# Title

Systematic review of e-health interventions to address sexual health, substance use and mental health among men who have sex with men: synthesis of process evaluations

# Authors

Rebecca Meiksin, GJ Melendez-Torres, Jane Falconer, T Charles Witzel, Peter Weatherburn, Chris Bonell

# Abstract

## Background

Men who have sex with men (MSM) face disproportionate risks concerning HIV and other sexually transmitted infections, substance use and mental health. These outcomes constitute an interacting syndemic among MSM; interventions addressing all three together could have multiplicative effects. E-health interventions can be accessed privately and evidence from general populations suggests these can effectively address all three health outcomes. However, It is unclear how useable, accessible or acceptable e-health interventions are for MSM and what factors affect this.

## Objective

We undertook a systematic review of e-health interventions addressing sexual risk, substance use and common mental illnesses among MSM and synthesised evidence from process evaluations.

## Methods

We searched 19 databases, three trials registers, Open Grey and Google, supplemented by reference-checking and requests to experts. Eligible reports reported on e-health interventions offering ongoing support to MSM aiming to prevent sexual risk, substance use, and/or anxiety or depression; and assessed how intervention delivery or receipt varied with characteristics of interventions, providers, participants and/or context. Reviewers screened citations on title and abstract then full text. Reviewers assessed quality of eligible studies and extracted data on intervention and study characteristics and on process evaluation findings. Analysis used thematic synthesis.

## Results

Twelve reports were eligible for process synthesis, reporting on ten studies of eight unique interventions. Most addressed sexual risk alone or with other outcomes. Studies were assessed as medium and high reliability (reflecting the trustworthiness of overall findings) but tended to lack depth and breadth in terms of the process issues explored. Intervention acceptability was enhanced by: ease of use; privacy protection; use of diverse media; opportunities for self-reflection and to gain knowledge and skills; and content that was clear, interactive, tailored, reflective of MSM’s experiences and affirming of sexual-minority identity. Technical issues and interventions that were too long detracted from acceptability. Some evidence suggested that acceptability varied by race/ethnicity and educational level; findings on variation by socioeconomic status were mixed. No studies explored how intervention delivery or receipt varied by provider characteristics.

## Conclusions

Findings suggest that e-health interventions targeting sexual risk, substance use and mental health are acceptable for MSM across sociodemographic groups. We identify factors shaping MSM’s receipt of such interventions, highlighting the importance of tailored content reflecting MSM’s experiences and of language affirming sexual-minority identities. Intervention developers can draw on these findings to increase the usability and acceptability of integrated e-health interventions to address the syndemic of sexual risk, substance use and mental ill health among MSM. Evaluators of such interventions can draw on our findings to plan evaluations that explore the factors shaping usability and acceptability.

## Systematic review registration

Protocol registered on PROSPERO, September 2018 (CRD42018110317)

# Key words

ehealth; digital health; men who have sex with men; sexual health; HIV; STI; substance use; substance abuse; mental health; systematic review; process evaluation

# Introduction

MSM face disproportionate risks in relation to use of tobacco, alcohol and legal/illegal drug use (henceforth termed substance use), mental ill health, and HIV and other sexually transmitted infections (STIs).1-12 These outcomes constitute a syndemic whereby they interact2,13 to increase overall risks of substance use, mental ill health and sexual risk among MSM across age groups and ethnicities.13-16 This clustering and interaction of adverse outcomes suggests that interventions which address substance use, mental ill health and sexual risk together could have multiplicative effects. E-health interventions, delivered via electronic media and devices, offer a means to access prevention and treatment programmes privately and anonymously particularly for MSM, who generally report high use of such media and devices.17 Systematic reviews for general or mixed populations suggest that e-health interventions can be effective in reducing alcohol use18 and addressing common mental health issues,19-25 and emerging evidence indicates potential effects on drug use and sexual risk.26-29 The few reviews assessing e-health interventions among MSM suggest they can achieve short-term behaviour change for STI/HIV prevention,28,30 increase HIV testing28,31 and, among HIV-positive MSM, improve treatment adherence.31,32 To our knowledge, no systematic reviews have assessed the effectiveness of e-health interventions to reduce substance use or improve mental health among MSM.

In addition to their effectiveness, it is important to examine what factors affect the usability and acceptability of e-health interventions addressing these various outcomes among MSM. This should inform the development of interventions that can feasibly and acceptably address all three outcomes together.33 Designing e-health interventions to address MSM’s needs and affirm sexual-minority identities is likely to be important.34 Product assessments suggest that e-health interventions to reduce depression and anxiety among the general population rarely address the needs of gay and lesbian users.34 However, there have been no systematic reviews to date of the acceptability and usability of e-health interventions addressing sexual health, substance use and/or mental health risks among MSM.

To address these gaps, we undertook a systematic review of e-health interventions addressing these three outcomes and targeting this population. We included interventions addressing these outcomes together or separately, and aimed to synthesise evidence of effectiveness, describe intervention theories of change and synthesise evidence from economic and process evaluations. The present paper reports on the synthesis of process evaluations examining what factors relating to interventions, providers, participants or contexts (i.e., environmental or structural factors) promote or impede delivery or receipt of these interventions.

# Methods

## Inclusion criteria

Reports eligible for inclusion in the overall review reported on e-health interventions that were: delivered by mobile phone apps, the internet or other electronic communication technology; offered ongoing support to populations consisting entirely or principally of gay, bisexual and other men (including cisgender and transgender men) who have sex with men; and aimed to prevent HIV/ STIs, sexual risk behaviour, alcohol, tobacco or drug use, and/or anxiety or depression. We excluded interventions that offered one-off (rather than ongoing) support or involved human providers (e.g., in a chat room). Reports eligible for the process evaluation synthesis reported on characteristics of interventions, providers, participants or context affecting delivery or receipt of eligible interventions. We included published and grey literature and set no restrictions by location or language.

## Search strategy and screening for eligibility

Terms used in our search strategy covered two concepts joined by the Boolean operator “and”: MSM and e-health. We searched 19 databases containing health and social science literature (October-November 2018, updated April 2020). Our complete search strategy for the original OvidSP Medline database is included in Appendix 1 and the search strategies for all databases are available at the London School of Hygiene & Tropical Medicine’s Data Repository.35 We conducted additional searches using three clinical trials registers; the OpenGrey database; Google (limited to first 100 results); reference-checking of included reports; and requests from experts.

Citations were uploaded to EndNote, deduplicated and then uploaded to Eppi-Reviewer (version 4.0) for screening. Two reviewers independently screened titles and abstracts in batches of the same 50 references, resolving disagreements by discussion. After reaching an agreement rate of at least 95%, they single-screened all remaining citations. Screening of full texts followed a comparable process.

