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E-health interventions targeting STIs, sexual risk, substance use and mental health among men who have sex with men: four systematic reviews

*Rebecca Meiksin, GJ Melendez-Torres, Alec Miners, Jane Falconer, T Charles Witzel,
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Abstract

E-health interventions targeting STIs, sexual risk, substance use and mental health among men who have sex with men: four systematic reviews

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Background: Human immunodeficiency virus/sexually transmitted infections, sexual risk, substance (alcohol and other legal and illegal drugs) use and mental ill health constitute a 'syndemic' of mutually reinforcing epidemics among men who have sex with men. Electronic health (e-health) interventions addressing these epidemics among men who have sex with men might have multiplicative effects. To our knowledge, no systematic review has examined the effectiveness of such interventions on these epidemics among men who have sex with men.

Objective: The objective was to synthesise evidence addressing the following: (1) What approaches and theories of change do existing e-health interventions employ to prevent human immunodeficiency virus/sexually transmitted infections, sexual risk, alcohol/drug use or mental ill health among men who have sex with men? (2) What factors influence implementation? (3) What are the effects of such interventions on the aforementioned epidemics? (4) Are such interventions cost-effective?

Data sources: A total of 24 information sources were searched initially (October–November 2018) [the following sources were searched: ProQuest Applied Social Sciences Index and Abstracts; Campbell Library; EBSCO Cumulative Index to Nursing and Allied Health Literature Plus, Wiley Online Library The Cochrane Library; Centre for Reviews and Dissemination databases (the Database of Abstracts of Reviews of Effects and the NHS Economic Evaluation Database); the Health Technology Assessment database; Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) database of health promotion research (Bibliomap); ProQuest Dissertations & Theses Global; OvidSP EconLit; OvidSP EMBASE; OvidSP Global Health; OvidSP Health Management Information Consortium; ProQuest International Bibliography of the Social Sciences; Ovid MEDLINE ALL; OvidSP PsycINFO; Web of Science Science Citation Index Expanded; Elsevier Scopus; OvidSP Social Policy & Practice; Web of Science Social Sciences Citation Index Expanded; ProQuest Sociological Abstracts; ClinicalTrials.gov; World Health Organization International Clinical Trials Registry Platform; EPPI-Centre Trials Register of Promoting Health Interventions; and the OpenGrey database], and an updated search of 19 of these was conducted in April 2020. Reference lists of included reports were searched and experts were contacted.

Review methods: Eligible reports presented theories of change and/or process, outcome and/or economic evaluations of e-health interventions offering ongoing support to men who have sex with men to prevent human immunodeficiency virus/sexually transmitted infections, sexual risk behaviour, alcohol/drug use and/or common mental illnesses. References were screened by title/abstract, then by full text. Data extraction and quality assessments used existing tools. Theory and process reports were synthesised using qualitative methods. Outcome and economic data were synthesised narratively; outcome data were meta-analysed.

Results: Original searches retrieved 27 eligible reports. Updated searches retrieved 10 eligible reports. Thirty-seven reports on 28 studies of 23 interventions were included: 33 on theories of change, 12 on process evaluations, 16 on outcome evaluations and one on an economic evaluation. Research question 1: five intervention types were identified – ‘online modular’, ‘computer games’ and ‘non-interactive’ time-limited/modular interventions, and open-ended interventions with ‘content organised by assessment’ and ‘general content’. Three broad types of intervention theories of change were identified, focusing on ‘cognitive/skills’, ‘self-monitoring’ and ‘cognitive therapy’. Research question 2: individual tailoring based on participant characteristics was particularly acceptable, and participants valued intervention content reflecting their experiences. Research question 3: little evidence was available of effects on human immunodeficiency virus or sexually transmitted infections. The analysis did not suggest that interventions were effective in reducing instances of human immunodeficiency virus or sexually transmitted infections. The overall meta-analysis for sexually transmitted infections reported a small non-significant increase in sexually transmitted infections in the intervention group, compared with the control group. Meta-analyses found a significant impact on sexual risk behaviour. The findings for drug use could not be meta-analysed because of study heterogeneity. Studies addressing this outcome did not present consistent evidence of effectiveness. Trials did not report effects on alcohol use or mental health. Research question 4: evidence on cost-effectiveness was limited.

Limitations: The quality of the eligible reports was variable and the economic synthesis was limited to one eligible study.

Conclusions: There is commonality in intervention theories of change and factors affecting receipt of e-health interventions. Evidence on effectiveness is limited.

Future work: Future trials should assess the impact of interventions on multiple syndemic factors, among them sexual risk, substance use and mental health; incorporate sufficient follow-up and sample sizes to detect the impact on human immunodeficiency virus/sexually transmitted infections; and incorporate rigorous process and economic evaluations.

Study registration: This study is registered as PROSPERO CRD42018110317.

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List of supplementary material

Report Supplementary Material 1 Trial registration

Report Supplementary Material 2 Slide deck for initial stakeholder consultation

Report Supplementary Material 3 Slide deck for second stakeholder consultation

Supplementary material can be found on the NIHR Journals Library report page (<https://doi.org/10.3310/BRWR6308>).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

List of abbreviations

AO	assessment only	LGBT	lesbian, gay, bisexual and transgender
ASSIA	Applied Social Sciences Index and Abstracts	LGBTQ+	lesbian, gay, bisexual, transgender, queer or questioning
CAI	condomless anal intercourse	MOTIVES	Mobile Technology and Incentives
CBT	cognitive-behavioural therapy	MSM	men who have sex with men
CHEERS	Consolidated Health Economic Evaluation Reporting Standards	NHS EED	NHS Economic Evaluation Database
CI	confidence interval	NMA	network meta-analysis
CINAHL	Cumulative Index to Nursing and Allied Health Literature	nPEP	non-occupational post-exposure prophylaxis
CRD	Centre for Reviews and Dissemination	OR	odds ratio
DARE	Database of Abstracts of Reviews of Effects	PPI	patient and public involvement
df	degrees of freedom	PrEP	pre-exposure prophylaxis
e-health	electronic health	PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
EPPI-Centre	Evidence for Policy and Practice Information and Co-ordinating Centre	RCT	randomised controlled trial
GRADE	Grading of Recommendations Assessment, Development and Evaluation	ROBINS-I	Risk Of Bias In Non-randomized Studies – of Interventions
HIV	human immunodeficiency virus	RQ	research question
HMIC	Health Management Information Consortium	RR	risk ratio
HTA	Health Technology Assessment	SE	standard error
IBSS	International Bibliography of the Social Sciences	SES	socioeconomic status
ICER	incremental cost-effectiveness ratio	SOLVE	Socially Optimized Learning in Virtual Environments
ICTRP	International Clinical Trials Registry Platform	STI	sexually transmitted infection
IMB	information-motivation-behavioural skills	TRoPHI	Trials Register of Promoting Health Interventions
		WRAPP	Wyoming Rural Acquired immunodeficiency syndrome Prevention Project

Plain English summary

Men who have sex with men are at higher risk of human immunodeficiency virus and other sexually transmitted infections than the general population. They are more likely to drink heavily or use drugs. They are also more likely to experience anxiety or depression. Men experiencing one of these problems are more likely to experience others.

Electronic health (e-health) interventions use applications, websites or other electronic methods to improve health. Among the general population, these can reduce alcohol consumption and address common mental illnesses. They show promise for reducing sexual risks and drug use. There might be a benefit in developing a single e-health intervention addressing these outcomes among men who have sex with men. We reviewed existing studies to see if this looks like a promising approach.

We searched for all studies of e-health interventions targeting men who have sex with men to address sexual risks, substance use and mental ill health. We assessed study quality. We summarised what this research says about the sorts of interventions that have been used and how they are meant to work, what factors affect how well they are delivered/received, whether or not they improve the health of men who have sex with men and whether or not these benefits are worth the money they cost.

We found 37 relevant reports. These suggest that e-health interventions addressing sexual risk, substance use and mental ill health among men who have sex with men are intended to work in similar ways, even when focused on different outcomes. Users liked interventions that were tailored to their personal experiences and needs.

There was limited evidence on whether or not these interventions improve the health of men who have sex with men. They appear to reduce sexual risks and may reduce drug use. There was no evidence on whether or not they reduce alcohol use or mental ill health. There was little information on whether or not the interventions represented value for money. Future research should assess e-health interventions that aim to improve the health of men who have sex with men across more than one of these areas, including areas with less existing evidence (human immunodeficiency virus/sexually transmitted infections, substance use and mental health).

Scientific summary

Background and rationale

This review synthesises evidence on electronic health (e-health) interventions aiming to reduce the 'syndemic' (simultaneous, mutually reinforcing epidemics) of human immunodeficiency virus (HIV)/sexually transmitted infections (STIs) and sexual risk, substance (alcohol and legal and illegal drug) use and mental ill health among men who have sex with men (MSM).

E-health interventions are delivered via electronic media and devices; previous studies suggest that such interventions can reduce alcohol use and mental ill health among general or mixed populations, and might reduce drug use and sexual risk behaviour. If such interventions are also effective in addressing these outcomes among MSM, there may be value in developing an e-health intervention that targets these outcomes simultaneously among MSM. To our knowledge, no systematic review has assessed the effectiveness of e-health interventions across these outcomes. This systematic review aimed to synthesise theories of change and process, outcome and economic evaluations of e-health interventions targeting sexual risk, substance use and mental ill health among MSM.

Aims and research questions

The aims were to search systematically for, appraise the quality of and synthesise evidence to address the following research questions:

- What approaches and theories of change do e-health interventions employ to prevent HIV, STIs, sexual risk behaviour, alcohol and drug use or common mental illness symptoms among MSM?
- What factors relating to interventions, providers, participants or contexts promote or impede delivery or receipt of such interventions?
- What are the effects of such interventions on HIV and STIs, sexual risk behaviour, alcohol and drug use, and depression and anxiety overall, and by intervention and client subgroup?
- Are such interventions cost-effective in reducing these outcomes?
- Does the existing evidence overall suggest that these outcomes can coherently, feasibly and effectively be addressed by an e-health intervention targeting UK MSM and, if so, what might such an intervention look like?

Methods

Inclusion criteria

Eligible studies focused on e-health interventions providing ongoing support to MSM to prevent HIV, STIs, sexual risk behaviour, alcohol/drug use or common mental illnesses. The review excluded interventions delivering one-off support; addressing HIV self-testing, clinic attendance or STI partner notification only; and/or delivered by human providers via electronic media. Eligible reports described intervention theories of change and/or reported on process, outcome and/or economic evaluations.

Search methods for the identification of studies

Searching information sources

The search strategy included terms covering two core concepts: MSM and e-health. Publication dates were limited from 1995 to date. We initially searched 24 information sources (23 October to 26 November 2018). We conducted an updated search (22–27 April 2020) across 19 information sources.

We searched various websites for additional results throughout 1–26 November 2018, and updated this throughout 22–27 April 2020.

We also searched reference lists from all included studies and contacted subject experts.

Information management and study selection

Citations identified by our searches were uploaded to EndNote [Clarivate Analytics (formerly Thomson Reuters), Philadelphia, PA, USA] and deduplicated before being uploaded to EPPI-Reviewer (version 4.0) [Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre), Social Science Research Unit, Institute of Education, University of London].

Two reviewers double-screened batches of the same 50 references. Disagreements were resolved by discussion, referring to a third reviewer when needed. After reaching an agreement rate of at least 95%, each reference was henceforth single-screened on title/abstract. Retained references were then reviewed on the basis of the full report.

Data collection and assessment

Data extraction

Two reviewers independently extracted data using existing tools. Disagreements were resolved by discussion, referring to a third reviewer when necessary. For theory reports, we extracted data on the constructs and mechanisms described, the evidence presented in support of the theory of change and how the theory of change was developed. For all empirical studies, we extracted data on basic study details, methods and interventions. For process evaluations, we extracted data on how processes of delivery/receipt varied with the characteristics of the interventions, providers, participants or contexts. For outcome evaluations, we extracted data on allocation; sequence generation and concealment (randomised controlled trials); control of confounding (quasi-experimental studies); measures, follow-up and blinding; retention; and outcomes/effects at follow-up(s), both overall and, when available, by sexuality and gender identity, socioeconomic status and ethnicity. For economic evaluations, we extracted data on key issues such as the perspective (direct and indirect costs), evaluation framework, source of effectiveness estimates, critical assumptions, discount rates and cost-effectiveness in the form of either incremental cost-effectiveness ratios or net (health) benefits. We also aimed to report on the key cost-effectiveness drivers.

Assessments of quality and risk of bias

The quality of each report was assessed independently by two reviewers using standard or modified versions of existing tools. The reviewers met to compare their assessments and resolved any differences through discussion, referring to a third reviewer when necessary.

Theory reports were assessed on the basis of the extent to which the theory of change described the path from intervention to outcomes; the clarity with which theoretical constructs were defined; the clarity with which causal inter-relationships between constructs were defined; the extent to which the mechanisms underlying these inter-relationships were explained; and the extent to which the theory of change considered how mechanisms and outcomes might vary by context.

Process evaluations were assessed on the basis of the rigour of sampling, data collection and data analysis; the extent to which the study findings were grounded in the data; whether or not the study privileged the perspectives of participants; breadth of findings; and depth of findings. These assessments were then used to assign to each study a 'weight of evidence' (low, medium or high) to rate the (a) reliability or trustworthiness and (b) usefulness of the findings.

Outcome studies were assessed for risk of bias on the basis of sequence generation, allocation concealment, blinding of participants or personnel, blinding of outcome assessors, incomplete outcome data, selective outcome reporting and other sources of bias. Each study was subsequently identified as being at 'high risk', 'low risk' or 'unclear risk' of bias within each domain.

