another.⁵²⁻⁵⁵ Tele-PrEP should therefore report not only prescriptions but also laboratory monitoring, STI screening, persistence, seroconversions, discontinuation, and re-engagement.

ART adherence, linkage, and retention

ART adherence and retention evidence matters because treatment is prevention. WelTel and Pop-Eleches show that low-burden interactive SMS can improve adherence.^{16,17} Later app evidence is more mixed. PositiveLinks improved retention and viral suppression in a small clinic-linked cohort,⁴¹ whereas SmartLink did not clearly improve linkage after HIV diagnosis in South Africa.⁴² The difference illustrates a central principle: digital tools work better when a responsive human service is ready to act on digital contact.

The cross-domain comparison in [table 2](#) reinforces this pattern. Digital tools show the clearest effect when the outcome is close to the digital action: ordering a test, completing a test, initiating tele-PrEP, or responding to adherence support. Outcomes farther downstream, including durable PrEP persistence, viral suppression, and linkage after diagnosis, depend on laboratories, pharmacies, clinicians, transport, cost, stigma, and the quality of human follow-up. This explains why a strong tele-PrEP initiation result cannot be assumed to translate into long-term prevention coverage.

Implementation challenges, inequities, and critical limitations

Digital health can widen access and still reproduce inequity. The digital divide includes more than device ownership. It includes data affordability, device privacy, literacy, disability access, language, documentation, banking, insurance, postal address, and trust. Tele-PrEP that requires online payment or private laboratory access may serve insured users while missing people with unstable housing or no coverage. A sexual health app can be unusable if a user shares a phone or fears visible notifications.

Privacy is a clinical safety issue. Digital programs may encrypt messages but still reveal sensitive information through app icons, notifications, browser history, delivery packages, billing, or laboratory records. Sexual orientation, sex work, PrEP use, STI testing, or HIV status may have social, legal, or economic consequences. Programs should minimize data collection, avoid unnecessary third-party tracking, provide discreet communication options, and explain escalation and data-use rules in plain language.

Engagement decay is a common limitation. Many app interventions show high initial interest followed by

declining use. This may be acceptable for single-action services such as test ordering, but it matters for adherence and persistence. Designers should define the minimum engagement needed for the target outcome. A PrEP adherence app requires repeated contact; an HIVST ordering platform may need only one successful session.

Linkage is another weak point. HIVST and online STI testing can increase testing, but public health impact depends on confirmatory testing, ART, PrEP, partner services, and treatment. Studies often measure kit ordering and self-reported results more completely than linkage. Reactive self-tests are uncommon in many trials, so linkage comparisons are underpowered. Digital programs should offer multiple linkage routes, including phone, secure messaging, community navigation, clinics, pharmacies, and emergency support.

Methodological limits are substantial. Studies often use short follow-up, self-reported sexual behavior, selected online samples, and changing platform environments; these recurring limitations are also evident across the broader systematic-review literature.⁵⁶ Blinding is rarely possible. Commercial telehealth evaluations may have large samples but limited independent outcome verification. Randomized trials may be rigorous but too small or artificial to reflect service delivery. Economic evidence is also underdeveloped. Programs should report cost per test, cost per diagnosis, cost per linked diagnosis, cost per PrEP start, cost per persistent user, and distributional impact.

[Table 3](#) translates these limitations into a reporting standard. Many digital studies document enrollment and satisfaction but provide weaker information on denominator loss, privacy incidents, linkage, and cost. These omissions matter because a program can appear effective among enrolled users while excluding people without private devices, stable addresses, insurance, or safe digital access. Future studies should therefore present implementation outcomes with the same care as clinical endpoints, including stratified uptake, completion, linkage, and retention.

Future directions for scalable, integrated, and ethical digital sexual health systems

Primary prevention education should be treated as a fifth priority alongside HIVST, online STI testing, tele-PrEP initiation, and interactive adherence support. Digital content should be positive, developmentally sequenced, and offered before harmful patterns are established. Early modules can address bodily