## Data extraction and assessment of quality

For process evaluations, two reviewers used an adapted version of an existing tool36 to independently extract data reporting empirically on how processes of delivery and/or receipt varied with characteristics of interventions, providers, participants or contexts. They also extracted data on basic study details, methods and intervention descriptions. They then independently assessed the quality of process evaluation reports using standard Critical Appraisal Skills Program and EPPI-Centre tools.37 These addressed the rigour of sampling, data collection and data analysis; the extent to which study findings were grounded in the data; whether the study privileged the perspectives of participants (e.g., by including open-ended questions or otherwise allowing space for participants to set out their own views); and the breadth and depth of findings (i.e., the extent to which the study explored a broad range of process issues and/or provided in-depth insights into participant perspectives). Drawing on these criteria, each reviewer then assigned weights (high, medium or low) to rate (1) the reliability or trustworthiness of the findings, and (2) the usefulness of the findings for shedding light on the research question(i.e., the extent to which they shed light on how processes of intervention delivery/receipt varied with characteristics of interventions, providers, participants or contexts). Reliability reflected the trustworthiness of the overall findings (i.e., the extent to which the methods employed were rigorous and could minimise bias and error in the findings). Reviewers met to compare their assessments, resolving all differences through discussion.

## Data analysis

Using thematic synthesis methods,38-40 we explored themes concerning the characteristics of interventions, participants and context acting as potential barriers and facilitators of delivery and receipt, and which themes applied across or only within the domains of sexual health, substance use and mental health interventions. Synthesis followed a meta-ethnographic approach.41 We undertook line-by-line coding of reports examining ‘first-order constructs’ (directly quoted qualitative data) and second-order constructs (author interpretations). In the case of findings from quantitative study components, we coded author interpretations, first checking as part of quality assessment whether these aligned with quantitative data presented (i.e., the extent to which study findings were grounded in the data, as noted above). Coding developed third-order constructs by drawing connections between these data. We did not exclude studies based on quality assessment, but rather gave less interpretive weight to conclusions that drew only on poorer-quality reports.

First, two reviewers prepared tables describing the quality of each evaluation, intervention details, study site and population, and pertinent findings. Second, the reviewers independently piloted coding of two high-quality studies. Coding began with in-vivo codes which closely reflected the words used in findings sections. The reviewers then grouped and organised codes, applying axial codes that reflected higher-order, cross-cutting themes. They then met to compare and contrast their coding, developing an overall set of codes. They each then went on to independently code the remaining reports, drawing on the agreed set of codes and developing new in-vivo and axial codes as new themes emerged. At the end of this process, they met to compare their sets of codes. They identified commonalities, differences of emphasis and contradictions to develop an overall analysis which drew on the strengths of the two sets of codes and which resolved any contradictions or inconsistencies.

# Results

## Results of the search for overall review

Our search retrieved 26,044 unique results, including one identified via reference-checking (see Figure 1). After title and abstract screening, six full texts were unobtainable and 345 reports were screened on full text. Of these, 37 reports were eligible for inclusion in the overall review. These reported on 28 unique studies and 23 unique interventions.42-78 Reports were published between 2006 and 2020, with most published in 2015 or later.

## Reports included in process evaluation synthesis

Twelve reports were eligible for inclusion in the process evaluation synthesis (see Appendix 2 for details of each intervention and Appendix 3for study characteristics).42,49,52,54,59,63,64,67,68,75,76,78 These reported on 11 studies which assessed eight unique interventions; two interventions were assessed in two different studies.54,59,67,78 Included process evaluation reports presented findings on how intervention receipt (but not delivery) varied by characteristics of the intervention,42,49,52,59,63,64,67,68,75,76,78 participants42,49,59,63,64,75,76,78 and context 54,75,78 but not providers. Three interventions addressed sexual health alone,54,68,75,78 two addressed mental health alone,42,63,64 one addressed sexual health and substance use49,59,67 and two addressed all three outcomes of interest for this review52,76 (see Appendix 2). Four interventions targeted sexual minority youth or young adults,49,52,59,63,64,67,68 two targeted MSM more generally,42,75 one targeted rural MSM54,78 and one targeted people living with HIV.76 Five were delivered via the internet,42,49,52,54,59,67,68,78 two via smartphone app75,76 and one via computer CD-ROM.63,64 Process evaluations for seven of the included interventions took place in the United States42,49,52,54,59,67,68,75,76,78 and one took place in New Zealand.63,64,76

Figure 1. Searches and screening

Records identified through database searching  
(n = 49,473)

Additional records identified through other sources   
(n = 1)

Records after duplicates removed  
(n = 20,727)

Records screened  
(n = 26,044)

Records excluded  
(n = 25,693)

Full-text articles assessed for eligibility  
(n = 351)

ToC

(n = 33)

PE

(n = 12)

OE

(n = 16)

EE

(n = 1)

Unique records identified through updated search  
(n = 5,317)

Full-text articles excluded, with reasons  
(n = 314)

* Date: 2
* Unobtainable: 6
* Population: 19
* Intervention: 157
* Study design: 68
* Outcomes: 16
* Duplicates: 16
* Registered studies – reports already included: 7
* Pertinent registered studies but no reports: 23

Reports included  
(n = 37)

ToC = theory of change

PE = process evaluation

OE = outcome evaluation

EE = economic evaluation

## Quality assessment

Appendix3 shows the results of our quality assessments. Nine of the 11 included reports were assessed as reporting findings tat were grounded in the data presented. Overall quality varied, with most reports assessed as medium or high quality. In terms of the reliability or trustworthiness of their overall findings, four reports were assessed as medium-quality42,68,75,76 and eight as high-quality.49,52,54,59,63,64,67,78 In terms of their overall usefulness for addressing our research questions, four were assessed as low-quality,52,54,68,78 three as medium-quality63,64,67 and five as high-quality.42,49,59,75,76 Only two reports were assessed as high-quality in both reliability/trustworthiness and usefulness49,59 and all were assessed as medium- or high-quality in at least one of these two domains.42,49,52,54,59,63,64,67,68,75,76,78

## Themes emerging from synthesis of process evaluation reports

Appendix 4 shows the relationship between primary, secondary and tertiary codes developed through our analysis and synthesis of process data.

#### Intervention characteristics affecting intervention receipt

Nearly all process evaluations explored ways in which intervention characteristics affected receipt, though the included reports tended to lack breadth of the areas explored and in-depth exploration of the findings that they did report.42,49,52,59,63,64,67,68,75,76,78 However, several sub-themes emerged in our analysis.