Economic evaluations were assessed using an adapted version of an existing tool comprising 24 questions ranging from the type of economic evaluation to the time horizon and rationale for the choice of modelling approach. We expanded its questions to ensure that information that was particularly relevant to this review was extracted, such as identifying uptake rates and assumptions regarding the heterogeneity of risk.

Data analysis

Typology of intervention approaches

The intervention descriptions and theories of change were analysed to develop a typology of interventions, which were described in terms of behaviour change techniques.

Theories of change synthesis

We synthesised theories of change using a meta-ethnographic approach. We developed a novel diagrammatic approach to theory synthesis that allowed us to summarise the components of each intervention's theory of change and the relationships between them.

Process data synthesis

We synthesised qualitative and quantitative elements of process evaluation reports using thematic synthesis methods.

Outcome data synthesis

We conducted a narrative synthesis by outcome, grouping effect estimates by post-intervention follow-up duration. When necessary, we rebased follow-up times using the stated intervention duration, but report in our narrative synthesis follow-up times as described in original reports. We produced forest plots for each of our review outcomes, with separate plots for different outcomes and follow-up times, and pairwise comparisons between intervention types (e.g. intervention vs. no treatment control, or vs. another treatment type). Plots included point estimates and standard errors for each study, expressed as standardised mean differences (Cohen's *d*) to ensure comparability across reports.

When data allowed, we calculated pooled effect sizes within each pairwise comparison, accounting for the extent of heterogeneity among the studies. If an indication of substantial heterogeneity was determined with fewer than three studies (e.g. study-level $I^2 > 50\%$), we did not present a pooled estimate by follow-up time or across follow-up times. When we produced pooled estimates, we used a robust variance estimation meta-analysis model to synthesise effect sizes. We estimated separate models for each outcome: HIV, STIs, defined sexual risk behaviours, alcohol use, drug use, anxiety and depression. We regarded follow-up times of < 3 months, 3 months to 1 year and > 1 year post intervention as different outcomes, pooling first by follow-up times and, when appropriate, overall across follow-up times. We used the Grading of Recommendations Assessment, Development and Evaluation to present the quality of evidence.

Synthesis of economic data

Measures of costs, indirect resource use and cost-effectiveness were summarised in a table and adjusted for currency and inflation to the current UK context. These data were used to inform a narrative synthesis of economic evidence and applicability to the UK context.

Stakeholder consultation

We assembled a patient and public involvement stakeholder group and met with members twice during the review. In April/May 2020, stakeholders reviewed slides summarising the main findings in relation to the typology of interventions and to the theory of change and process evaluation syntheses. We asked stakeholders to advise on the feasibility of drawing on the interventions presented to inform the development of an overall intervention addressing the syndemic of sexual risk, substance use and mental ill health among UK MSM. In December 2020, stakeholders reviewed slides summarising the results of the outcome and economic syntheses. We explored with stakeholders whether or not this evidence suggested that it would be worth investing in the development of an e-health intervention to address multiple outcomes among UK MSM, and we sought advice on dissemination and knowledge transfer.

Ethics approval

The research involved no human participants and drew solely on evidence already in the public realm; therefore, research ethics approval was not required.

Results

Included studies

The original searches retrieved 20,727 unique references and 27 eligible reports. The updated search retrieved 5317 unique references and 10 eligible reports. In total, 37 reports on 28 studies of 23 interventions were included: 33 on theories of change, 12 on process evaluations, 16 on outcome evaluations and one on an economic evaluation. Of the included interventions, 20 addressed sexual health, 10 addressed substance use and seven addressed mental health outcomes.

What approaches and theories of change do existing e-health interventions employ to prevent immunodeficiency virus, sexually transmitted infections, sexual risk behaviour, alcohol and drug use or common mental illness symptoms among men who have sex with men?

Interventions fell into two overarching types, each containing subtypes: time-limited/modular (guiding participants sequentially through intervention content from beginning to end) and open ended (not designed as fixed and sequenced bodies of learning intended for all participants to work through).

Among time-limited/modular interventions, 'online modular' interventions were interactive, modular programmes delivered online. The other two subtypes identified were 'computer games' and 'non-interactive interventions'. Among open-ended interventions, the 'content organised by assessment' subtype comprised interventions that tailored the delivery of core content based on user risk assessments. The 'general content' subtype comprised interventions delivering the same content to all participants.

We developed three synthesised intervention theories of change. In the 'cognitive/skills' synthesised theory of change, which drew on the vast majority of intervention theories of change included in this review, information and exercises were theorised to influence behavioural skills directly and via various cognitive factors relating to motivation/intention and self-efficacy/perceived control. The 'self-monitoring' synthesised theory of change focused more narrowly on the role of self-monitoring in triggering reflection, self-reward/critique and behavioural self-regulation. In the 'cognitive therapy' synthesised theory of change, intervention activities were theorised to promote awareness and recognition of a participant's thoughts, feelings and situations and, via either challenging or accepting negative cognitions, aimed to reframe negative emotions to improve mental health.

What factors relating to interventions, providers, participants or contexts promote or impede delivery or receipt of such interventions?

Perceived usefulness was key to intervention acceptability. Acceptability was enhanced when interventions were easy to use and free from technical problems, and when their content was clear and comprehensive, engaging, interactive and aesthetically pleasing. Privacy was an important aspect of acceptability, suggesting that detailed, partner-level questions on sexual behaviour could feel intrusive and that features protecting application (hereafter referred to as 'app') access and obscuring the manifest purpose of apps would promote acceptability. Language and tone were highlighted as important aspects of acceptability. Individual tailoring based on participant characteristics and risk profiles also increased acceptability, and participants valued interventions that presented scenarios and other content that reflected their experiences as MSM. There was little evidence on how intervention receipt varied by participant or provider characteristics.

What are the effects, overall and by intervention and client subgroup, of such interventions on the outcomes of human immunodeficiency virus, sexually transmitted infections, sexual risk behaviour, alcohol and drug use, and depression and anxiety?

Little evidence was available on the effects of included interventions on HIV or STI outcomes. Analysis did not suggest that included interventions were effective at reducing HIV infections, but with low certainty of evidence (based on assessment of bias and statistical imprecision in the evidence): there was an increase in HIV infections in the intervention versus control groups of 0.12 standard deviations [95% confidence interval (CI) -0.34 to 0.59]. A pooled analysis of short-term (< 3 months) effects on STI outcomes found no impact, with very low precision, while the single trial exploring mid-term (3 months–1 year) effects of such an intervention suggested a significant reduction in incident STIs with moderate certainty. The overall analysis across short- and medium-term follow-ups suggested a small and non-significant increase in STIs in the intervention group, compared with the control group (Cohen's $d = 0.07$, 95% CI -0.79 to 0.94).

Pooled estimates suggested a statistically significant impact on sexual risk behaviour at mid-term follow-up, with low or very low certainty. Estimates pooling across measures and follow-up time suggested interventions reduced sexual risk, compared with control groups (Cohen's $d = -0.15$, 95% CI -0.26 to -0.05). We tested whether or not interactivity of interventions (users entering information that determined intervention content) related to intervention impact on sexual risk behaviours, but did not find a significant effect.

The findings for drug use could not be meta-analysed because of study heterogeneity, and were of very low certainty. Studies addressing this outcome did not present consistent evidence of effectiveness, with only one reporting evidence of impact (short term).

Trials did not include data on alcohol use or mental health outcomes.

We found only two studies that examined the effects of e-health interventions on outcomes that spanned sexual health and drug use, with one reporting no effects of an e-health intervention on sexual risk behaviour, but an effect on one measure of drug use, and another reporting effects on measures of sexual risk behaviour and drug use, but not on HIV or STIs. We found no evaluations of e-health interventions reporting effects for other combinations of outcome domains.

Moderation of intervention effectiveness by income, ethnicity and other social variables was not meaningfully addressed by this body of evidence.

Are such interventions cost-effective in reducing these outcomes?

The single eligible study assessing cost-effectiveness suggested that the intervention may have been cost-effective in reducing condomless anal intercourse, but this finding was undermined by a large degree of uncertainty around these results.

Does the existing evidence overall suggest that these outcomes can coherently, feasibly and effectively be addressed by a single, joined-up e-health intervention targeting UK men who have sex with men?

We identified three distinct theory of change pathways underpinning existing e-health interventions for MSM targeting sexual health, substance use and mental health outcomes, two of which underpin interventions targeting all three of these outcomes. Similarly, we identified several factors shaping the receipt of e-health interventions by MSM, which applied across targeted outcomes. However, evidence of effectiveness is currently limited because the majority of interventions were focused on individual outcomes, with patchy effects for the outcomes that were assessed.

Conclusions

Future trials of e-health interventions are needed and these should aim to address the multiple syndemically linked outcomes of HIV, STIs, sexual risk behaviours, drug and alcohol use and mental ill health among MSM, including domains with less existing evidence (HIV/STIs, substance use and mental health). Future studies should involve interventions using common theories of change to address the multiple outcomes, and incorporate follow-up and sample sizes sufficient to detect meaningful impact.

Study registration

This study is registered as PROSPERO CRD42018110317.

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Chapter 1 Introduction

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Background

This review synthesises evidence on electronic health (e-health) interventions aiming to reduce the 'syndemic' of human immunodeficiency virus (HIV)/sexually transmitted infections (STIs) and sexual risk, substance use (defined as use of alcohol and other legal and illegal drugs) and mental ill health among men who have sex with men (MSM). A syndemic refers to simultaneous, mutually reinforcing epidemics, in this case of sexual risk, substance use and mental ill health.

Description of the problem

Despite major advances in treatments and pharmacological prevention, MSM continue to experience the highest incidence of STIs and HIV of any population group in the UK, and report high levels of sexual risk behaviours.^{2,3} The lifetime cost of treatment per HIV infection in the UK is almost £380,000.⁴ Each case of other STIs is estimated to cost £1215 per infection.⁵ MSM also report high rates of alcohol⁶⁻⁸ and recreational drug use⁹⁻¹¹ and high rates of common mental illnesses.¹² MSM are twice as likely as other men to be depressed or anxious.¹³ According to the 2013 Annual Report of the Chief Medical Officer, mental health problems cost the UK economy an estimated £70–100 billion each year.¹⁴

Sexual risk, alcohol and drug use, and mental ill health are increasingly considered to constitute a 'syndemic', in that these outcomes commonly co-occur and mutually reinforce one another. There is consistent evidence that these outcomes intercorrelate strongly at the level of the individual and the sexual event.¹⁵⁻²¹ Drug use is both a symptom and cause of mental ill health, and both drug use and mental illness are associated with increased sexual risk behaviours.²² Nationally representative surveys suggest that almost half of MSM experience one or more of these outcomes.²³ MSM who report using certain drugs – nitrite inhalants and various drugs commonly used during sex and at parties – are more likely to report sexual risk with multiple partners.²⁴ Survey data indicate that MSM reporting substance use are more likely to report condomless anal intercourse (CAI) and HIV infection,²⁵ MSM with higher levels of anxiety and depression are more likely to have potential alcohol dependency²⁶ and MSM with depressive symptoms report more CAI.²⁷ Therefore, public health strategies to address these outcomes together have the potential to achieve multiplicative effects because interventions may have impacts directly on each outcome, as well as via multipliers involving other outcomes acting as mediators.

Existing public health strategies have failed to adequately address these outcomes either separately or together.^{28,29} Common mental illnesses among MSM are underdiagnosed and undertreated, partly because of low rates of general practice registration.³⁰ One study reported that, among MSM attending sexual health clinics in the UK, 42% of those with depressive symptoms were not diagnosed and 48% were not receiving treatment.³¹ Spending on HIV prevention for MSM is falling³² despite strong evidence, albeit primarily from non-UK studies, for effective interventions.³³ Drug treatment services tend to focus predominantly on heroin and crack cocaine, rather than the drugs most commonly used by MSM. There is an urgent need for cost-effective new strategies to address these outcomes.

Description of the intervention

E-health interventions are those facilitated by electronic media and devices. Such interventions aim to promote healthy behaviours and mental health by increasing or maintaining motivation, setting and reviewing goals, providing feedback on behaviour, and challenging thought patterns that obstruct change. Behaviour change interventions typically draw on social learning theory and the transtheoretical model, while mental health interventions draw on mindfulness or cognitive-behavioural approaches. There is good evidence from systematic reviews focused on general or mixed populations that e-health interventions can reduce alcohol use³⁴ and address common causes of mental ill health.³⁵⁻⁴¹ Emerging evidence also suggests that e-health interventions might reduce drug use and sexual risk behaviour.⁴²⁻⁴⁵ Given the clustered and interacting nature of these problems among MSM, if e-health interventions were found to be effective in addressing these outcomes among MSM, then this might suggest the value of developing an e-health intervention that addresses these outcomes simultaneously and holistically. Such an approach might well have multiplicative, not merely additive, effects.

Rationale for the current study

We cannot assume that effects found for e-health interventions targeting general or mixed populations^{34-42,44-46} are applicable to MSM. Effect sizes may be greater for MSM because of MSM's greater use of social media, including to meet sexual partners and obtain drugs.⁴⁷ But effects may be limited by MSM's risk being influenced by factors that e-health interventions cannot address, such as early and ongoing experience of homophobia⁴⁸⁻⁵⁰ and participation in social networks in which social norms support risk behaviour.⁵¹ Therefore, there is a need to assess the potential effects of e-health interventions on these outcomes among MSM.