Table 2. Quantitative comparison across intervention domains

Domain	Digital mode	Best-supported outcome	Representative quantitative result	Evidence interpretation	References
ART adherence	Weekly two-way SMS	Adherence and viral suppression	62% versus 50% adherence; 57% versus 48% suppression	Simple interactive messaging can improve care outcomes	16
ART adherence	Weekly SMS reminder	Adherence	Weekly reminders improved adherence	Cadence and burden matter	17
STI testing	Online testing	Completed testing	50.0% versus 26.6%; RR about 1.87	Strong evidence for service access	20
HIV testing	Mailed HIVST	Any HIV testing	76.6% versus 22.0%	Strong uptake effect	21
HIVST	Digital support	Acceptability	Often 77-97%	Acceptability high when privacy is protected	26
HIVST	Digital support	Accuracy	Sensitivity 92.9-100%; specificity 96.8-99.9%	Accuracy evidence stronger than linkage evidence	22
App-based testing	Risk self-assessment	Testing frequency	2.51 versus 1.72 tests/person-year	Platform-embedded risk feedback can shift testing	29
Crowdsourced promotion	Community campaign	HIV testing	RR 1.43; HIVST RR 1.89	Community-designed messaging can improve demand	30
Behavioral prevention	Online program	Selected risk/STI outcomes	Risk outcomes reduced in Keep It Up!	Effects vary by endpoint	32
Behavioral prevention	Mobile app	Condomless sex	Short-term reduction at 3 months	Later durability less consistent	33
HIVST among sex workers	SMS or phone-supported HIVST	Recent testing	Uptake increased	Privacy and legal risk remain	34-36
Partner testing	Secondary HIVST	Male partner testing	Partner testing increased	Social harm monitoring is essential	37
PrEP adherence	Two-way SMS	Retention/adherence	Retention 86% versus 71%; adherence 72% versus 57%	Promising but small	38
PrEP adherence	Gamified app	Drug-level adherence	Short-term difference +0.13; no 6-month effect	Engagement decay limits impact	18
PrEP adherence	Youth PrEP app	Drug detection	No significant difference at 3 or 6 months	Usability does not ensure adherence	19
PrEP initiation	Tele-PrEP	Initiation and retention	89.4% versus 42.9% initiation	Strong access effect	40
Rural PrEP	Public tele-PrEP	Reach and persistence	127 served; about 62% active at 6 months	Useful rural model	27
Commercial PrEP	Online tele-PrEP	Scale	162422 users; 67.3% retained after year 1	Large reach but selection concerns	28
HIVST support	Chatbot	Uptake and counseling	Uptake non-inferior; counseling 91.2% versus 62.6%	Bounded automation may reduce workload	31
HIV care	Clinic-linked app	Retention and viral suppression	Improved in small cohort	Requires responsive clinic team	41
Linkage	Smartphone app	ART linkage	No clear improvement	System barriers may dominate	42

SMS: short message service; ART: antiretroviral therapy, STI: sexually transmitted infection, HIVST: HIV self-testing; PrEP: pre-exposure prophylaxis.

Table 3. Implementation outcomes and limitations that should be reported in digital sexual health studies

Issue	Quantitative marker	Why it matters	Example evidence	References
Reach	Number exposed, enrolled, eligible, and served	Detects early exclusion	eSTAMP enrolled 2665 online MSM	21
Testing completion	Tests ordered versus completed	Separates demand from completion	SH: 24 increased completed testing	20
Result reporting	Valid result returned or recorded	Identifies cascade loss	Digital HIVST reviews show variable reporting	22,26
Linkage	Confirmatory testing or ART/PrEP start	Determines public health effect	HIVST evidence stronger for uptake than linkage	23-25
Message burden	Response rate over time	Detects fatigue	Weekly SMS more useful than daily reminders	16,17
App engagement	Log-ins, completed modules, attrition	Predicts durability	P3 and Thai app showed engagement limits	18,19
Youth confidentiality	Private device and insurance status	Protects adolescents and young adults	MyPEEPS and P3 target youth populations	18,33
Key-population privacy	Shared phones, legal risk, disclosure	Prevents harm	FSW HIVST studies require privacy safeguards	34-36
Partner safety	Social harm and coercion	Essential for secondary distribution	Partner HIVST increased testing but needs monitoring	37
Rural access	Distance, laboratory access, medication delivery	Telehealth does not remove all barriers	Iowa TelePrEP reached rural users	27
Commercial scale	Users served and retained	Distinguishes reach from quality	MISTR included 162422 users	28
Telehealth quality	Laboratory completion, STI screening, persistence	Prescribing alone is insufficient	PrEPTECH improved initiation and retention	40
Automation safety	Escalation and counseling completion	Prevents unsafe chatbot use	Chatbot HIVST was bounded and non-inferior	31
Behavioral endpoint	Self-report versus biomarker/service data	Reduces bias	Behavioral app trials vary by endpoint	32,33
Clinic responsiveness	Staff action after digital signal	Converts contact into care	PositiveLinks was clinic-linked	41
System barriers	Transport, clinic readiness, documentation	Explains null linkage effects	SmartLink did not clearly improve linkage	42
Platform dependency	Algorithm and policy changes	Affects reproducibility	Blued trial depended on app ecosystem	29
Community language	Local relevance and trust	Improves demand creation	Crowdsourcing improved HIV testing	30
Cost	Staff, lab, postage, platform, medication	Avoids hidden cost shifting	Web testing and tele-PrEP require infrastructure	20,28
Equity	Stratified uptake and retention	Shows who benefits	Digital programs should report subgroup cascades	1,14