##### Ease of use

Across health domains, acceptability was enhanced when interventions were easy to use and free of technical problems. Few technical problems were reported. For example, from studies assessed as medium reliability, 10% or fewer *Smartphone Self-Monitoring* users reported technical difficulties76 and participants reported that the *HealthMindr* app was easy to use.75 However, from studies of medium42,76 and high49,54,59,63,67,78 reliability, when participants did encounter technical issues, such as freezing59 or incompatibility with mobile devices,42,49 this eroded acceptability. In a 2007 study of an intervention targeting rural MSM, features such as sound, animation or graphics could cause the intervention to load too slowly for participants with slower internet speeds, which authors suggested might derail participation.54

From studies of medium and high reliability, accompanying materials outside of the electronic environment (such as printable materials42 or a notebook63,64) were reported to potentially enhance acceptability, but participants disliked exercises that required using materials they might not have readily to hand.42

##### Intervention content

###### Clear and comprehensive content

From studies of medium reliability across health domains, it was apparent that intervention content which involved clear and comprehensive information facilitated acceptability. For example, *Queer Sex Ed* participants appreciated that this intervention provided comprehensive information on a range of sexual health and relationship topics rather than focusing narrowly on STIs.68 In studies of other interventions, acceptability was reportedly enhanced where content was clear and up to date42 while content participants found confusing detracted from acceptability.76

###### Engaging intervention content

Fun68 and enjoyable42 content increased acceptability, and the use of different types of content arose as a common theme influencing the acceptability. For example, in studies of medium42 and high49,59,63,67 reliability, participants tended to give positive feedback on the use of diverse contents42,49,59 including animations, videos, graphics and games,67 as well as on interventions’ visual appearances.42,63 In a high-reliability study of *Rainbow SPARX*, users were particularly positive about the computer game format and the intervention’s “look and feel,”63(p. 271) as expressed by one user aged 13 years:63(p. 271) “I liked, like, how it looked really shiny on my computer, and it looked like a completely different world.”*Rainbow SPARX* participants also liked particular characters who appeared in the game,63 a theme echoed in a high-reliability study of the *Keep it Up!* intervention where participants reported liking the scenarios and examples presented.67 Factors detracting from acceptability included content that participants found boring,42,76 repetitive,42,76 too easy,63 too difficult or draining,42 “not soothing”,42(p. 53) “cheesy”49(p.9),59(p. 241) or generally unenjoyable42 and videos that users judged as too long or that featured low-quality sound and dialogue.49

###### Language and tone

Language and tone emerged as an important aspect of acceptability across interventions addressing all three health domains and in studies of medium42,68,75 and high49,59,63,64,67 reliability. Participants liked what authors described as a “frank, candid, and sex-positive tone,”59(p. 243) colloquial language,67 and what one participant described as an “up-beat manner.”67(p. 3005) For example, *Queer Sex Ed* users appreciated that the intervention did not rely on “scare tactics” and that its content was easy to understand without making them feel “talked down to.”68(p. 228) A *Keep it Up!* user echoed this sentiment, describing the intervention as “realistic and not condescending or out of touch.”49(p. 9)

There were also some challenges in getting the language right for MSM-specific interventions. Some users of the *Rainbow SPARX* and *Online Mindfulness-Based Cognitive Therapy* interventions suggested that the sexuality-related terminology could be improved63 and voiced concerns about the intervention’s approach to sexual minorities and a feeling of “anti-gay sentiment.”42(p.60) Avellar suggests content might have been overly clinical and miscommunicated the aim of improving overall well-being,42 though it was not clear whether participant concerns stemmed primarily from intervention content or from content about participating in a research study.

###### Interaction and personalisation

Participants in studies of medium68 and high49,63,67 reliability valued interactive aspects of interventions spanning all three health outcomes. Studies of medium75,76 and high59 reliability found that individual-level tailoring based on participant assessments could enhance acceptability. For example, 81% of *HealthMindr* users found recommendations based on their responses useful or very useful,75 and *Smartphone Self-Monitoring* users recommended adding what the authors summarised as “more in-depth questions to better reflect their experiences.”76(p. 13)

###### Privacy and intrusiveness

In studies of medium reliability, privacy and intrusiveness emerged as important themes influencing acceptability across two interventions which between them addressed all three health outcomes. 75,76 Some *Smartphone Self-Monitoring* users felt the intervention’s use of daily surveys on substance use, sexual behaviours and medication adherence, and four-times daily surveys on physical and mental health-related quality of life were too long and/or too frequent.76 Users expressed concerns about privacy regarding questions about sexual behaviour including experiences with individual partners.76 The vast majority of *HealthMindr* app users (86%) reported feeling confident in the app’s security, including its PIN/password features and the fact that the app’s name and icon did not suggest it was focused on HIV prevention.75 At least one participant in the *Smartphone Self-Monitoring* intervention was uncomfortable with geolocation tagging of phone survey responses, though the authors note that participants were instructed on how to disable this feature.76

###### Pacing and structuring

The pacing and structuring of content influenced acceptability across health domains. In studies of medium42 and high49,64,67 reliability, a modular as opposed to single-session approach could reportedly help users absorb content,67 though they tended to like setting their own pace64 and one suggested they would have preferred to complete all modules in one sitting.49 Requiring a full week between sessions of the *Online Mindfulness-Based Cognitive Therapy* was reported as too long, detracting from acceptability.42

Users liked when intervention content progressed in a cumulative way.42 Module order and how far the participant had progressed could also affect acceptability. Findings from a high-reliability study of the three-module *Hope Project* (addressing knowledge, motivation and behaviour), which randomised the order in which modules were delivered, suggested that participants were more likely to find the knowledge module interesting when they encountered it last rather than first.78 Assessing level of interest after each module, this study also found that among those completing all modules, participants were more likely to report finding them very interesting after completing all three compared to only the first.

Programme length arose as a common theme affecting the acceptability of some modular interventions. Users of the eight-session *Online Mindfulness-Based Cognitive Therapy*,42 the seven-module *Keep it Up!* intervention49,59,67 and the five-module *Queer Sex Ed* intervention68 suggested that these programmes were too long or too time-consuming.