A 2014 review by Schnall *et al.*⁴³ examined e-health interventions to reduce HIV and other sexual risks among MSM (but did not examine alcohol or drug use or mental health), reporting that such interventions have the potential to be effective. This review had several important limitations such as a very narrow search, unreliable quality assessment and a lack of synthesis of effect estimates. These limitations explain why it was not able to provide a clear answer to the question of whether or not e-health interventions are effective in reducing sexual risk behaviour. A 2017 review by Daher *et al.*⁵² synthesised evidence on a range of e-health interventions addressing different aspects of the prevention and treatment of HIV/STIs, but did not address substance use or mental health. This review had broad inclusion criteria focused on 'innovative' interventions and all populations, not just MSM. Its very limited search strategy found only two studies pertinent to this review, and so can offer no clear indication of the impact of e-health interventions on sexual risk among MSM.^{53,54} A 2019 review by Nguyen *et al.*⁵⁵ assessed e-health interventions targeting HIV/STI prevention among MSM, concluding that such interventions could achieve short-term behavioural impacts, but with only one intervention reporting an impact after 1 year. In this review, heterogeneity precluded meta-analysis, neither substance use nor mental health were addressed, the search was limited to four databases and interventions included those with a human component (e.g. chat room). Only one existing review has examined e-health interventions addressing mental ill health among gay and lesbian populations, but it did not synthesise empirical evidence on these, and so provides no guide as to their effectiveness.⁵⁶ Furthermore, none of the above reviews synthesised the theories of change for how included interventions were intended to modify the health outcomes, nor synthesised evidence on factors affecting delivery or receipt.

The present systematic review aimed to address these gaps in order to determine the effectiveness of e-health interventions addressing these outcomes among MSM. It focused on interventions addressing HIV, STIs, sexual risk behaviour, alcohol and drug use, or mental health, aiming to synthesise evidence of effects on these outcomes. We were interested in studies of interventions that addressed outcomes

in these different domains either in combination or separately. The former would indicate whether or not there is already good evidence for 'holistic' e-health interventions to address this syndemic of interclustered outcomes. The latter would provide some indication of the potential for developing and testing such a holistic intervention, particularly if no such holistic interventions have been evaluated to date. It also aimed to synthesise theories of change to understand how interventions are intended to work, evidence from process evaluations on what factors affect delivery and receipt to assess what factors might affect the transferability of such interventions, and evidence from economic evaluations to examine the cost-effectiveness of such interventions. This review thus aimed to provide the evidence required to determine the value of, and inform the development of, an e-health intervention holistically addressing the syndemic of HIV and STIs, sexual risk behaviour, alcohol and drug use and mental ill health among MSM.

This review also aimed to use a network meta-analytic approach to compare the effectiveness of interventions that had not, to date, been the subject of empirical comparisons. This approach has not been used in any previous reviews of e-health interventions among MSM and could transform our understanding of which intervention approaches and combinations are most effective. However, we were unable to undertake these models with the body of evidence included because pairwise comparisons did not form an interconnected network with similar populations and outcomes.

Review aims, questions and objectives

Review aims and questions

The aims of this review were to search systematically for, appraise the quality of and synthesise evidence to address the following research questions:

- Research question (RQ) 1. What approaches and theories of change do existing e-health interventions employ to prevent HIV, STIs, sexual risk behaviour, alcohol and drug use or common mental illness symptoms among MSM?
- RQ2. What factors relating to interventions, providers, participants or contexts promote or impede delivery or receipt of such interventions?
- RQ3. What are the effects of such interventions on HIV and STIs, sexual risk behaviour, alcohol and drug use, and depression and anxiety, overall and by intervention and client subgroup?
- RQ4. Are such interventions cost-effective in reducing these outcomes?
- RQ5. Does the existing evidence overall suggest that these outcomes can coherently, feasibly and effectively be addressed by a single, joined-up e-health intervention targeting UK MSM and, if so, what might such an intervention look like?

Review objectives

- To conduct electronic and other searches.
- To screen found references and reports for inclusion in the review.
- To extract data from, and assess the quality of, included studies.
- To develop a typology of interventions and synthesise theories of change and process evaluations.
- To consult with policy/practice and community stakeholders on the typology and theory of change/process synthesis.
- To synthesise outcome evaluation and cost-effectiveness data.
- To draw on these syntheses to draft a report addressing our research questions.
- To consult with policy/practice and community stakeholders on the draft report (to inform amendments and dissemination).
- To submit the final report to the National Institute for Health Research.

Chapter 2 Review methods

About this chapter

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Research design overview

The aim was to conduct a multimethod systematic review of intervention types, theories of change, processes and outcomes, and cost-effectiveness of e-health interventions employed to prevent HIV and STIs, sexual risk behaviour, alcohol and drug use or common mental illness symptoms among MSM. The review followed criteria for the good conduct and reporting of systematic reviews [e.g. the guidance from the Centre for Reviews and Dissemination (CRD)⁵⁹ and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)⁶⁰], and the PRISMA checklist⁶¹ is provided. The protocol was registered with PROSPERO (International Prospective Register of Systematic Reviews) (see *Report Supplementary Material 1*).⁶²

Our review and synthesis of intervention descriptions and theories of change enabled us to categorise intervention types and describe theories of change (RQ1). Our review of process evaluations enabled us to identify what characteristics of interventions, providers, participants and contexts tended to facilitate or limit implementation and receipt (RQ2). Our review of outcome evaluations enabled us to estimate the effectiveness of interventions (RQ3). Our review of economic evaluations was designed to enable us to estimate the cost-effectiveness of the interventions (RQ4). Synthesis across these elements informed assessment of the value of developing an e-health intervention targeting UK MSM (RQ5).

Inclusion criteria for this review

Types of participant

The review focused on gay, bisexual and other men (including trans men) who have sex with men, including those who have been diagnosed as HIV positive, as well as those whose last HIV test was negative or who have never tested for HIV. To determine study eligibility, we operationalised this focus by requiring that MSM constituted at least half of the sample.

Types of intervention

The review focused on interactive or non-interactive e-health interventions delivered via mobile phone applications (hereafter referred to as 'apps'), the internet or other electronic media (i.e. electronic communication technology) that aimed to provide ongoing support to populations consisting entirely or principally of MSM to prevent HIV, STIs, sexual risk behaviour, alcohol and drug use or common mental illnesses. These could include interventions that also aimed to promote HIV treatment adherence or that addressed HIV testing or pre-exposure prophylaxis, as long as these also addressed sexual risk behaviour, substance use behaviour or mental health. It excluded e-health interventions facilitating merely one-off, as opposed to ongoing, support and those addressing HIV self-testing, clinic attendance or STI partner notification only. The e-health interventions were electronically delivered; interventions delivered by human providers via electronic media were excluded. The interventions could be distributed by commercial, statutory, academic or voluntary sector agencies.

Types of control

The review focused on treatment as usual, no treatment or other active treatment control groups.

Types of outcome

The review focused on HIV or STIs, sexual risk behaviour, alcohol consumption (e.g. self-reported alcohol consumption via questionnaires or diaries), legal and illegal drug use (e.g. self-reported drug use) and anxiety or depression (clinical or self-report measures). Studies were included if they addressed any, some or all of these outcomes. Outcome measures could draw on dichotomous or continuous variables, and self-reports or reports by other raters. Behavioural outcomes could use measures of frequency (monthly, weekly or daily), the number of episodes of use or an index constructed from multiple measures. Alcohol measures could examine alcohol consumption or problem drinking. Drug outcomes could examine drugs in general or specific illicit drugs, and could include drug convictions.

Types of studies

To address RQ1, we included process and outcome evaluations providing intervention descriptions or theories of change, as well as theoretical reports. To address RQ2, we included process evaluations. To address RQ3, we included outcome evaluations. To address RQ4, we included economic evaluations. To address RQ5, we drew on all of the above. Included theoretical reports described intervention theories of change, logic models or mechanisms of effect. Included process evaluations could employ any quantitative and/or qualitative design, but were required to report empirically how delivery or receipt varied by characteristics of intervention, provider, user or context using quantitative and/or qualitative data. These studies could report exclusively on process evaluations or report process alongside outcome data. Included outcome and economic evaluations employed prospective experimental or quasi-experimental control groups.

Search strategy

Database search strategy

The search string used in a limited preliminary search in PubMed (see *Appendix 1*) informed the development of a more sophisticated search strategy (see *Appendix 2*), thereby maximising sensitivity, as recommended by the *Cochrane Handbook for Systematic Reviews of Interventions*.⁶³

Search terms

A draft search strategy was compiled in the OvidSP MEDLINE database by an experienced information specialist (JF). The search strategy included strings of terms, synonyms and controlled vocabulary terms (when available) to reflect two concepts:

- concept 1: MSM
- concept 2: e-health.

These concepts were combined using the Boolean operator 'AND'. We did not use outcome terms in our searches as these are likely to miss studies reporting non-significant effects on our outcomes, and therefore bias the review. Our searches involved different free-text and controlled vocabulary terms for each of these concepts, linked using 'OR'. The combination of these concepts was considered specific enough to include all available studies regardless of study design. We restricted the searches by date (from 1995 onwards, as e-health interventions were unavailable prior to this), but not by language or publication type.

Key search terms were determined by using published strategies covering lesbian, gay, bisexual, transgender, queer or questioning (LGBTQ+) populations and e-health interventions, and tested using a systematic approach. Our LGBTQ+ search strategy derived from a search put together by Parker *et al.*⁶⁴ Our e-health search strategy derived from a search published by Thabrew *et al.*⁶⁵ Our approach to testing our search strategy was informed by the technique described by Bramer *et al.*⁶⁶ Our search strategy was refined with the project team until the results retrieved reflected the scope of the project. The agreed OvidSP MEDLINE search was adapted for each database to incorporate database-specific syntax and controlled vocabularies. Full details of the search strings used for each database can be found in *Appendix 2* and are available at the London School of Hygiene & Tropical Medicine's Data Repository.⁶⁷

Databases

The following databases were searched between 23 October 2018 and 26 November 2018 (see *Appendix 2*), with searches updated between 22 and 27 April 2020 (see *Appendix 3*). Owing to the COVID-19 lockdown in the UK and a lack of access to libraries, some databases were not included in the updated searches: OvidSP Health Management Information Consortium (HMIC), ProQuest Applied Social Sciences Index and Abstracts (ASSIA), ProQuest Sociological Abstracts and ProQuest International Bibliography of the Social Sciences (IBSS).

- ProQuest ASSIA (1987–current, as of 29 October 2018). Owing to lack of access, this database search was not updated in April 2020.
- Campbell Library (complete database as of 27 April 2020).
- EBSCO Cumulative Index to Nursing and Allied Health Literature (CINAHL) Plus (complete database as of 22 April 2020).
- Wiley Online Library The Cochrane Library (complete database as of 27 April 2020).
- CRD databases. Since 2015, the Database of Abstracts of Reviews of Effects (DARE) and the NHS Economic Evaluation Database (NHS EED) are no longer updated. The Health Technology Assessment (HTA) database was updated to 26 October 2018. These databases had not been updated, and so were not searched in 2020.
- Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI-Centre) database of health promotion research (Bibliomap) (full database as of 27 April 2020).
- ProQuest Dissertations & Theses Global (1951–current, as of 27 April 2020).
- OvidSP EconLit (1886 to 16 April 2020).
- OvidSP EMBASE (1980 to 21 April 2020).
- OvidSP Global Health (1910 to 2020 week 15).
- OvidSP HMIC (1979 to July 2018). Owing to lack of access, this database search was not updated in April 2020.
- ProQuest IBSS (1951–current, as of 29 October 2018). Owing to lack of access, this database search was not updated in April 2020.
- Ovid MEDLINE ALL (1946 to 21 April 2020).
- OvidSP PsycINFO (1806 to April week 2, 2020).
- Web of Science Science Citation Index Expanded (1970–present, data last updated 21 April 2020).
- Elsevier Scopus (complete database as of 22 April 2020).
- OvidSP Social Policy & Practice (as of 2020).
- Web of Science Social Sciences Citation Index Expanded (1970–present, data last updated 21 April 2020).
- ProQuest Sociological Abstracts (1952–current, as of 29 October 2018). Owing to lack of access, this database search was not updated in April 2020.

These databases were selected to retrieve research literature from the fields of health and social sciences. We amended the list of databases that were originally intended to be searched (see *Appendix 4*) on the advice of, and informed by initial pilot searches by, the information scientist (JF).

Search strategy for other literature sources

The following clinical trials registers were searched for relevant ongoing and unpublished trials:

- ClinicalTrials.gov (complete database as of 27 April 2020).
- World Health Organization International Clinical Trials Registry Platform (ICTRP) (complete database as of 26 November 2018). Owing to the COVID-19 pandemic, the ICTRP search functionality was removed. Therefore, this search could not be updated.
- EPPI-Centre Trials Register of Promoting Health Interventions (TRoPHI) (full database as of 27 April 2020).

Search terms were derived from the OvidSP MEDLINE search compiled for database searching. All trial details were examined for their relevance and included if they met our inclusion criteria.

To find other grey literature, the complete OpenGrey database was searched on 1 November 2018 and again on 27 April 2020, using a version of the OvidSP MEDLINE search compiled for database searching. Google (Google Inc., Mountain View, CA, USA) was searched on 21 November 2018 in incognito mode to look for non-governmental organisation and governmental publications. Search terms were derived from the OvidSP MEDLINE search compiled for database searching. The first 100 results for each search were examined for their relevance and included if they met our inclusion criteria. The Google search was not updated in 2020.