MSM: men who have sex with men; SMS: short message service; ART: antiretroviral therapy; STI: sexually transmitted infection; HIVST: HIV self-testing; PrEP: pre-exposure prophylaxis; FSW: female sex worker.

autonomy, consent, respectful relationships, communication, online safety, and diverse family and relationship contexts; later modules can add condoms, vaccination, HIV/STI testing, PrEP and post-exposure prophylaxis,

partner communication, and the risks associated with sexualized substance use. Messages should be adapted by age, developmental stage, literacy, culture, and local epidemiology, with links to confidential services and

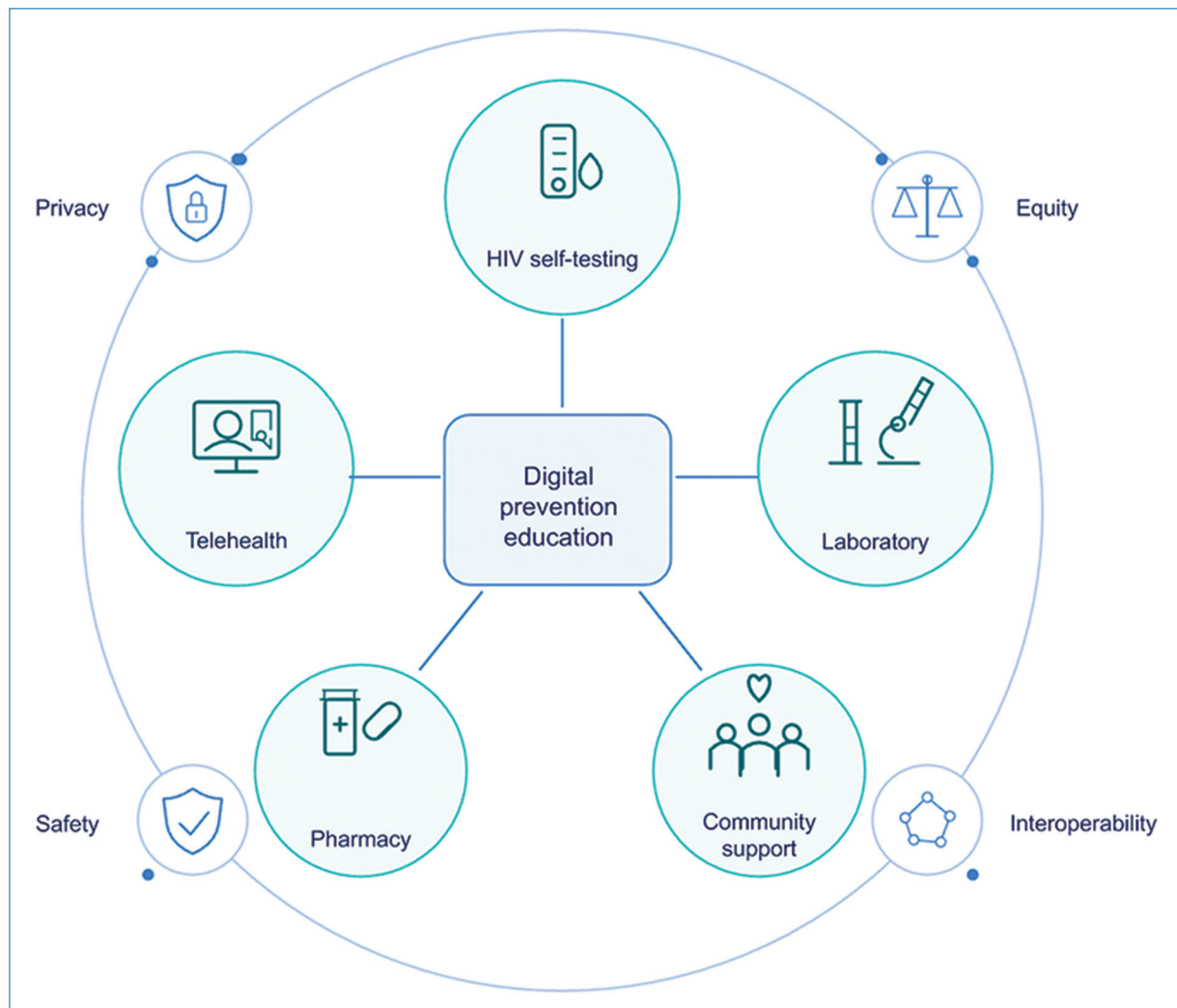


Figure 3. Future hybrid model integrating digital prevention education with HIV self-testing, telehealth, laboratory services, pharmacy access, and community support under privacy, equity, safety, and interoperability safeguards.