###### Content designed to be relevant to participants’ lives and experiences

Participants valued that interventions were designed for people like them. From studies of high reliability, it was apparent that participants valued when interventions presented realistic scenarios and examples and addressed issues relevant to their own lives.49,59,63,67 A *Keep it Up!* user appreciated that the intervention “was geared towards gay men and it understood how we operate and how dating works in the contemporary moment.”49(p. 8)

Users of the *Rainbow SPARX* and *Queer Sex Ed* interventions liked that these programmes were “LGBT-specific,”68(p. 228) designed for young people64 and included “’rainbow’ content” tailored to this group.63(p.270) Some felt there was room to go further,63,68 for example by removing content on female sexual anatomy for MSM users and adding more trans-specific content.68

*Online Mindfulness-Based Cognitive Therapy* users had mixed views on how effectively this intervention was tailored for people like them.42 Some reported appreciating that the programme was designed for men who were attracted to men, while others felt the intervention “did not have much value in the context of their lives.”42(p. 53) Some *Rainbow SPARX* users reported that tailoring could be further enhanced by including more sexuality-specific content.63

##### Perceived usefulness of the intervention

###### Gaining knowledge and skills

In studies of medium42 and high49,52,59,63,64,68,78 reliability, participants frequently cited perceived usefulness as positive in terms of the knowledge and skills the interventions aimed to impact. For example, *Queer Sex Ed* users liked that the intervention aimed to support communication and closeness with their partners, helping as one participant described to “open up doors to healthy communication.”68(p. 227)

###### Opportunities for self-monitoring and self-reflection

Findings from the evaluation of the *Smartphone Self-Monitoring* intervention (targeting sexual health, substance use and mental health outcomes)suggest that some participants valued its daily, mobile-based self-monitoring compared to the comparison group’s bi-weekly web-based approach. One user described the benefits this way:76(p. 11)

*“Helps me keep a ‘log’, like therapy—but can do it every day instead of waiting for a week to see your therapist…Nice to do it throughout the day, multiple times a day, on a daily basis. Life happens daily – not weekly like when you see a therapist.”*

Participants in three interventions which between them addressed all three health domains highlighted the opportunities for introspection and self-reflection that the interventions presented.42,49,59,67,76 As a *Smartphone Self-Monitoring* user described:76(p. 9)

*“I started changing my behavior once I started taking the surveys – I have been thinking about it for a while but the surveys make me concentrate on certain areas of my life that I wasn’t focusing on.”*

A few also reported that engaging in self-monitoring across multiple domains enhanced their awareness of the relationships between their substance use, sexual behaviours and other triggers for drug use.76 A *Keep it Up!* user described how observing the characters in the intervention helped him to reflect on his own behaviours:67(p. 3005)

*“I was able to see mistakes that I make in the actions of the characters. I wasn’t completely aware of my behavior until I judged a character’s behavior and then compared the same behavior to my own.”*

###### Opportunity for self-expression

Participants in the *Smartphone Self-Monitoring* intervention, which addressed all three health outcomes, valued the opportunity for self-expression that the intervention offered, as described by this participant:76(p. 23) “I feel free to vent to the phone about things that I can’t talk to my partner about- I can really express how I feel.”

#### Participant characteristics affecting intervention engagement and receipt

Evaluations of four interventions (two targeting sexual health alone,75,78 one targeting mental health alone,42 one targeting sexual health and substance use49) quantitatively explored the relationship between participant characteristics and intervention engagement.

A study of medium reliability of the *HealthMindr* mobile phone app found no differences in the time spent on the app by participant location in different cities in the United States, age, ethnicity or knowledge of local HIV testing,75 while a high-reliability study of the *Keep it Up!* intervention targeting young ethnically and racially diverse MSM found that among Black users, those with graduate degrees spent more time on the intervention than those with high school-level or lower levels of education.49 A study of medium reliability found no significant variation in retention for a modular mental health intervention by age, socioeconomic status (SES), ethnicity, internalised homonegativity or experience of homophobic bullying.42 A study of high reliability found no differences in participants completing one versus all three modules of the *Hope Project* (an extension of the *WRAPP* intervention, targeting rural MSM) by age, ethnicity, marital status, sexual orientation, education or student status but did find higher completion among higher-earning participants.78

Madkins, et al. conducted a high-reliability, extensive exploration of the relationship between participant characteristics and receipt of the *Keep it Up!* intervention,49 which was developed with the engagement of diverse young MSM and designed for young MSM of all racial groups.67 Researchers found several differences in the acceptability of the *Keep it Up!* intervention by race/ethnicity, education level, age and city in the United States.49 Black, Latino and other non-White users reported higher acceptability in a range of domains than did White users, and Latino users rated content more highly compared to other non-White users. In the overall sample, users with high school-level education or less rated the intervention more highly than those with higher education. Exploring the interaction of race/ethnicity and education level, the study found that higher levels of education were associated with lower acceptability among White users, while no such differences were found among Black, Latino or other non-White users. Older users and those in Atlanta compared to New York tended to rate modules more highly.

Exploring intervention receipt qualitatively, a high-reliability study found that for *Rainbow SPARX*, a computer game intervention for sexual minority youth aged 13-19 years,some older users reported that some aspects were too easy and the programme “babied” them.63(p. 272) Acknowledging the challenge of designing a programme appropriate for a range of young people, one participant aged 19 years said:63(p. 272)

*“I thought some things were a little easy…Like overall it wasn’t difficult to figure out what you needed to do. Those little puzzles were quite easy to do. I guess it would be hard to make them more difficult though because you would have to be careful that everyone could actually get it.”*

Qualitative research with participants of *Rainbow SPARX* and *Smartphone Self-Monitoring* found that these interventions could play a role in complementing external mental health support participants were receiving.64,76

#### Contextual factors affecting intervention engagement

Few studies explored how the context for using the intervention was associated with the experience of its use. Those that did focused on internet speed in high-reliability 200754 and 201078 studies of two iterations of the *WRAPP* sexual health intervention, which targeted rural MSM in the United States. Bowen, et al. found that users with dial-up compared to high-speed connections were more likely to report taking too long to load programme graphics,54 while Williams, et al. found no differences in participants completing one versus all three modules by type of internet connection.78

# Discussion

## Summary of findings

One third of reports included in the overall review reported process evaluation data. All but one process evaluation took place in the United States. Most interventions targeted a single health domain of interest for this review (sexual health, substance use or mental health), with the majority focused on sexual health. However, two aimed to address aspects of all three.52,76 Some interventions employed personal tailoring, an approach that has been associated with effective e-health behaviour change interventions.79,80

Process evaluations rarely explored how intervention receipt varied between contexts. We found no eligible reports examining what factors affected intervention delivery as opposed to receipt. This seems to reflect the emerging state of process evaluations in e-health literature, with other reviews of e-health interventions reporting a similar pattern.81-84 There was some suggestion that slower internet speed could reduce acceptability of a multi-media intervention among rural MSM in the United States, who are less likely than non-rural residents to have high-speed internet at home.85

In terms of intervention characteristics, as with use of e-health interventions among general populations,83 participants appreciated when interventions were easy to use and free of technical problems, while incompatibility with mobile platforms detracted from acceptability and could impede participation. Privacy also emerged as an important aspect of acceptability, suggesting that detailed partner-level questions on sexual behaviour could feel intrusive and that features protecting app access and obscuring the purpose of apps (for sensitive health domains) promote acceptability. The importance of privacy is also supported by existing evidence on behaviour change interventions for MSM86 and general populations.83

Participants liked content that was interactive and aesthetically pleasing, and they enjoyed the use of diverse media such as animations, videos and graphics. However, among rural MSM these media could also reduce loading times for users with slower internet connectivity. While modular approaches could support users to absorb programme content cumulatively, interventions that were too long detracted from acceptability and some users preferred that less or no time be required between sessions. The ideal number and length of modules will likely depend on a variety of participant, intervention and contextual factors.