Full details of the search strings used for these sources can be found in *Appendix 2* and *Appendix 3* and are available at the London School of Hygiene & Tropical Medicine's Data Repository.⁶⁷

We also carefully searched reference lists from all studies that met our inclusion criteria. We contacted subject experts during the initial search and again at the time of our updated search to identify relevant ongoing or completed research (see *Appendix 5*). Our protocol specified that we would hand-search journals that published included studies that were found only via reference checking, and which were not indexed on databases we had searched, but no journals met this criterion.

Information management and study selection

All citations identified by our searches conducted in 2018 were uploaded to EndNote [Clarivate Analytics (formerly Thomson Reuters), Philadelphia, PA, USA] for duplicate removal. Duplicates were identified and removed using an established technique.⁶⁸ Deduplicated results were then uploaded to EPPI-Reviewer (version 4.0) (EPPI-Centre, University of London, London, UK). The updated search results retrieved in 2020 were uploaded to the same EndNote library, where citations already identified in 2018, and duplicates found within the results of the 2020 search, were removed. Any citations published before 1995 were also removed. Deduplicated results were then uploaded to EPPI-Reviewer.

To inform screening, an inclusion criteria worksheet with guidance notes was prepared and piloted by two reviewers screening batches of the same 50 references (as allocated automatically by EpPI-Reviewer). When the two reviewers disagreed, they met to discuss this and, if possible, reach a consensus. When the reviewers were unable to reach consensus regarding the inclusion of a specific article, judgement for selection was referred to a third reviewer. We planned to organise translation of reports published in languages in which no reviewers were proficient, but this issue did not arise. After this piloting process achieved an agreement rate of at least 95%, each reference was henceforth screened on the basis of title

and abstract for potential inclusion by one reviewer. Full reports were obtained for those references judged as meeting our inclusion criteria or for those for which there was insufficient information from the title and abstract to judge inclusion. A second round of screening with a comparable piloting process then occurred, focused on full study reports, to determine which studies would be included in the review. We maintained a record of the selection process for all screened material.

Data extraction

Two reviewers independently extracted data from, and assessed the quality of, theory, process, outcome and economic reports meeting our inclusion criteria using existing tools.^{63,69,70} When the two reviewers disagreed, they met to discuss this and, if possible, reach a consensus. If the reviewers could not reach consensus regarding the particulars of data extraction for a specific study, judgement was referred to a third reviewer. Included studies were described using the EPPI-Centre classification system for health promotion and public health research,⁷¹ supplemented by additional codes developed for this review. For reports included in the theory of change synthesis (henceforth termed 'theory reports'), we extracted data on the constructs and mechanisms described, the evidence presented in support of the theory of change and how the theory of change was developed. Intervention theories of change typically draw on existing scientific theories of behaviour (which consider factors that predict behaviours) and/or existing scientific theories of behaviour change (which propose general mechanisms of changing behaviour). We extracted data on intervention theory of change, as well as the existing scientific theories of behaviour and behaviour change that informed these. For all empirical studies, we extracted data on basic study details (target population, study location, timing and duration, research questions or hypotheses), methods (design, sampling and sample size, data collection and analysis) and intervention description (timing and duration, programme development, content and activities, providers, details of any intervention offered to the control group). For process evaluations, two reviewers used an adapted version of an existing tool⁷² to independently extract data reporting empirically on how processes of delivery/receipt varied with characteristics of interventions, providers, participants or contexts. For outcome evaluations, we also extracted data on allocation; sequence generation and concealment [randomised controlled trials (RCTs)]; control of confounding (quasi-experimental studies); measures, follow-up and blinding; retention; and data on outcomes/effects at follow-up(s) both overall and, when available, by sexuality and gender identity, socioeconomic status (SES) and ethnicity. For economic evaluations, we extracted data on key issues such as the perspective (direct and indirect costs), evaluation framework, source of effectiveness estimates, critical assumptions, discount rates and cost-effectiveness in the form of either incremental cost-effectiveness ratios (ICERs) or net (health) benefits. We also aimed to report on the key cost-effectiveness drivers. We aimed to involve a translator if included studies were reported in languages that could not be translated by the review team, but this issue did not arise. The data extraction tools for theory reports and for process, outcome and economic evaluation reports are provided.

Where there was a risk of missing data from published reports affecting our analysis, we contacted authors whenever possible to request additional information. If authors were not traceable or if the sought information was unavailable from the authors within 2 months of contacting them, we recorded that the study information was missing on the data extraction form, and this was included in our risk-of-bias assessment of the study.

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Assessments of quality and risk of bias

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We assessed reporting bias according to Sterne *et al.*'s⁷⁵ guidance. We aimed to reduce the effect of reporting bias by focusing the synthesis on studies rather than publications, thereby avoiding duplicated data. Following the Cho *et al.*⁷⁶ statement on redundant publications, we attempted to identify duplicate studies and, when multiple articles reported on the same study, we extracted duplicated data only once. We prevented location bias by searching across multiple databases. We prevented language bias by not excluding any article based on language.

Assessment of theories of change

We assessed the quality of descriptions of intervention theories of change using a modified version of the criteria developed in our previous systematic reviews of school-based interventions integrating health and academic education, positive youth development and school health education interventions,^{77,78} modified in the light of our more recent work on realist methods.⁷⁹ The assessment focused on (a) the extent to which the theory of change described the path from intervention to outcomes, (b) the clarity with which theoretical constructs were defined, (c) the clarity with which causal inter-relationships between constructs were defined, (d) the extent to which the mechanisms underlying these inter-relationships were explained and (e) the extent to which the intervention theory of change considered how mechanisms and outcomes might vary by context. The two reviewers then met to compare their assessments, resolving any differences through discussion and, when necessary, by calling on a third reviewer.

Assessment of process evaluations

We assessed the quality of the qualitative and quantitative elements of process evaluations using an EPPI-Centre tool.⁸⁰ The assessment addressed the rigour of sampling, data collection and data analysis; the extent to which the study findings were grounded in the data; whether or not the study privileged the perspectives of participants; the breadth of findings (i.e. the extent to which the study explored a broad range of process issues); and the depth of findings (i.e. the extent to which the study provided in-depth insights into participant perspectives). This was then used to assign studies to two categories of 'weight of evidence'. First, reviewers assigned a weight (low, medium or high) to rate the reliability or trustworthiness of the findings (the extent to which the methods employed were rigorous/could minimise bias and error in the findings). Second, reviewers assigned an additional weight (low, medium, high) to rate the usefulness of the findings (i.e. the extent to which these could shed light on how processes of intervention delivery/receipt varied with characteristics of interventions, providers, participants or contexts). Guidance was given to reviewers to help them reach an assessment on each criterion and on the final weight of evidence. The two reviewers then met to compare their assessments, resolving any differences through discussion and, when necessary, by calling on a third reviewer.

Assessment of outcome evaluations

For outcome evaluations, we assessed the risk of bias of each included experimental study using the tool outlined in the *Cochrane Handbook for Systematic Reviews of Interventions*.⁶³ For each study, two reviewers independently judged the likelihood of bias in seven domains: sequence generation, allocation concealment, blinding of participants or personnel, blinding of outcome assessors, incomplete outcome data, selective outcome reporting and other sources of bias (e.g. recruitment bias in cluster randomised studies). Each study was subsequently identified as being at 'high risk', 'low risk' or 'unclear risk' of bias in each domain. In cases of disagreement, the reviewers met to seek consensus and, when necessary, referred judgement to a third reviewer. The protocol did not originally specify a quality assessment tool for non-random studies. An amendment to the protocol (see *Appendix 7*) stipulated that such studies would be assessed using the Risk Of Bias In Non-randomised Studies – of Interventions (ROBINS-I) tool,⁸¹ but no non-random evaluations were eligible for inclusion in the review.

Assessment of economic evaluations

We initially planned to assess the quality of economic evaluations using the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist,⁸² but amended the protocol (see *Appendix 7*) to do so using a more appropriate tool: an adapted version of the Drummond *et al.*⁸³ reporting guideline. It requires the assessor to answer 24 questions regarding each study, ranging from

the type of economic evaluation (e.g. cost–utility analysis) to the time horizon and rationale for the choice of modelling approach. Although the questionnaire is detailed, we expanded a number of its questions to ensure that information that was particularly relevant to this review was extracted, such as identifying uptake rates and assumptions regarding the heterogeneity of risk (see *Appendix 6*). Two reviewers each conducted this assessment independently, then met to compare their assessments, resolving any differences through discussion and, when necessary, by calling on a third reviewer.

Data analysis

Typology of intervention approaches

Intervention descriptions and theories of change were first analysed to develop a typology of interventions. We intended to incorporate whether or not interventions were focused solely on the prevention of alcohol or drug use; HIV, STIs and sexual risk behaviour (sometimes referred to as 'sexual health outcomes' in this report, for brevity); or mental illness; and whether or not they had other aims such as access to HIV testing or adherence to HIV treatment. As planned, we identified interventions' targeted outcomes. However, we ultimately developed a typology of interventions based on authors' narrative descriptions of intervention methods because the strongest similarities and differences between interventions emerged in relation to the approaches used, and interventions addressing similar outcomes often took different approaches to doing so.

Research question 1: synthesis of intervention theories of change

Using thematic synthesis methods,^{84–86} we undertook a synthesis of author narratives and depictions describing theories of how interventions were intended to generate outcomes. The aim was to develop an overarching theory of change for e-health interventions, or multiple such overarching theories if this was more appropriate. The synthesis was not restricted to studies judged to be of high quality. Instead, conclusions drawing on poorer-quality reports were given less interpretive weight. We focused on prospective theories of change rather than retrospective reflections on how interventions might have worked in the light of study findings. Author narratives describing rationales for aspects and characteristics of the intervention in which the author did not link these to theorised mechanisms of change were also excluded. Theory of change synthesis commonly uses a meta-ethnographic approach, originally developed to synthesise findings across multiple qualitative studies.⁸⁷ As originally applied to qualitative research, meta-ethnographic methods draw on primary constructs (verbatim qualitative data presented in reports of primary research) and secondary constructs (author interpretations of data presented in primary research) to develop tertiary constructs (reviewer interpretations presented in syntheses). Applied to theory synthesis, such methods draw solely on primary constructs (author descriptions of theories of change).

Informed by our typology of included interventions, two reviewers undertook a pilot analysis of the theory of change extracted from each of the two highest-quality studies of the same intervention type. We initially planned to undertake line-by-line coding of theory reports in order to identify recurring narrative themes across theories of change, as we have done in previous theory syntheses.^{77,78} Each of two reviewers independently applied line-by-line codes, beginning with in vivo codes that closely reflected the words used in the theory reports. They then grouped and organised codes, applying axial codes reflecting higher-order themes, and met to compare and contrast the resulting coding. Because this narrative-based approach did not readily capture the well-described and complex inter-relationships between theoretical constructs present in the reports (often in the form of a diagram), we instead decided to develop a novel diagrammatic approach to theory synthesis. This methodological innovation allowed us to summarise the components of each intervention's theory of change and the explicitly and/or implied causal relationships between them, drawing on text and diagrams present in included reports. Summarising these diagrammatically also facilitated the comparison and synthesis of these components and relationships across the included theories of change.

Like the approach we had initially planned, this novel method of theory synthesis was a form of qualitative synthesis, but one that aimed to describe theories of change primarily in terms of constructs, interconnections and interactions, rather than as narrative themes. Like conventional thematic analysis, it involved an initial stage of 'in vivo' coding of author descriptions to identify theories of change for each intervention (but expressed diagrammatically rather than as a set of narrative themes), followed by a stage of 'axial' coding to explore interconnections between in vivo coding, identifying similarities and differences across interventions to develop overarching theories of change (again expressed diagrammatically). This represents a deviation from protocol, albeit one that added, rather than detracted from, the rigour of the analysis; this protocol deviation is reported in *Appendix 4*.

We read and re-read textual descriptions of theories of change and (when available) diagrammatic logic models of theories of change contained in the data extraction forms relating to each study. Two reviewers then independently drew an initial diagram of the theory of change underpinning each intervention. When more than one report addressed the same intervention, reviewers used theory of change descriptions from all relevant reports to inform the diagram. The two reviewers then met to compare their diagrams for each intervention theory of change and reconciled discrepancies through discussion. Drawing on the strengths of each diagram, they developed a single diagram of each intervention's theory of change, which included intervention components, mediators and moderators (when described by authors) and intended outcomes. When author descriptions implied, but did not explicitly state, inter-relationships between components of the theory of change, reviewers made inferences and noted when the diagrams were, in part, based on such inferences.

The two reviewers grouped these theory of change diagrams by (1) intervention type and (2) targeted health outcomes (sexual health, mental health and substance use) to explore the scope for developing overarching theories of change within and across these categories. Finding that the theory of change approaches underpinning the interventions were not patterned by intervention type or targeted outcomes, we took an inductive approach, grouping diagrams of theories of change that shared important constructs and pathways. Then, using reciprocal translation (to identify and describe similar concepts occurring across theories of change underpinning different interventions), refutational synthesis (to identify contradictory or opposing concepts occurring across theories of change) and line of argument (to synthesise distinct elements occurring across theories of change that form part of a broader whole) approaches from meta-ethnography,⁸⁸ each reviewer independently analysed the diagrams within each grouping. We did this by systematically examining the constructs and the relationships between constructs presented in each intervention-specific diagram and by examining whether these recurred, appeared only once or conflicted with those depicted in other intervention-specific diagrams in the grouping. Based on their analyses, each reviewer then independently drafted one synthesised diagram for each grouping of similar intervention theories of change.