trusted adults where appropriate. Experience from hepatitis C care among people who inject drugs underscores a transferable implementation lesson: information alone is insufficient when adherence, reinfection, and access barriers remain.⁵⁷ International technical guidance on sexuality education supports a curriculum-based, incremental, age-appropriate, and evidence-informed approach.⁵⁸ Programs should therefore measure not only knowledge but also help-seeking, consent and communication skills, testing and vaccination uptake, protective behaviors, and unintended harms.

The next phase should be built around integrated hybrid systems. A user should be able to move from risk assessment to HIVST, STI testing, PrEP choice, contraception, vaccination, partner services, or HIV treatment without restarting at each step. Digital front

doors should connect to laboratories, pharmacies, clinicians, community navigators, public clinics, and emergency support. A person ordering an HIV self-test should be offered STI testing and PrEP information when appropriate. A person with a reactive HIVST should receive confirmatory testing and rapid ART linkage, not a generic automated message.

Interoperability is necessary but must be privacy-preserving. Minimum data elements should support care and accountability: consent, eligibility, testing, result delivery, linkage, PrEP initiation, laboratory monitoring, adverse events, discontinuation, and re-engagement. These data should be limited, role-based, auditable, and understandable to users. Interoperability should not become uncontrolled sexual health data sharing.

AI should be used cautiously. The most appropriate near-term uses are constrained and auditable: HIVST guidance, symptom triage, laboratory reminders, routine questions, and routing to human support. AI should not replace counseling after reactive results, sexual violence disclosure, suicidality, intimate partner violence, complex drug interactions, or legal concerns. Systems should disclose automation and test performance across language, literacy, gender identity, age, and cultural context.

Digital systems must also adapt to long-acting prevention. Injectable cabotegravir and lenacapavir reduce daily pill burden but increase the importance of appointment scheduling, missed-dose outreach, side-effect triage, pharmacy benefits, and injection delivery.^{5-7,10,11} Digital PrEP systems should therefore support prevention choice rather than focus only on daily oral adherence.

Evaluation should mature. For testing interventions, studies should report kit order, kit use, valid result, reporting, positivity, confirmatory testing, linkage, PrEP referral, ART initiation, and social harms. For PrEP interventions, they should report initiation, persistence, adherence or pharmacologic coverage, STI screening, adverse events, seroconversion, discontinuation, and re-engagement. For telehealth programs, they should report prescribing quality, laboratory completion, insurance barriers, geographic reach, and stratified retention. Economic evaluations should examine both efficiency and equity. The future model in figure 3 places digital prevention education at the entry point and surrounds the pathway with governance and service integration. Interoperability without privacy protection can increase harm, while privacy without linkage can limit clinical impact. The model also shows why digital sexual health should remain hybrid: users need to move between education, remote ordering, telehealth, pharmacies, laboratories, peer navigation, and in-person services without restarting the cascade. Evaluation should follow the same integrated logic by measuring both immediate digital actions and downstream prevention and care outcomes.

Conclusion

Digital health innovation has become a substantive part of HIV prevention and sexual health promotion. Evidence is strongest when digital tools reduce concrete barriers to testing, self-sampling, result delivery, PrEP initiation, or adherence support. Online STI testing, mailed HIVST, interactive SMS, tele-PrEP, and bounded chatbot support have all shown measurable

benefits in specific settings. Digital prevention education adds an important earlier function by reaching people before high-risk patterns are established, provided that messages are positive, age-appropriate, inclusive, and linked to services. Evidence remains less consistent for complex behavior change, sustained PrEP persistence, linkage after reactive self-tests, and equity.

The field should now move from novelty pilots to accountable hybrid systems. Digital interventions need clear endpoints, active linkage pathways, privacy protections, community governance, cost transparency, and equity monitoring. They should connect users to laboratories, pharmacies, clinicians, peer navigators, public health systems, and in-person care. For people facing stigma, criminalization, rural isolation, unstable housing, or limited digital access, the safest model may be low-burden, hybrid, and human-supported.

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Conflicts of interest

None.

Ethical considerations

Protection of human subjects and animals. The authors declare that no experiments on humans or animals were performed for this research.

Confidentiality, informed consent, and ethical approval. This study does not involve personal patient data, medical records, or biological samples, and does not require ethical approval. SAGER guidelines do not apply.

Declaration on the use of artificial intelligence. The authors declare that Gemini was used to improve the English language.

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