Individual tailoring based on participant characteristics and risk profiles increased acceptability, highlighting this as a particularly promising approach and aligning with other studies of e-health behavioural interventions.79,84,87 Participants valued when interventions presented scenarios and other content that reflected their experiences as MSM, an approach that stands in contrast to most existing e-health interventions targeting mental health and HIV prevention.34,88 Where interventions targeted sexual minority groups more broadly, some suggested further tailoring based on the sexual and gender identities of its users. The language and tone of intervention content emerged as an important factor shaping acceptability for MSM, who appreciated the use of colloquial, direct, “up-beat”67(p.3005) and sex-positive language. Our findings also highlight the importance of paying careful attention to language and framing to ensure that these affirm sexual-minority identities. That these concerns arose in interventions designed explicitly for sexual minority users, including one adapted for sexual minority young people using participatory approaches,63 suggests this is an important area to explore during the pilot phase of intervention development.

As with studies of e-health interventions for general populations,81,83 perceived usefulness was key to acceptability. Participants liked gaining new knowledge and skills from e-health interventions and developing an awareness of the relationship between sexual behaviours and substance use.

While reviews of e-health interventions for general populations report higher use and engagement among participants with higher levels of education,81,83,84 our findings suggest that in the context of generally high use of electronic devices among MSM17 the targeting of intervention content might be a more important determinant of the relationship between education level and receipt of e-health interventions than their electronic mode of delivery.49 Similarly, our findings on the higher acceptability of the *Keep it Up!* intervention among Black, Latino and other non-White users compared to White users suggest that e-health interventions can be developed to enhance inclusive acceptability among racially and ethnically diverse users.49 There was otherwise little evidence of engagement varying by socio-demographic factors, though findings on SES were mixed.42,78 Qualitative data suggest e-health interventions can play a role in complementing external mental health support among MSM63,76 and that interventions targeting all adolescents might struggle to pitch content appropriately for those across this age range.63

## Limitations

Our process evaluation synthesis was limited by the size and quality of eligible reports. Most were assessed as medium- or high-quality in terms of their reliability and usefulness. However, studies often lacked depth and breadth of analysis, and only around half were judged to privilege MSM’s perspectives.

While the vast majority of interventions targeted MSM only and all were evaluated principally among MSM, three were assessed among samples that included cisgender women.63,64,68,76 Author narratives and quantitative data did not always disaggregate MSM from other participants, presenting the possibility that specific findings from these three studies might reflect data from other groups. The process evaluation of *Smartphone Self-Monitoring* was the sole study contributing to findings on intervention benefits of self-monitoring and self-expression.76 While the intervention targeted people of all genders and sexual identities living with HIV, more than 80% of study participants identified as male and more than 80% identified as gay or bisexual.76 In two studies just under half of participants identified as female,63,64,68 but all themes informed by these studies also drew on other studies. The make-up of participants in these three studies is therefore unlikely to affect the validity of the themes to which they contributed. Studies of relevant interventions among broader sexual and gender minority populations might add further insight but could not be included as we could not be certain which findings reflected experiences of or relevant to MSM.

## Implications for research and practice

E-health interventions offer an avenue for MSM to access behaviour change interventions privately, anonymously and at times they find convenient. This synthesis identified several factors shaping MSM’s receipt of e-health interventions addressing substance use, mental ill health and sexual risk. Its findings suggest such interventions are acceptable for MSM across sociodemographic groups, though evidence in this area is limited and mixed. Different content for younger and older adolescents might be warranted. Variation in engagement and acceptability by participant characteristics should be explored in future research, and new interventions should be rigorously piloted to refine aspects affecting usability and acceptability.30,81

Our review has identified several intervention characteristics affecting acceptability that existing research suggests are applicable to e-health interventions for MSM and non-MSM populations alike. These include aspects of usability, length, aesthetics, multi-media use and tailoring to participants’ personal and risk characteristics.79,81,83,84,86,87 Other factors should be considered carefully in designing interventions for MSM, including ensuring that language and tone are affirming of sexual minority identity and that content reflects the reality and experiences of MSM. These findings can inform the development of integrated e-health interventions to address the syndemic of substance use, mental ill health and sexual risk among MSM and guide research questions for pilot and process evaluation studies. Going forward, process evaluations should explore a broader range of individual, intervention and contextual factors that might affect implementation, and they should collect more in-depth, ideally qualitative, data privileging the perspectives of intended beneficiaries. Outcome evaluations of such e-health interventions should conduct linked process evaluations wherever possible, which would shed further light on factors affecting how they are delivered and received.89

Our findings regarding the value that participants place on interventions that address the reality of their lives and inter-relationships between the different domains of health suggest that e-health interventions simultaneously addressing sexual health, substance use and mental health might be particularly acceptable. Our review of theories of change (forthcoming) suggests that interventions addressing these different outcomes may aim to exert impacts via common mechanisms of action, further adding to the potential for e-health interventions targeting multiple outcomes together. Our next analyses will assess the potential effectiveness of e-health interventions on these outcomes.

# Acknowledgments

This work was funded by the National Institute for Health Research Public Health Research Programme (PHR 17/44/48). This report presents independent research commissioned by the NIHR. The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, MRC, CCF, NETSCC, the Public Health Research programme or the Department of Health. The funder had no role in study design, in the collection, analysis or interpretation of data, or in writing this manuscript.

# Authors’ contributions

CB conceptualised and led the design of the study. AM, TCW, GJMT, JF, PW and RM contributed to the development of the study’s methods. RM and CB developed the intervention typology and quality-assessed and synthesised process evaluation studies. RM led the drafting of the manuscript, with significant input from AM, CB, TCW, GJMT and PW.

# Conflicts of interest

None declared.

# References

1. Knight D, Jarrett D. Preventive Health Care for Men Who Have Sex with Men. *American Family Physician.* 2015;91(12):844-852.