We documented each stage of this process, noting when theory of change components or relationships between these components differed between individual diagrams in the grouping, the approach used to synthesise these components (i.e. reciprocal translation, refutational synthesis, line-of-argument synthesis, or the exclusion of a theory of change component) and the resulting decision for the synthesised theory of change diagram. The two reviewers then met to compare their synthesised diagrams of change for each grouping, reconciling discrepancies and drawing on the strengths of each to develop a single synthesised theory of change diagram for each theory of change grouping. To demonstrate this process, *Appendix 8* presents the theory of change diagrams for each of two individual interventions in one grouping and the resulting diagram of the synthesised theory of change for that grouping. Each synthesised theory of change was given a descriptive title inductively drawing on the central approaches of the theories of change synthesised.

In this application of meta-ethnographic methods to the synthesis of theories of change, our first-order constructs were the theory of change information described in theory reports and represented in data

extraction forms; our second-order constructs (analogous to in vivo codes) were the reviewers' interpretations of these concepts, represented in the intervention-specific theory of change diagrams; and our third-order constructs (analogous to axial codes) were the higher-order interpretations, represented by the diagrams of the synthesised theories of change developed for each inductive grouping.

Thematic synthesis of process data

We undertook a synthesis of process data using thematic synthesis methods.^{84–86} Syntheses of findings from qualitative and quantitative elements of process evaluations were used to understand characteristics of interventions, participants and contexts that acted as potential barriers to and facilitators of implementation and receipt, and which of these applied across or only within the domains of sexual health, substance use and mental health interventions.

Synthesis followed a meta-ethnographic approach. Second-order constructs (author narratives) were distinguished from first-order constructs (directly quoted qualitative data). In the case of findings from qualitative elements, we undertook line-by-line coding examining 'first-order constructs' (directly quoted qualitative data) and second-order constructs (author interpretations). In the case of findings from quantitative elements, we coded author interpretations, first checking as part of the quality assessment whether or not these aligned with the quantitative data presented (i.e. the extent to which study findings were grounded in the data). The synthesis drew these together through a thematic analysis, which developed third-order constructs by drawing connections between these data. This synthesis was not restricted to studies judged to be of high quality. Instead, conclusions drawing on poorer-quality reports were given less interpretive weight.

First, two reviewers prepared detailed results tables to describe the quality of each process evaluation report; details of the intervention examined (drawing on all included reports on the intervention, regardless of report type); study site and population; and study findings, including which aspects were explored in regard to how processes vary by intervention characteristics, providers, participants and/or context (see *Appendix 9*). Second, the two reviewers independently piloted coding of two high-quality process reports. They each read and re-read the study findings, applying line-by-line codes to capture the content of the data. Coding began with in vivo codes that closely reflected the words used in findings sections. The reviewers then grouped and organised codes, applying axial codes reflecting higher-order themes. They then met to compare and contrast their coding of these first two reports, developing an overall set of codes. Third, the two reviewers went on to code the remaining reports for each synthesis, drawing on the agreed set of codes, but developing new in vivo and axial codes as these arose from the analytical process. At the end of this process, the two reviewers met to compare their sets of codes. They identified commonalities, differences of emphasis and contradictions with the aim of developing an overall analysis that drew on the strengths of the two sets of codes and that resolved any contradictions or inconsistencies. We planned a priori to produce tables from our analysis demonstrating how first-, second- and third-order constructs related to one another, thereby enhancing transparency about emergent themes.

Synthesis of outcome data

We first produced a narrative account of the effectiveness of included interventions. Subsequently, we conducted a narrative synthesis by outcome, then, within this, by follow-up time and intervention type. Outcomes were categorised into sexual health outcomes, alcohol use, drug use, anxiety and depression. Two reviewers prepared detailed results tables describing intervention characteristics (drawing on all included reports on an intervention), study characteristics and study findings (see *Appendix 10*). We produced forest plots for each of our review outcomes, with separate plots for different outcomes and follow-up times, and pairwise comparisons between intervention types (e.g. intervention vs. no treatment control, or vs. another treatment type). Plots included point estimates and standard errors for each study, expressed as standardised mean differences (Cohen's *d*) to ensure comparability across reports.

When data allowed, we calculated pooled effect sizes within each pairwise comparison (e.g. intervention type vs. control), accounting for the extent of heterogeneity among the studies (as determined both by a Cochran's Q test and inspection of I^2).⁸⁹ The results of statistical tests were evaluated in accordance with the Cochrane handbook.⁶³ If an indication of substantial heterogeneity was determined with fewer than three studies (e.g. study-level I^2 value of > 50%), we did not present a pooled estimate. When we had high levels of unexplained statistical heterogeneity (e.g. study-level I^2 value of > 50%) in any of our study groupings and a sufficient number of studies, we aimed to investigate this further using subgroup and sensitivity analyses.⁹⁰ As is appropriate for complex interventions, we used the random-effects model in meta-analyses; we did not undertake fixed-effects analyses because these would not have been interpretable given the effect estimates and statistical procedures used.

Where we produced pooled estimates, we used a robust variance estimation meta-analysis model to synthesise effect sizes.⁹¹ This is because outcome evaluations are likely to include multiple measures of conceptually related outcomes and robust variance estimation meta-analysis improves on previous strategies for dealing with multiple relevant effect sizes per study, such as meta-analysing within studies or choosing one effect size, by including all relevant effect sizes but adjusting for interdependencies within studies.⁹² Unlike multivariate meta-analysis, it does not require the variance-covariance matrix of included effect sizes to be known. We estimated separate models for each outcome: HIV, STIs, defined sexual risk behaviours, alcohol use, drug use, anxiety and depression. We regarded follow-up times of < 3 months (short term), 3 months to 1 year (mid-term) and > 1 year (long term) post intervention as different outcomes, pooling first by follow-up times and, when appropriate, overall across follow-up times. We ran these models for interventions overall and, when sufficient studies were found, we ran separate models for different intervention types. Categorisation by intervention type was into 'clinically meaningful units,' or subgroups of interventions that are useful and meaningful from a clinical and practice perspective, and were informed by the typology derived from our prior synthesis of intervention descriptions and synthesis of theories.⁹³ When meta-analyses were performed, we included pooled effect sizes in forest plots, with the individual study point estimates weighted by a function of their precision.

In addition, we aimed to consider all outcome evaluation evidence jointly in a network meta-analysis (NMA). A NMA integrates all pairwise comparisons for a specific outcome in the same model, to allow for the comparison of intervention types that may not have been directly compared head-to-head in empirical studies, and to combine direct, empirical head-to-head evidence with indirect estimates. However, we were unable to undertake these models with the body of evidence included because pairwise comparisons did not form an interconnected network with similar populations and outcomes. All included studies allocated individuals rather than clusters, so there was no need to account for clustering in any analyses.

We used the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach, as described in the *Cochrane Handbook for Systematic Reviews of Interventions*, to present the quality of the evidence and the tables summarising the findings.⁶³ GRADE is a tool for researchers to describe how close the effect estimated in a meta-analysis is to the 'true' effect of the intervention. The downgrading of the quality of a body of evidence for a specific outcome was based on five factors: limitations of study, indirectness of evidence, inconsistency of results, precision of results and publication bias. The GRADE approach specifies four levels of quality (high, moderate, low and very low). If we had found a sufficient number of studies, we would have drawn funnel plots to assess the presence of possible publication bias (trial effect vs. standard error). Although funnel plot asymmetry may indicate publication bias, this can be misleading with a small number of studies.

We planned to undertake a sensitivity analysis to explore whether or not the findings of the review were robust in the light of the decisions made during the review process. This would have included assessing the impact of risk of bias in the included studies via restricting analyses to studies deemed to be at low risk of selection bias, performance bias and attrition bias. However, we did not undertake these analyses because too few studies would have been included in each meta-analysis to permit

meaningful interpretation. When data allowed, we planned to undertake additional exploratory meta-analyses to determine intervention effects on theorised intermediate outcomes (such as goal-setting or self-efficacy) to examine the plausibility that these might mediate or otherwise precede behavioural effects, as well as to explore whether or not intervention effects on some of our outcomes (e.g. drug use) appear to mediate effects on other outcomes (e.g. risk of HIV infection). However, the reported intermediate outcomes were diverse between studies, poorly reported so as to preclude estimation of effect sizes and unlinked to estimates of outcomes, thereby precluding a meaningful synthesis of these outcomes.

If sufficient studies had reported appropriate information, we would have examined intervention effects by participant subgroups in terms of participant sexuality and gender identity, SES and ethnicity to explore potential impacts on health inequalities. This would have drawn on existing methods involving an 'equity lens' to examine evidence that equity-related characteristics (individual sexuality or gender identity, SES or ethnicity) moderate intervention effects, both in terms of evidence within studies and, if enough evidence had existed, between studies of significant effect modification.

Synthesis of economic data

Measures of costs, indirect resource use and cost-effectiveness were summarised in a table. If measures of resource use were judged to be sufficiently homogeneous across studies, we planned to synthesise these using statistical meta-analysis, but this was precluded by the sparse evidence available.⁷⁰ Measures of costs, indirect resource use and cost-effectiveness were adjusted for currency and inflation to the current UK context. These data were used to inform a narrative synthesis of economic evidence and applicability to the UK context (RQ4).

Interpreting overall findings

In *Chapter 10*, we draw together what we have learnt overall from the syntheses of theories of change, facilitators of and barriers to implementation, and outcomes of e-health interventions addressing sexual health, substance use and mental health among MSM. This discussion focuses on implications for intervention research. We assessed whether or not interventions addressing the various outcomes, or some subsets of these, appeared to have similar, or at least compatible, theories of change (e.g. similar mediating factors or mechanisms) that could pragmatically be combined to develop an overall intervention with a coherent theory of change addressing the syndemic or some sub-elements of the syndemic. We then assessed whether different or similar factors appeared to facilitate or impede implementation or receipt of interventions addressing the various outcomes in order to further develop our sense of whether these outcomes might be feasibly addressed by a single intervention or might be better addressed by separate interventions addressing some, but not all, outcomes. Finally, we draw on the findings from our outcome syntheses to judge whether or not there is scope for a single intervention addressing sexual health, substance use and mental health to have synergistic effects. We established a priori that we would judge this to be likely if there was evidence that e-health interventions addressing the various outcomes all tended to be effective, particularly when there was evidence that interventions addressing different outcomes appear to positively affect similar mediators. We determined a priori that when this was found not to be the case, for example because of evidence of a lack of, or even harmful, effect on some outcomes, or a lack of evidence for some outcomes, our recommendations would reflect this.

Patient and public involvement in data interpretation, dissemination and knowledge transfer

We assembled a patient and public involvement (PPI) stakeholder group (by contacting a mixture of organisations already known to us or found through web searches) and met with members of this group twice during the review, first in April/May 2020 and again in December 2020. Six stakeholders from Cardiff Royal Infirmary, Central and North West London NHS Foundation Trust, HIV Scotland, London Friend, MESMAC (Men Who Have Sex with Men – Action in the Community) and METRO

Charity took part. Each of these organisations focuses on the health and well-being of gay, bisexual and other MSM and/or is a community organisation for such men. Meetings were held individually, rather than as group discussions as initially planned, which was a minor deviation from our protocol (see *Appendix 4*). This was to enable more in-depth discussion and to accommodate busy stakeholder schedules.

For the first meeting, stakeholders were sent slides with a summary of the main findings in relation to the typology of interventions, the synthesis of evidence on theories of change and factors affecting delivery and receipt (see *Report Supplementary Material 2*). Each of these three areas was then examined during a structured discussion. We asked stakeholders to advise on the feasibility of drawing on the interventions presented to inform the development of an overall intervention addressing the syndemic of HIV/STIs, sexual risk, alcohol and drug use and mental ill health among UK MSM, focusing on the following questions:

- What do you think would be the potential benefits of e-health approaches for the groups you work with?
- What would be the potential drawbacks?
- What types of interventions do you think would be most appropriate?
- What are your thoughts on the theoretical underpinnings of these? Do any of the three models seem to be the most appropriate? Or the most comprehensive?
- What are your feelings on the acceptability of these interventions for your client group? And for your staff?
- Do you have thoughts on the feasibility of delivering something similar? What concerns would you have?

The first round of consultations took place with six stakeholders from England, Scotland and Wales. Four were affiliated with the voluntary sector and two were affiliated with clinical settings.

For the second meeting, stakeholders reviewed slides summarising the syntheses of outcome and economic evaluations (see *Report Supplementary Material 3*). At this stage, we explored with stakeholders whether or not the evidence of effectiveness and cost-effectiveness overall and by subgroup suggested that it would be worth investing in the development of an e-health intervention to address multiple outcomes among UK MSM and sought input on dissemination and knowledge transfer. We asked stakeholders the following questions during this consultation:

- Having reviewed the evidence we found, what are your overall impressions of the effectiveness of e-health interventions? Which interventions, if any, do you conclude are effective or highly promising?
- In the earlier part of the review, we found more interventions targeting all areas of the syndemic. What are your thoughts about having data only for drug use, HIV, STIs and sexual behaviours?
- What concerns do you have about the limitations of the evidence that has been found?
- Are there specific areas you think are a priority for generating more evidence? Are there promising interventions that need to be evaluated?
- What are your thoughts on the (potential) cost or cost-effectiveness of these interventions relative to their impacts?
- In your opinion, would it be worth pursuing the development of an e-health intervention either for immediate scale-up or for an intervention study in the UK in the future?
- What/how should we disseminate the findings to policy and practice stakeholders?
- Do you think we should do an intervention study, and, if so, focused on what outcomes? Or do you think the evidence on sexual behaviour effects warrants immediate scale-up of an intervention focused on this outcome?

The second round of consultations took place with four stakeholders from England, Scotland and Wales. Three were affiliated with the voluntary sector and one was affiliated with a clinical setting.