2. Stall R, Friedman M, Catania J. Interacting epidemics and gay men’s health: a theory of syndemic production among urban gay men. In: Wolitski R, Stall R, Valdiserri R, eds. *Unequal opportunity: health disparities affecting gay and bisexual men in the United States.* New York, NY: Oxford University Press; 2008.

3. Beyrer C, Baral S, van Griensvan F, et al. Global epidemiology of HIV infection in men who have sex with men. *Lancet.* 2012;380(9839):367-377.

4. Aghaizu A. *HIV in the United Kingdom: 2013.* London2013.

5. Guasp A. *The gay and bisexual men’s health survey.* London2012.

6. Buffin J. *Part of the picture: lesbian, gay and bisexual people's alocohol and drug use in England (2009-2011).* Manchester2012.

7. Lee J, Griffen G, Melvin C. Tobacco use among sexual minorities in the USA 1987-May 2007: a systematic review. *Tobacco Control.* 2009;18(275-282).

8. Vosburgh H, Mansergh G, Sullivan P, Purcell D. A review of the literature on event-level substance use and sexual risk behavior among men who have sex with men. *AIDS Behav.* 2012;16(6):1394-1410.

9. Hickson F, Bonell C, Weatherburn P, Reid D. Illicit drugs use among men who have sex with men in England and Wales. *Addiction Research & Theory.* 2010;18(1).

10. Schmidt A, Bourne A, Weatherburn P, et al. Illicit drug use among gay and bisexual men in 44 cities: Findings from the European MSM Internet Survey (EMIS). *Int J Drug Policy.* 2016;38:4-12.

11. King M, Semlyen J, Tai S, et al. A systematic review of mental disorder, suicide, and deliberate self harm in lesbian, gay and bisexual people. *BMC Psychiatry.* 2008;8(70).

12. McFall S. *Understanding Society.* Colchester2012.

13. Friedman M, Stall R, Plankey M, et al. Effects of syndemics on HIV viral load and medication adherence in the Multicenter AIDS Cohort Study. *AIDS.* 2015;29(9):1087-1096.

14. Halkitis P, Kapadia F, Bub K, Barton S, Moreira A, Stults C. A longitudinal investigation of syndemic conditions among young gay, bisexual, and other MSM: the P18 Cohort Study. *AIDS and Behavior.* 2015;19:970-980.

15. Halkitis P, Kupprat S, Hampton M, et al. Evidence for a syndemic in aging HIV-positive gay, bisexual, and other MSM: implications for a holistic approach to prevention and health care. *Annals of Anthropological Practice.* 2013;36(2):365-386.

16. Jie W, Ciyong L, Xueqing D, Hui W, Lingyao H. A Syndemic of Psychosocial Problems Places the MSM (Men Who Have Sex with Men) Population at Greater Risk of HIV Infection. *PLoS One.* 2012;7(3):e32312.

17. Melendez-Torres G, Nye E, Bonell C. Internet sex-seeking is inconsistently linked with sexual risk in men who have sex with men: systematic review of within-subjects comparisons. *Sex Health.* 2015;12(3):183-187.

18. Riper H, Blankers M, Hadiwijaya H, et al. Effectiveness of guided and unguided low-intensity internet interventions for adult alcohol misuse: a meta-analysis. *PLoS One.* 2014;9(6):e99912.

19. Andersson G, Cuijpers P. Internet-based and other computerized psychological treatments for adult depression: a meta-analysis. *Cogn Behav Ther.* 2009;38(4):196-205.

20. Andrews G, Cuijpers P, Craske MG, McEvoy P, Titov N. Computer therapy for the anxiety and depressive disorders is effective, acceptable and practical health care: a meta-analysis. *PLoS One.* 2010;5(10):e13196.

21. Arnberg FK, Linton SJ, Hultcrantz M, Heintz E, Jonsson U. Internet-delivered psychological treatments for mood and anxiety disorders: a systematic review of their efficacy, safety, and cost-effectiveness. *PLoS One.* 2014;9(5):e98118.

22. Pasarelu CR, Andersson G, Bergman Nordgren L, Dobrean A. Internet-delivered transdiagnostic and tailored cognitive behavioral therapy for anxiety and depression: a systematic review and meta-analysis of randomized controlled trials. *Cogn Behav Ther.* 2017;46(1):1-28.

23. Spijkerman MP, Pots WT, Bohlmeijer ET. Effectiveness of online mindfulness-based interventions in improving mental health: A review and meta-analysis of randomised controlled trials. *Clin Psychol Rev.* 2016;45:102-114.

24. Christensen H, Batterham P, Calear A. Online interventions for anxiety disorders. *Curr Opin Psychiatry.* 2014;27(1):7-13.

25. Kaltenthaler E, Parry G, Beverley C, Ferriter M. Computerised cognitive-behavioural therapy for depression: systematic review. *Br J Psychiatry.* 2008;193(3):181-184.

26. Gabarron E, Wynn R. Use of social media for sexual health promotion: a scoping review. *Glob Health Action.* 2016;9(1):32193.

27. L'Engle KL, Mangone ER, Parcesepe AM, Agarwal S, Ippoliti NB. Mobile Phone Interventions for Adolescent Sexual and Reproductive Health: A Systematic Review. *Pediatrics.* 2016;138(3).

28. Schnall R, Travers J, Rojas M, Carballo-Diéguez A. eHealth Interventions for HIV Prevention in High-Risk Men Who Have Sex With Men: A Systematic Review. *J Med Internet Res.* 2014;16(5):e134.

29. Noar SM, Black HG, Pierce LB. Efficacy of computer technology-based HIV prevention interventions: a meta-analysis. *AIDS.* 2009;23(1):107-115.

30. Nguyen L, Tran B, Rocha L, et al. A systematic review of eHealth interventions addressing HIV/STI prevention among men who have sex with men. *AIDS and Behavior.* 2019;23:2253-2272.

31. Purnomo J, Coote K, Mao L, et al. Using eHealth to engage and retain priority populations in the HIV treatment and care cascade in the Asia-Pacific region: a systematic review of literature. *BMC Infect Dis.* 2018;18(1).

32. Muessig K, LeGrand S, Horvath K, Bauermeister J, Hightow-Weidman L. Recent mHealth interventions to support medication adherence among HIV-positive men who have sex with men. *Curr Opin HIV AIDS.* 2017;12(5):432-441.

33. Glasgow R, Vogt T, Boles S. Evaluating the public health impact of health promotion interventions: the RE-AIM framework. *Am J Public Health.* 1999;89(9):1322-1327.

34. Rozbroj T, Lyons A, Pitts M, Mitchell A, Christensen H. Assessing the applicability of e-therapies for depression, anxiety, and other mood disorders among lesbians and gay men: analysis of 24 web- and mobile phone-based self-help interventions. *J Med Internet Res.* 2014;16(7).

35. Falconer J. *Search strategies for: How can e-health interventions reduce the ‘syndemic’ of HIV/STIs and sexual risk, substance use and mental ill health among men who have sex with men? [Data Collection].* London, United Kingdom: London School of Hygiene & Tropical Medicine;2020.

36. Egan M, Bambra C, Petticrew M, Whitehead M. Reviewing evidence on complex social interventions: development and testing of a new tool for appraising implementation. *Journal of Epidemiology & Community Health.* 2009;63:4-11.

37. Shepherd J, Harden A, Rees R, et al. *Young People and Healthy Eating: A systematic review of barriers and facilitators.* London: EPPI-Centre, Social Science Research Unit; 2001.

38. Arai L, Roen K, Roberts H, Popay J. It might work in Oklahoma but will it work in Oakhampton? Context and implementation in the effectiveness literature on domestic smoke detectors. *Inj Prev.* 2005;11:148-151.

39. Noyes J, Popay J, Garner P. What can qualitative research contribute to a Cochrane systematic review of DOT for promoting adherence to tuberculosis treatment? . Qualitative Research and Systematic Reviews workshop; 28-29 June, 2005; Continuing Professional Development Centre, University of Oxford.

40. Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology.* 2008;8:45.

41. Green J, Torogood N. *Qualitative methods for health research.* 4 ed. London: Sage; 2018.

42. Avellar T. *The feasibility and acceptability of an online mindfulness-based cognitive therapy intervention for same-sex attracted men*, University of California Santa Barbara; 2016.

43. Cheng W, Xu H, Tang W, et al. Online HIV prevention intervention on condomless sex among men who have sex with men: a web-based randomized controlled trial. *BMC Infect Dis.* 2019;19.

44. Chiou P, Liao P, LIU C, H Y. Effects of mobile health on HIV risk reduction for men who have sex with men. *AIDS CARE.* 2020;32(3):316-324.

45. Coulter R, Sang J, Louth-Marquez W, et al. Pilot Testing the Feasibility of a Game Intervention Aimed at Improving Help Seeking and Coping Among Sexual and Gender Minority Youth: Protocol for a Randomized Controlled Trial. *JMIR Res Protoc.* 2019;8(2).

46. Hirshfield S, Downing MJ, Chiasson M, et al. Evaluation of Sex Positive! A Video eHealth Intervention for Men Living with HIV. *AIDS and Behavior.* 2019;23:3103-3118.

47. Kuhns L, Garofalo R, Hidalgo M, et al. A randomized controlled efficacy trial of an mHealth HIV prevention intervention for sexual minority young men: MyPEEPS mobile study protocol. *BMC Public Health.* 2020;20(65).

48. Jones J, Dominguez K, Stephenson R, et al. A Theoretically Based Mobile App to Increase Pre-Exposure Prophylaxis Uptake Among Men Who Have Sex With Men: Protocol for a Randomized Controlled Trial. *JMIR Res Protoc.* 2020;9(2).

49. Madkins K, Moskowitz D, Moran K, Dellucci T, Mustanski B. Measuring Acceptability and Engagement of the Keep It Up! Internet-based HIV Prevention Randomized Controlled Trial for Young Men who have Sex with Men. *AIDS Educ Prev.* 2019;31(4):287-305.

50. Reback C, Fletcher J, Leibowitz A. Cost effectiveness of text messages to reduce methamphetamine use and HIV T sexual risk behaviors among men who have sex with men. *Journal of Substance Use Treatment.* 2019;100:59-63.

51. Tan R, Koh W, Le D, et al. Effect of a web drama video series on HIV and other sexually transmitted infection testing among gay, bisexual and queer men: study protocol for a community-based, pragmatic randomised controlled trial in Singapore: the People Like Us (PLU) Evaluation Study. *BMJ Open.* 2020;10.

52. Bauermeister J, Tingler R, Demers M, et al. Acceptability and Preliminary Efficacy of an Online HIV Prevention Intervention for Single Young Men Who Have Sex with Men Seeking Partners Online: The myDEx Project. *AIDS and Behavior.* 2019;23:3064-3077.

53. Bauermeister J, Tingler R, Michele Demers M, Harper G. Development of a Tailored HIV Prevention Intervention for Single Young Men Who Have Sex With Men Who Meet Partners Online: Protocol for the myDEx Project. *JMIR Research Protocols.* 2017;6(7):12.

54. Bowen A, Horvath K, Williams M. A randomized control trial of Internet-delivered HIV prevention targeting rural MSM. *Health Education Research.* 2007;22(1):8.

55. Bowen A, Williams M, Daniel C, Clayton S. Internet based HIV prevention research targeting rural MSM: feasibility, acceptability, and preliminary efficacy. *J Behav Med.* 2008;31(6):15.

56. Carpenter K, Stoner S, Mikko A, Dhanak L, Parsons J. Efficacy of a Web-Based Intervention to Reduce Sexual Risk in Men Who Have Sex with Men. *AIDS Behav.* 2010(14):9.

57. Christensen J, Miller L, Appleby P, et al. Reducing shame in a game that predicts HIV risk reduction for young adult men who have sex with men: a randomized trial delivered nationally over the web. *Journal of the International AIDS Society.* 2013;16:8.

58. Davidovich U, de Wit J, Stroebe W. Using the internet to reduce risk of HIV-infection in steady relationships: A randomized controlled trial of a tailored intervention for gay men. In:2006.

59. Greene G, Madkins K, Andrews K, Dispenza J, Mustanski B. Implementation and evaluation of the Keep it Up! online HIV prevention intervention in a community-based setting. *AIDS Education and Prevention.* 2016;28(3):15.

60. Hirshfield S, Downing MJ, Parsons J, et al. Developing a Video-Based eHealth Intervention for HIV-Positive Gay, Bisexual, and Other Men Who Have Sex with Men: Study Protocol for a Randomized Controlled Trial. *JMIR Research Protocols.* 2016;5(2):14.

61. Kok G, Harterink P, Vriens P, de Zwart O, Hospers H. The Gay Cruise: Developing a Theory- and Evidence-Based Internet HIV-Prevention Intervention. *Sexuality Research & Social Policy.* 2006;3(2):52-67.

62. Linnemayr S, MacCarthy S, Kim A, Giguere R, Carballo-Dieguez A, Barreras J. Behavioral economics-based incentives supported by mobile technology on HIV knowledge and testing frequency among Latino/a men who have sex with men and transgender women: Protocol for a randomized pilot study to test intervention feasibility and acceptability. *Trials.* 2018(19):9.