Registration

The review protocol was publicly registered online.

Revisions to the protocol

The protocol was amended four times from 3 October 2018 to 5 August 2019 (see *Appendix 7*).

Governance and ethics review

As the principal investigator, Chris Bonell was responsible for the conduct and delivery of the work. The sponsor of the research was Professor Kara Hanson, Dean of the Faculty of Public Health and Policy, London School of Hygiene & Tropical Medicine. The co-applicants formed an investigator committee, which met monthly throughout the project, overseeing its conduct. These meetings were minuted to keep a record of tasks, deadlines and responsibilities. The research involved no human participants and drew solely on evidence already in the public realm, so research ethics approval was not required. The team followed relevant guidelines and best practice including the Social Research Association's ethics guidelines⁹⁴ and referred also to guidance recommended by the National Co-ordinating Centre for Public Engagement.⁹⁵

Chapter 3 Results: included studies

About this chapter

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Results of the search

A total of 49,473 references were retrieved by the original bibliographic databases, clinical trials register and Google searches. Of these, 28,747 (58%) were identified as duplicates, leaving 20,726 references. The updated search identified 5317 additional references, giving a total of 26,043 references identified. The number of references before and after deduplication are given in *Table 1*, as are the new references identified from the updated searches. Requests from subject matter experts (see *Appendix 5*) did not identify any additional eligible reports.

Screening

When piloting the process for screening by title and abstract, the rate of agreement for initial screening between two screeners, based on a pilot screen of 87 references, was 99%. Given this level of agreement, we moved to a system of one reviewer independently screening each reference, as set out in the protocol. *Figure 1* describes the results of screening. Of the 20,726 references from the initial search screened by title and abstract, 20,497 (98.9%) were excluded on this basis. Full reports were sought for the remaining 229 references.

Of these 229 references, we obtained full study reports for 168 and online registrations for 58. No reports or other information could be found for three references. Of the 226 references for which there was a report or online registration, 183 reports were excluded: three based on population, 104 based on intervention, 49 based on study design (of which two were systematic reviews), 12 based on outcomes and 15 because these were belatedly identified as duplicates. In addition, 17 online registrations were excluded: in the case of six, although the registration itself contained insufficient information to be included, the study appeared relevant and we noted that our searches had already identified the report of results from the registered study. For a further 11 online registrations, the study appeared to be of potential relevance, but did not contain sufficient information to be included and no reports could be found.

Overall, 26 reports were included after screening full reports and online registrations.⁹⁶⁻¹²¹ This included two reports that were included via two online registrations.^{101,102} In addition, one report not found from electronic searches was identified via checking the reference lists of included studies.¹²² The journal in which this study was published was indexed in at least one database included in our search, and so we did not hand-search the journal. Of the included study reports, 24 reported on theories of change,^{96-107,110-113,115-122} 10 on process evaluations,^{96,98,103,107,108,111,118,119,121,122} 12 on outcome evaluations^{99-102,109,110,113-117,122} and none on economic evaluations.

TABLE 1 Search results pre and post deduplication for initial search, and for updated search

Database/register name	References from initial search (n)	References once duplicates removed (n)	References from updated search (n)
ProQuest ASSIA	1812	142	NA
Campbell Library	0	0	0
EBSCO CINAHL Plus	3061	977	406
Wiley Online Library The Cochrane Library	378	125	83
CRD databases	95	77	NA
EPPI-Centre database of health promotion research (Bibliomap)	7	0	0
ProQuest Dissertations & Theses Global	2231	1427	243
OvidSP EconLit	56	53	9
OvidSP EMBASE	5995	2289	805
OvidSP Global Health	1893	302	95
OvidSP HMIC	90	33	NA
ProQuest IBSS	2503	968	NA
OvidSP MEDLINE ALL	4701	4596	1279
OpenGrey	87	50	0
OvidSP PsycINFO	4854	2675	472
Web of Science Science Citation Index Expanded	3212	1031	185
Elsevier Scopus	10537	3729	981
OvidSP Social Policy & Practice	204	100	15
Web of Science Social Sciences Citation Index Expanded	4365	809	339
ProQuest Sociological Abstracts	3314	1277	NA
ClinicalTrials.gov	58	58	405
World Health Organization ICTRP	15	3	NA
Eppi-Centre TRoPHI	0	0	0
Google	5	5	NA
Total	49,473	20,726	5317

NA, not applicable.

The updated search identified 5317 new references, of which 121 were retained after screening by title and abstract. Of these, three were unobtainable and 118 were screened by full text. Ten eligible reports on 10 studies of 10 interventions were identified for inclusion.^{115,123-131} Of these, five were new reports on studies of interventions already included from the original searches^{115,123,127,128,130} and five reported on new interventions.^{124-126,129,131} The updated search added nine reports on theories of change,¹²³⁻¹³¹ two on process evaluations,^{123,130} four on outcome evaluations^{123-125,127} and one on economic evaluation.¹³²

After original and updated searches, a total of 37 reports were included: 33 reporting on theories of change,^{96-105,107,110-113,115-131} 12 on process evaluations,^{96,98,103,107,108,111,118,119,121-123,130} 16 on outcome evaluations^{99-102,109,110,113-117,122-125,127} and one on economic evaluation.¹³² Table 2 shows an overview of interventions examined in the review and the included theory, process evaluation, outcome evaluation and economic evaluation reports on each.

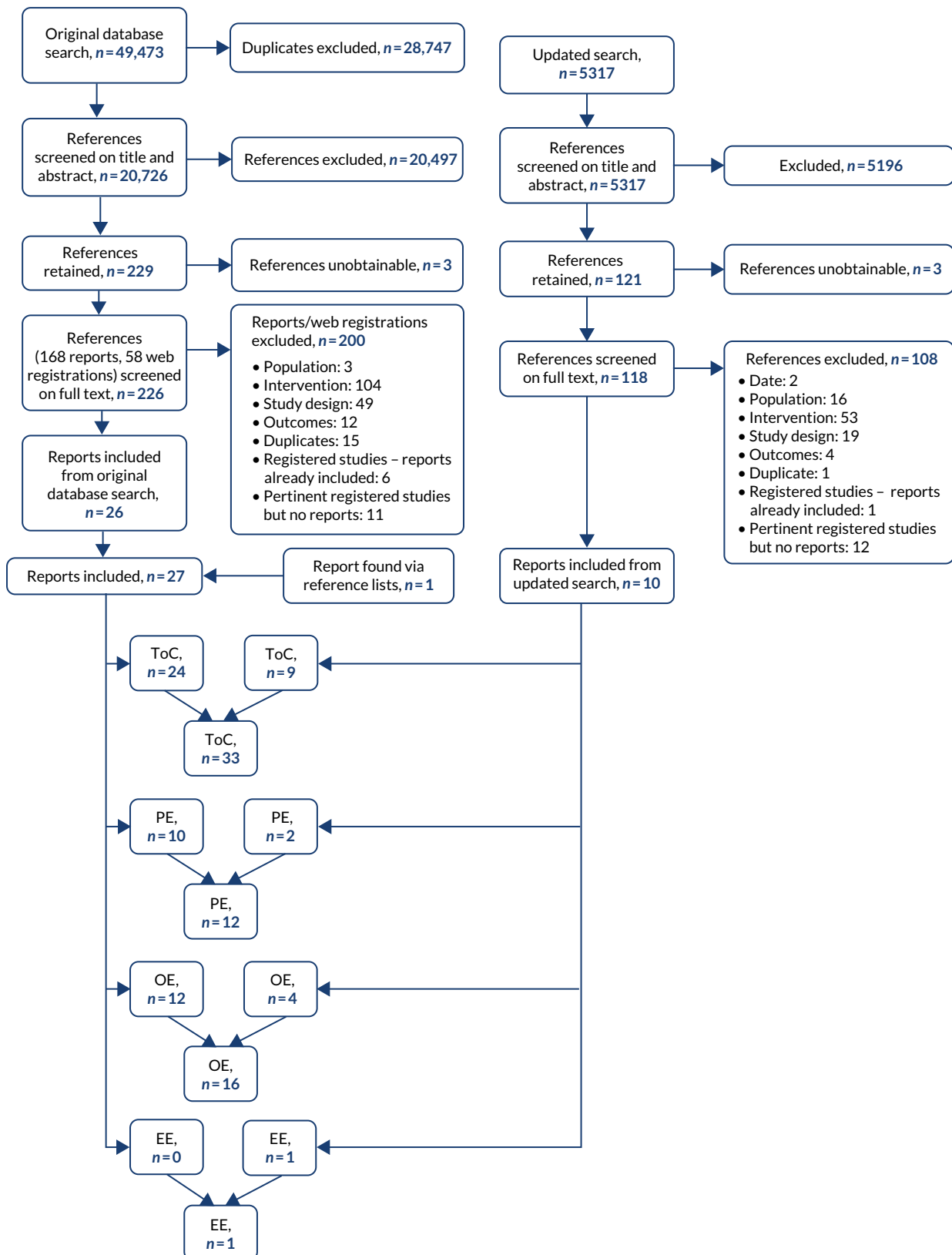


FIGURE 1 Literature search and screening. EE, economic evaluation; OE, outcome evaluation; PE, process evaluation; ToC, theory of change. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

RESULTS: INCLUDED STUDIES

TABLE 2 Overview of included theory, process, outcome and economic reports by intervention

Interventions examined in the review	Included reports on theories of change (n = 33)	Included reports on process evaluations (n = 12)	Included reports on outcome evaluations (n = 16)	Included reports on economic evaluations (n = 1)
China-Gate HIV Prevention Program online intervention (no name)	Cheng <i>et al.</i> ¹²⁴ 2019		Cheng <i>et al.</i> ¹²⁴ 2019	
Cognitive Vaccine Approach (tailored and non-tailored versions)	Davidovich <i>et al.</i> ¹⁰² 2006		Davidovich <i>et al.</i> ¹⁰² 2006	
Gay Cruise	Kok <i>et al.</i> ¹⁰⁵ 2006			
HealthMindr	Sullivan <i>et al.</i> ¹¹⁸ 2017 Jones <i>et al.</i> ¹²⁸ 2020	Sullivan <i>et al.</i> ¹¹⁸ 2017		
Hot and Safe M4M (website name)	Carpenter <i>et al.</i> ¹⁰⁰ 2010		Carpenter <i>et al.</i> ¹⁰⁰ 2010	
Internet-based safer sex intervention (no name)			Milam <i>et al.</i> ¹⁰⁹ 2014 ^a (published abstract) Milam <i>et al.</i> ¹¹⁰ 2016 ^a (published paper)	
Keep it Up!	Mustanski <i>et al.</i> ¹²² 2013 (intervention version 1.0) Greene <i>et al.</i> ¹⁰³ 2016 (intervention version 1.5, identical to 1.0) Mustanski <i>et al.</i> ¹¹² 2017 ^b (intervention version 2.0) Mustanski <i>et al.</i> ¹¹³ 2018 ^b (intervention version 2.0) Madkins <i>et al.</i> ¹³⁰ 2019 ^b (intervention version 2.0)	Mustanski <i>et al.</i> ¹²² 2013 (intervention version 1.0) Greene <i>et al.</i> ¹⁰³ 2016 (intervention version 1.5, identical to 1.0)	Mustanski <i>et al.</i> ¹²² 2013 (intervention version 1.0) Mustanski <i>et al.</i> ¹¹³ 2018 ^b (intervention version 2.0)	
Mobile Technology and Incentives (MOTIVES)	Linnemayr <i>et al.</i> ¹⁰⁶ 2018			
myDEX	Bauermeister <i>et al.</i> ⁹⁷ 2017 ^c Bauermeister <i>et al.</i> ¹²³ 2019 ^c	Bauermeister <i>et al.</i> ¹²³ 2019 ^c	Bauermeister <i>et al.</i> ¹²³ 2019 ^c	
MyPEEPS Mobile	Kuhns <i>et al.</i> ¹²⁹ 2020			
Online mindfulness-based cognitive therapy (no name)	Avellar ⁹⁶ 2016	Avellar ⁹⁶ 2016		
People Like Us	Tan <i>et al.</i> ¹³¹ 2020			
Queer Sex Ed	Mustanski <i>et al.</i> ¹¹¹ 2015	Mustanski <i>et al.</i> ¹¹¹ 2015		
Rainbow SPARX	Lucassen <i>et al.</i> ¹⁰⁸ 2015 ^d	Lucassen <i>et al.</i> ¹⁰⁸ 2015 ^d Lucassen <i>et al.</i> ¹⁰⁷ 2015 ^d		

TABLE 2 Overview of included theory, process, outcome and economic reports by intervention (continued)

Interventions examined in the review	Included reports on theories of change (n = 33)	Included reports on process evaluations (n = 12)	Included reports on outcome evaluations (n = 16)	Included reports on economic evaluations (n = 1)
Role-playing game	Coulter <i>et al.</i> ¹²⁶ 2019			
Safe Behaviour and Screening	Chiou <i>et al.</i> ¹²⁵ 2020		Chiou <i>et al.</i> ¹²⁵ 2020	
Sex Positive!	Hirshfield <i>et al.</i> ¹⁰⁴ 2016 ^e			
	Hirshfield <i>et al.</i> ¹²⁷ 2019 ^e		Hirshfield <i>et al.</i> ¹²⁷ 2019 ^e	
Sexpulse	Rosser <i>et al.</i> ¹¹⁶ 2010 ^f		Rosser <i>et al.</i> ¹¹⁶ 2010 ^f	
	Wilkerson <i>et al.</i> ¹²⁰ 2011 ^f			
Smartphone self-monitoring (no name)	Swendeman <i>et al.</i> ¹¹⁹ 2015	Swendeman <i>et al.</i> ¹¹⁹ 2015		
Socially Optimized Learning in Virtual Environments (SOLVE)	Christensen <i>et al.</i> ¹⁰¹ 2013		Christensen <i>et al.</i> ¹⁰¹ 2013	
TXT-Auto			Reback <i>et al.</i> ¹¹⁴ 2017 ^g (published abstract)	
	Reback <i>et al.</i> ¹¹⁵ 2019 ^g (published paper)		Reback <i>et al.</i> ¹¹⁵ 2019 ^g (published paper)	
				Reback <i>et al.</i> ¹³² 2019 ^g
Wyoming Rural AIDS Prevention Project (WRAPP)	Bowen <i>et al.</i> ⁹⁸ 2007 (no name; preliminary work to WRAPP intervention)	Bowen <i>et al.</i> ⁹⁸ 2007 (no name; preliminary work to WRAPP intervention)		
	Bowen <i>et al.</i> ⁹⁹ 2008		Bowen <i>et al.</i> ⁹⁹ 2008	
	Williams <i>et al.</i> ¹²¹ 2010 (Hope Project; extends WRAPP)	Williams <i>et al.</i> ¹²¹ 2010 (Hope Project; extends WRAPP)		
	Schonnesson <i>et al.</i> ¹¹⁷ 2016 (SMART; Swedish adaptation of WRAPP)		Schonnesson <i>et al.</i> ¹¹⁷ 2016 (SMART; Swedish adaptation of WRAPP)	

AIDS, acquired immunodeficiency syndrome.

a The abstract¹⁰⁹ and the paper¹¹⁰ report on the same study.

b These three papers report on the protocol (Mustanski *et al.*¹¹²) and results (Mustanski *et al.*¹¹³ and Madkins *et al.*¹³⁰) of the same study.

c These two papers report on the protocol (Bauermeister *et al.*⁹⁷) and results (Bauermeister *et al.*¹²³) of the same study.

d These two papers^{107,108} report findings from the same study.

e These two papers report on the protocol (Hirshfield *et al.*¹⁰⁴) and results (Hirshfield *et al.*¹²⁷) of the same study.

f These two papers^{116,120} report findings from the same study.

g This abstract (Reback *et al.*¹¹⁴) and these two papers (Reback *et al.*^{115,132}) report findings from the same study.

Included reports and interventions

The 37 reports included in this review reported on 28 unique studies⁹⁶⁻¹³² focused on 23 interventions. Seven reports were study protocols, which were included because they reported on theory of change;^{97,104,106,112,126,128,129} for four studies, only a protocol was included.^{106,126,128,129} Seven studies were each featured in more than one report: one was featured in a protocol and two subsequent empirical papers,^{112,113,130} two were each featured in a protocol and one subsequent empirical paper,^{97,104,123,127} one was featured in a published abstract and two subsequent full empirical reports,^{114,115,132} one was featured in a published abstract and one subsequent full empirical report,^{109,110} and two were each featured in two empirical reports.^{107,108,116,120}

In the case of reports of three interventions, reports presented multiple versions of very similar interventions.^{98,99,102,112,113,117,121,122,130} One report by Davidovich *et al.*¹⁰² presented two versions of the Cognitive Vaccine Approach intervention: one version offered all content to all users and the other tailored the content delivered based on an initial user assessment. We determined that this was a core difference and therefore treated these as two unique interventions. In the cases of the Keep it Up!^{103,112,113,122,130} and the Wyoming Rural Acquired immunodeficiency syndrome Prevention Project (WRAPP)^{98,99,117,121} interventions, author descriptions suggest that intervention content was very similar across versions, and so we treated Keep it Up! and WRAPP as single interventions. Therefore, the included reports report on 23 unique interventions. Of these, nine interventions are featured in more than one included report: two in corresponding published abstracts and papers,^{109,110,114,115} two in two unique papers reporting results from the same study,^{107,108,116,120} two in a protocol and corresponding paper reporting results from the same study,^{97,104} one in a protocol and results paper from two different studies,^{118,128} one in five reports on three studies of two versions of the same intervention^{103,112,113,122,130} and one in four reports on four studies of four versions of the same intervention.^{98,99,117,121}

Table 3 describes the characteristics of the included interventions. Thirty-three theory reports described 22 distinct theories of change underpinning all 23 interventions,^{96-107,110-113,115-131} with the two versions of the Cognitive Vaccine Approach intervention sharing a single theory of change.¹⁰² Twelve process evaluation reports presented empirical results on eight interventions.^{96,98,103,107,108,111,118,119,121-123,130} Sixteen outcome evaluations presented empirical results on 13 interventions.^{99-102,109,110,113-117,122-125,127} One economic evaluation presented empirical results on one intervention.¹³² Of the 37 included reports, 10 (27%) reported on theories of change only;^{97,104-106,112,120,126,128,129,131} one (3%) reported on a process evaluation only;¹⁰⁸ two (5%; both abstracts) reported on outcome evaluations only;^{109,114} one (3%) reported on economic evaluation only;¹³² nine reported on both theories of change and process evaluations (24%);^{96,98,103,107,111,118,119,121,130} 12 (32%) reported on both theories of change and outcome evaluations;^{99-102,110,113,115-117,124,125,127} and two (5%) reported on theories of change, process evaluations and outcome evaluations.^{122,123}

Years of report publication

Reports were published between 2006 and 2020, with more than two-thirds (26/37)^{96,97,103,104,106-108,110-115,117-119,123-132} published from 2015 onwards (Figure 2).

Targeted health outcomes

In total, 20 interventions addressed sexual health outcomes,^{97-106,109-125,127-132} 10 addressed substance use^{97,103,104,106,109,110,112-115,119,122,123,125-127,129,130,132} and seven addressed mental health.^{96,97,104,106-108,119,123,126,127} Thirteen addressed a single health outcome of interest for this review,^{96,98-102,105,107,108,111,116-118,120,121,124,128,131} six addressed two of these outcomes^{103,109,110,112-115,122,125,126,129,130,132} (with five addressing sexual health and substance use,^{103,109,110,112-115,122,125,129,130,132} and one addressing mental health and substance use¹²⁶) and four addressed all three outcomes.^{97,104,106,119,123,127}

TABLE 3 Included intervention descriptions and reports

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
China-Gate HIV Prevention Program Online Intervention Cheng <i>et al.</i> ¹²⁴	China	MSM	Not stated	Intervention was based on formative research and reviewed by professional and community experts. Gay community representatives provided the scenarios presented in part I which were reviewed by the research team and target population	Two-part interactive HIV prevention intervention delivered via a popular website for gay men in China. Part I comprised realistic interactive scenarios addressing sexual behaviour (CAI, condom breakage, encountering sex partner in a pub and commercial sexual encounter) and HIV testing, and presenting peer attitudes towards behavioural decisions. Delivering its content via e-mail, part II presented visually appealing HIV information tailored for MSM addressing HIV/AIDS basic knowledge and transmission, local epidemic data for MSM and misconceptions about sexual behaviours	Part I delivered immediately after completing baseline survey. Following completion of part I, part II was delivered in three parts, each delivered weekly	Interactive	Internet
continued								

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Cognitive Vaccine Approach (tailored and non-tailored versions) Davidovich <i>et al.</i> ¹⁰²	The Netherlands	Single gay men	Not stated	Content was based on past research on determinants of sexual risk behaviour in steady relationships and on the intervention's theory of change. To address concern that the impact would be limited by messaging that was too lengthy, the tailored version was designed to address user-specific needs	There were two versions of this online HIV prevention intervention promoting negotiated safety (i.e. unprotected anal intercourse between steady partners of a concordant negative HIV status). A non-tailored version delivered all modules, and a tailored version delivered general content considered relevant for all users in addition to selected modules considered relevant based on a baseline questionnaire. Information modules addressed how to practise negotiated safety; motivation modules addressed HIV transmission risk via steady partners, HIV testing and sexual agreements and stressed the consequences of HIV infection; and skills modules taught skills for negotiated safety	Users spent an estimated mean time of 30 minutes in the non-tailored version and 10-30 minutes in the tailored version	Non-interactive other than baseline questionnaire used in the tailored version	Internet

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Gay Cruise Kok <i>et al.</i> ¹⁰⁵	The Netherlands	MISM	Website operated by a lesbian and gay health service provider organisation in Amsterdam; intervention linked to and promoted by a popular MSM e-dating website	Used 'intervention mapping', a systematic method for developing interventions informed by evidence, theory and stakeholder input. Steps included conducting a needs assessment, establishing programme objectives and translating relevant theoretical models into intervention strategies that determined programme content. Materials were piloted with 15 professionals and 15 members of the target population	The <i>Gay Cruise</i> was an online interactive simulated cruise ship. Content included four 'trips' on the cruise ship and a follow-up quiz. Mimicking human face-to-face interaction via facial expressions, speech and tone, characters engaged in scripted, tailored dialogue with the user. Users selected a personal guide from among four virtual characters designed to be attractive. Intervention content (including videos, activities and virtual conversations) addressed HIV, partner communication and condom use. Users could tailor some content, for example by choosing either a 'hot' or 'love' movie to watch	Users could stop and continue at any point	Interactive	Internet
HealthMindr Sullivan <i>et al.</i> ¹¹⁸ and Jones <i>et al.</i> ¹²⁸	USA, with location varying by study: Atlanta, GA, and Seattle, WA; ¹¹⁸ and Atlanta, GA, Jackson, MS, and Washington, DC ¹²⁸	MISM	Not stated	Separate focus groups with MSM, HIV testing counsellors and key informants to identify preferences and requirements fed into an initial version of the app, which was then tested with focus group discussions. These phases fed into the beta version of the app	This multifeature mobile HIV prevention app included monthly risk-assessment quizzes followed by tailored HIV prevention recommendations; PrEP and nPEP resources including self-assessments; map locations and details of HIV testing locations; resources to create a HIV testing plan with reminders; ordering of free condoms and at-home HIV test kits; substance use and mental health screeners and directory; HIV treatment locator; health insurance resources; a frequently asked questions section; and a tool to submit questions to study staff ^a	Participants were asked to keep the app on their phones for 4 months ¹¹⁸ or for an unspecified amount of time during a 12-month study ¹²⁸	Interactive	Smartphone/ mobile app

continued

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Hot and Safe M4M (website name) Carpenter <i>et al.</i> ¹⁰⁰	USA	YMSM, including minority MSM	Not stated	Pilot tested with a sample of 21 MSM in New York City using a desktop computer at a community organisation specialising in HIV research and intervention development. Minor content revisions were made based on findings	This website-based intervention aimed to reduce HIV/STIs via modules addressing information about risk factors, skills (e.g. partner communication) and motivation. Multimedia content included didactic materials, quizzes, interactive exercises and audio from simulated peers. The approach was non-judgemental and emphasised both responsibility and freedom of choice. User assessments informed motivational exercises tailored to the user's readiness to change, as well as tailored feedback	Seven brief sequential modules completed within 1 week. Authors' description suggests intervention took approximately 1.5 hours	Interactive	Internet
Internet-based safer sex intervention (no name) Milam <i>et al.</i> ^{109,110}	USA (southern California)	HIV-positive MSM	Three clinic sites that were part of a HIV clinical research network	Messages were adapted from an existing intervention effective in reducing unsafe sex. Subsequent pre testing in focus groups with HIV-positive MSM informed changes to content and approach	This intervention aimed to reduce HIV/STI transmission by HIV-positive MSM by targeting condom use, disclosure to sex partners, antiretroviral therapy initiation, and reduced use of drugs and alcohol. Based on their responses to monthly sexual behaviour surveys, users were directed to static web pages tailored to their risk of transmission. Tailored messaging took into account each user's current behaviour and intent related to the targeted behaviour change	Brief intervention provided monthly for 1 year	Monthly risk assessment surveys informed other content, which was not interactive	Internet