63. Lucassen M, Hatcher S, Fleming T, Stasiak K, Shepherd M, Merry S. A qualitative study of sexual minority young people’s experiences of computerised therapy for depression. *Australasian Psychiatry.* 2015;23(3):6.

64. Lucassen M, Merry S, Simon Hatcher S, Frampton C. Rainbow SPARX: A Novel Approach to Addressing Depression in Sexual Minority Youth. *Cognitive and Behavioral Practice.* 2015;22(2):14.

65. Milam J, Jain S, Daar E, et al. Controlled Trial of an Internet-Based Risk Reduction Intervention in HIV+ Men Who Have Sex With Men [abstract]. *Topics in Antiviral Medicine.* 2014;22(e-1):2.

66. Milam J, Morris S, Jain S, et al. Randomized Controlled Trial of an Internet Application to Reduce HIV Transmission Behavior Among HIV Infected Men Who have Sex with Men. *AIDS Behav.* 2016;20(6):11.

67. Mustanski B, Garofalo R, Monahan C, Gratzer B, Andrews R. Feasibility, Acceptability, and Preliminary Efficacy of an Online HIV Prevention Program for Diverse Young Men who have Sex with Men: The Keep It Up! Intervention. *AIDS Behav.* 2013;17(9):14.

68. Mustanski B, Greene G, Ryan D, Whitton S. Feasibility, Acceptability, and Initial Efficacy of an Online Sexual Health Promotion Program for LGBT Youth: The Queer Sex Ed Intervention. *The Journal of Sex Research.* 2015;42(2):11.

69. Mustanski B, Madkins K, Greene G, et al. Internet-Based HIV Prevention With At-Home Sexually Transmitted Infection Testing for Young Men Having Sex With Men: Study Protocol of a Randomized Controlled Trial of Keep It Up! 2.0. *JMIR Research Protocols.* 2017;6(1):17.

70. Mustanski B, Parsons J, Sullivan P, Madkins K, Rosenberg E, Swann G. Biomedical and Behavioral Outcomes of Keep It Up!: An eHealth HIV Prevention Program RCT. *American Journal of Preventive Medicine.* 2018;55(2):8.

71. Reback C, Fletcher J, Swendeman D. Theory-based Text Messages Reduce Methamphetamine Use and HIV Sexual Risk Behaviors among MSM [abstract]. *Neuroimmune Pharmacol.* 2017;12:1.

72. Reback C, Fletcher J, Swendeman D, Metzner M. Theory‑Based Text‑Messaging to Reduce Methamphetamine Use and HIV Sexual Risk Behaviors Among Men Who Have Sex with Men: Automated Unidirectional Delivery Outperforms Bidirectional Peer Interactive Delivery. *AIDS and Behavior.* 2019;23(1):11.

73. Rosser B, Oakes J, Konstan J, et al. Reducing HIV Risk Behavior of MSM through Persuasive Computing: Results of the Men’s INTernet Study (MINTS-II). *AIDS.* 2010;24(13):9.

74. Schonnesson L, Bowen A, Williams M. Project SMART: Preliminary Results From a Test of the Efficacy of a Swedish Internet-Based HIV Risk-Reduction Intervention for Men Who Have Sex With Men. *Arch Sex Behav.* 2016;45(6):11.

75. Sullivan P, Driggers R, Stekler J, 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):14.

76. Swendeman D, Ramanathan C, Baetscher L, et al. Smartphone self-monitoring to support self-management among people living with HIV: Perceived benefits and theory of change from a mixed-methods, randomized pilot study. *J Acquir Immune Defic Syndr.* 2015;69:12.

77. Wilkerson J, Danilenko G, Myer B, Rosser B. The Role of Critical Self-Reflection on Assumptions in Changes in Sexual Beliefs and Behaviors by Men Who Use the Internet to Seek Sex with Men. *AIDS Education and Prevention.* 2011;23(1):12.

78. Williams M, Bowen A, Ei S. An Evaluation of the Experiences of Rural MSM Who Accessed an Online HIV/AIDS Health Promotion Intervention. *Health Promot Pract.* 2010;11(4):9.

79. Morrison L, Yardley L, Powell J, Michie S. What Design Features are Used in Effective eHealth Interventions? A Review using Techniques from Critical Interpretative Synthesis. *Telemedicine and e-Health.* 2012;18(2):137-144.

80. Noar S, Black H, Pierce L. Efficacy of computer technology-based HIV prevention interventions: a meta-analysis. *AIDS.* 2009;23(1):107-115.

81. Chib A, Lin S. Theoretical Advancements in mHealth: A Systematic Review of Mobile Apps. *Journal of Health Communication.* 2018;23(10-11):909-955.

82. Christie H, Bartels S, Boots L, Tange HJ, Verhey F, de Vugt M. A systematic review on the implementation of eHealth interventions for informal caregivers of people with dementia. *Internet Interventions.* 2018;13:51-59.

83. Simblett S, Greer B, Matcham F, et al. Barriers to and Facilitators of Engagement With Remote Measurement Technology for Managing Health: Systematic Review and Content Analysis of Finding. *J Med Internet Res.* 2018;20(7):e10480.

84. Perski O, Blandford A, West R, Michie S. Conceptualising engagement with digital behaviour change interventions: a systematic review using principles from critical interpretive synthesis. *Transl Behav Med.* 2017;7(2):254-267.

85. Center PR. Internet/Broadband Fact Sheet. Pew Research Center. Internet & Technology Web site. www.pewresearch.org/internet/fact-sheet/internet-broadband/. Published 2019. Updated 12 June 2019. Accessed 25 June 2020, 2020.

86. Hergenrather K, Emmanuel D, Durant S, Rhodes S. Enhancing HIV Prevention Among Young Men Who Have Sex With Men: A Systematic Review of HIV Behavioral Interventions for Young Gay and Bisexual Men. *AIDS Educ Prev.* 2016;28(3):252-271.

87. Gorini A, Mazzacco K, Triberti S, Sebri V, Savioni L, Pravettoni G. A P5 Approach to m-Health: Design Suggestions for Advanced Mobile Health Technology. *Front Psychol.* 2018;9:2066.

88. Sullivan P, Jones J, Kishore N, Stephenson R. The Roles of Technology in Primary HIV Prevention for Men Who Have Sex with Men. *Curr HIV/AIDS Rep.* 2015;12(4):481-488.

89. Moore G, Audrey S, Barker M, et al. Process evaluation of complex interventions: Medical Research Council guidance. *BMJ.* 2015;350:h1258.