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Keep it Up! Mustanski <i>et al.</i> , ^{112,113,122} Greene <i>et al.</i> , ¹⁰³ and Madkins <i>et al.</i> , ¹³⁰	USA, with location varying by study: Chicago, IL; ^{103,122} recruited from Atlanta, GA; Chicago, IL; and New York, NY; and via local and national advertising ^{112,113,130}	Ethnically and racially diverse YMSM	Not specified. Some participants were recruited from community-based organisations providing HIV testing and counselling	Developed in partnership with community-based organisations providing HIV testing to the LGBT community and with engagement of diverse YMSM, and informed by formative mixed-methods research	Multimodule HIV prevention intervention for YMSM, with content designed to appeal to users from all racial and ethnic groups. Online modules were based on situations and settings relevant to YMSM, and used a variety of media and methods such as video, animation and games. Modules addressed, among other topics, condom use; triggers for unprotected sex; obtaining support; communication; the effects of mood, drug and alcohol abuse and sexual arousal; power dynamics in relationships; and the limits of serosorting. Users developed a HIV/STI prevention plan, and goals were suggested tailored to users' baseline risks. In the intervention's first iteration, a booster session revisited goals and provided tailored feedback to address obstacles and set new or reaffirm existing goals. ¹²² In the second iteration, two booster sessions reinforced learning, introduced new skills and provided an opportunity to review earlier goals ^{112,113}	Seven modules completed across three sessions. In the first iteration, these took 2 hours and were followed by a booster session at 6 weeks. ¹²² In the second iteration, modules were followed by booster sessions at 3 and 6 months, with either the initial seven modules ¹¹² or the full intervention ¹¹³ lasting 2 hours. In Mustanski <i>et al.</i> , ^{112,113,122} and Madkins <i>et al.</i> , ^{122,130} but not in Greene <i>et al.</i> , ¹⁰³ modules had to be done at least 24 hours apart	Interactive	Internet

continued

TABLE 3 Included intervention descriptions and reports (*continued*)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
MOTIVES Linnemayr <i>et al.</i> ¹⁰⁶	USA (Los Angeles County, CA)	Latino/a MSM and transgender women	Recruitment via HIV testing sites of a community-based organisation offering programming and services primarily to the Latino/a population, including LGBT community and people living with HIV	Approach was informed by formative focus groups	This text message-based HIV prevention intervention drew on behavioural economics to optimise engagement and knowledge retention. Weekly, the user received a text message providing HIV prevention information, followed by a message 2 days later asking a question about that information. After sending their response, the user received a message indicating whether or not they were correct and providing a link with more information. A correct response increased their chance of winning an upcoming prize draw. Users also received HIV testing reminders via text message every 2.5 months	Information-related text messages weekly for 1 year; four prize draws (one every 3 months); and a HIV testing reminder every 2.5 months	Interactive	Text messaging
myDEX Bauermeister <i>et al.</i> ^{97,123}	USA	Young adult MSM aged 18–24 years	Not stated	A sociodemographically diverse youth advisory board of three YMSM provided input on content and delivery and trained developers on same-sex attraction and YMSM dating behaviours	This module-based comprehensive sex education intervention aimed to improve psychological well-being and reduce HIV risk by targeting condom use, HIV/STI testing, unprotected anal intercourse, PrEP and alcohol/drug use before sex. Content within each session was organised into three levels: a core message, deeper discussion of relevant topics and an activity. Content used storytelling, case scenarios, motivational interviewing strategies, graphics and videos, and it was	Six sessions, each lasting 10 minutes	Interactive	Internet

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
MyPEEPS Mobile Kuhns <i>et al.</i> ¹²⁹	USA	Young sexual minority men aged 13–18 years	Not stated	Adapted to e-health version for younger and more ethnically diverse users from effective group-based HIV prevention curriculum, featuring characters based on YMSM who took part in the formative phase of the development of the group-based intervention. Mobile version was previously tested for feasibility, acceptability and usability	tailored to the user via personalisation, content matching and feedback to maximise persuasiveness and relevance. Interactive activities included role-play scenarios, a diary, quizzes and opportunities to develop dating strategies Designed for less sexually experienced users, this interactive, modular HIV prevention intervention aimed to reduce sexual risk and promote health behaviours. Delivered via games, scenarios and role playing, and facilitated through the stories of four 'peeps' (YMSM characters), content addressed information on HIV/STIs among YMSM, minority stress, condom use, emotional regulation and negotiating interpersonal and substance-related risks. 'Bottom Line', a goal-setting activity running throughout the intervention, asked users to establish and regularly reconsider their limits and the risks they are willing to accept for different types of sexual acts	21 activities divided into four sequential modules, accessible throughout 3-month period	Interactive	Internet

continued

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Online mindfulness-based cognitive therapy (no name) Avellar ⁹⁶	USA	Same-sex attracted men with a range of bullying experiences during grade school and high school	Not stated	Modelled on an existing mindfulness-based cognitive therapy protocol for depression and anxiety symptoms, using that programme's audio files and handouts, and with much of the intervention content drawn from the mindfulness-based cognitive therapy trainers' manual	Module-based intervention integrating mindfulness and cognitive-behavioural techniques to improve mental health. Each weekly session began with an audio introduction and an outline of the session. Sessions introduced practices and skills to alleviate unpleasant thoughts, feelings and situations. Content included lectures, activities (including meditations), exercises, handouts, weekly homework assignments and both audio and video content, and directed participants to resources in the public domain, including a mindfulness meditation by a private psychologist	Eight weekly sessions, each lasting approximately 50–90 minutes	Interactive	Internet
People Like Us Tan <i>et al.</i> ¹³¹	Singapore	HIV-negative gay, bisexual and queer men aged 18–29 years	A community-based organisation developed the web series and was involved in the trial	Intervention includes videos from a previously launched web series developed by a community-based organisation	This educational, web-based drama miniseries featured stories of six ethnically and socioeconomically diverse gay, bisexual and queer men negotiating sexual health, mental health and relationship issues. Each video ended with community-based organisation representatives who summarised the episode and addressed key points on mental and sexual health. Although the planned evaluation focused on HIV/STI testing, key sexual health messages also addressed HIV/STI risk, homophobia and coming out, and safer sex negotiation and behaviours (including modelling safer sex behaviours)	Six videos, each lasting approximately 10 minutes, watched over 1 week	Non-interactive	Internet

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Queer Sex Ed Mustanki <i>et al.</i> ¹¹¹	USA	LGBT youth	Not stated	Informed by mixed-methods research	Multimedia, comprehensive sexual health curriculum including STI prevention. Comprised an introduction and five modules, moderated by a female-bodied avatar called 'Ed' who introduced the programme and provided a brief overview at the start of each module. Modules used varied media formats, each ending with a quiz. Content covered understanding and accepting one's sexual orientation and gender identity, sexuality education (e.g. pleasure, anatomy and STI risk), healthy relationships, safer sex, and sexual health improvement goal-setting	Five modules worked through at the user's own pace. Users could save their work and log back in at another time to continue. The intervention took a mean of 107.8 minutes to complete	Interactive	Internet
Rainbow SPARX Lucassen <i>et al.</i> ^{107,108}	New Zealand (Auckland)	Sexual minority youth with depressive symptoms	Participants could complete the programme at home, at a youth-led organisation promoting the study, at a selected secondary school or on a dedicated computer at the research centre where the study was based	Rainbow SPARX was an adaptation for LGBT youth of the computerised CBT programme SPARX. Researchers and clinicians worked collaboratively with young people to develop SPARX, with young people's feedback informing refinement and further improvement of prototypes. Separate consultations with sexual minority youth suggested the need for a specially adapted version for this population, which became Rainbow SPARX. Tailored content addressed issues and experiences	Computerised CBT programme to reduce depressive symptoms, designed as a multilevel game. Using interactive exercises and attractive graphics, the intervention presented the user's avatar with challenges set in a fantasy world from which they had to eradicate gloom and negativity. Following an introduction and information about depression from a guide character, the user's avatar entered each module and completed a mission. The guide then explained its relevance to real life, and homework tasks were set. Modules introduced CBT skills, each represented as a gem the user found and added to their 'shield	Each of the seven modules took approximately 30 minutes. Users were instructed to complete 1 or 2 modules per week and to complete all within 2 months	Interactive	Computer (CD-ROM), with paper-based user notebook

continued

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Role-playing game Coulter <i>et al.</i> ¹²⁶	USA	Sexual and gender minority youth aged 14–18 years	Not stated	of particular relevance to sexual minority youth. Changes were primarily script-related (accounting for 5.9% of the overall script) and included some changes to appearance. Mini-games, characters and homework tasks were unchanged	against depression'. CBT skills introduced included 'relax' (relaxation training), 'do it' (e.g. behavioural activation), 'sort it' (e.g. social skills training), 'spot it' (recognising or naming cognitive distortions), 'solve it' (problem-solving) and 'swap it' (e.g. cognitive restructuring)	Participants received a link to download the game following the baseline survey and could play an unlimited number of times. Questions about the intervention were presented at the 4- or 8-week follow-up, depending on when a participant reported having played the game (4 or 8 weeks)	Interactive	Computer download

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Safe behaviour and screening Chiou <i>et al.</i> ¹²⁵	Taiwan (Province of China)	MSM	Not stated	Informed by existing qualitative literature and by formative research. The latter included interviews with 10 MSM to inform initial development, then recommendations for refinement from five MSM and four experts	HIV prevention app with the following features: (1) log to record sexual behaviour and recreational drug use, which can inform output tables/figures showing changes over time, and links to PrEP resources; (2) information on HIV/STIs, safe sex strategies including partner communication, recreational drug use including alternative strategies to enhance arousal before sex, and PrEP; (3) recommendations, links and a log to promote and record testing; (4) search, messaging and message board to interact with other users; and (5) presentation of most popular users, message boards and testing locations	App was used for 6 months; quiz and prize activity related to HIV testing, safe sex and drug use were conducted every 3 weeks	Interactive	Smartphone/mobile app
Sex Positive! Hirshfield <i>et al.</i> ^{104,127}	USA	MSM living with HIV	Not stated	Core intervention videos were newly produced, based in part on videos from the earlier HIV Big Deal project, which showed effectiveness in reducing instances of CAI. Content was informed by a community advisory committee. A video from the HIV Big Deal project was edited to create three booster videos; the fourth booster video came from a video-sharing website	Sex Positive! aimed to prevent onward HIV transmission among MSM living with HIV, and targeted treatment adherence, mental health, substance use, sexual behaviour and interpersonal violence outcomes. The intervention's dramatic video series 'Just a Guy' followed 'Guy', a gay man living with HIV in Brooklyn, New York. The intervention used modelling to demonstrate risk reduction and health behaviours, including HIV disclosure and discussions about safer sex. Four follow-up booster videos, featuring dramatised vignettes showing HIV-negative MSM	Six videos, delivered weekly for 3 months, and four booster videos delivered weekly starting at 6 months. Full intervention was delivered over a 1-year period	Not interactive	Internet

continued

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Sexpulse Rosser <i>et al.</i> ¹¹⁶ and Wilkerson <i>et al.</i> ¹²⁰	USA	MISM	Not stated	Designed by health professionals, computer scientists and e-learning specialists, and developed by an e-learning company. Sexpulse was informed by formative research with 2716 MISM (recruited online) and developed by adapting an existing MSM sexual health curriculum from a seminar to an online setting. Module prototypes were reviewed by experts, tested with MISM and refined	asking and disclosing STI status in realistic situations, and a segment on social support for people living with HIV, aimed to help sustain the intervention's impact over time Sexpulse was a flexible, modular HIV prevention intervention that aimed to reduce instances of unprotected anal intercourse. It incorporated video segments, interactive text and animations. Examples of modules included a 'hot sex calculator' demonstrating decision-making, a virtual gym where users could explore body image concerns, an online chat simulation to explore evasive and ambiguous communication and a 'reflective journey' exploring past experiences, long-term goals and spirituality. The intervention addressed a range of topics including mental, emotional and physical health; intimacy; relationships; sexuality; and spirituality. Modules were supplemented with frequently asked questions, virtual peers sharing their experiences, cartoons and interactive polls	Multimodule intervention completed over a 7-day period	Interactive	Internet

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
Smartphone self-monitoring (no name) Swendeman <i>et al.</i> ¹¹⁹	USA (Los Angeles, CA)	People living with HIV	Did not specify a provider organisation for intervention delivery, but seemed to be the research team	Not stated	Self-monitoring intervention to support self-management in medication adherence, mental health, substance use and sexual risk behaviours. Users completed smartphone-based self-monitoring surveys daily (alcohol, tobacco and other drug use, sexual behaviours and medication adherence) and four times per day (physical and mental health), with reporting on stressful events and text diary entries at any time. Customisable alarms prompted users to fill in surveys and users could access a web-based visualisation tool to view their survey responses over time and by location, as well as to view associations between variables	Self-monitoring daily and four times per day, with reporting on stressful events and text diary entries at any time. Intervention duration was not specified, but the last follow-up assessment specified took place at 6 weeks	Interactive	Smartphone/mobile app
continued								

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
SOLVE Christensen <i>et al.</i> ¹⁰¹	USA	Young adult MSM	Not stated	This interactive, media-based intervention was informed by an approach previously developed and tested by a co-author of the included report and their colleagues, and was delivered in SOLVE as a downloadable three-dimensional animated game. Content was based on qualitative and quantitative pilot studies	SOLVE aimed to decrease instances of unprotected anal intercourse, thereby reducing HIV risk. In this three-dimensional animated game, the user took the role of a customisable avatar and made decisions that affected the narrative in simulated settings presenting risky situations and barriers to safer sex that young adult MSM typically confront on first dates or 'hook-ups'. The intervention simulated shame-inducing situations, and the avatar and other guide characters modelled acceptance and normalisation of the user's desires. At decision points, these characters used an 'ICAP' process involving: (I) interrupting automatic risky choices, (C) challenging those choices with persuasive messages, (A) acknowledging, accepting and sharing MSM's emotions/motives (e.g. desires for men) and (P) providing a way and skills for MSM to be safe ¹⁰¹	30 minutes	Interactive	Computer download

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
TXT-Auto Reback <i>et al.</i> ^{114,115,132}	USA (Hollywood area of Los Angeles County, CA)	Out-of-treatment methamphetamine-using MSM	Research activities took place at a community research centre with a long history of working with methamphetamine-using MSM	Pilot research identified peak times for high-risk activities. Text messages were written in collaboration with community/peer focus groups. A mobile-health development company programmed the text messaging software and hosted the system	TXT-Auto aimed to reduce substance use and HIV risk by decreasing methamphetamine use and instances of sex during methamphetamine use and CAI. A baseline survey assessed the user's risk profile in relation to HIV status, antiretroviral therapy adherence, drug use and sexual behaviours. Users then received five automated, unidirectional, scripted text messages per day, which included both general messages and messages tailored to their risk profile. A brief weekly text-based assessment asking about methamphetamine use and HIV sexual behaviours in the past 7 days aimed to increase self-monitoring	Five messages per day for 8 weeks, delivered at peak hours of high-risk activities (Monday and Tuesday 12.00–20.00, Wednesday and Thursday 12.00–01.00, Friday 12.00–02.00, Saturday 15.30–02.00, and Sunday 15:30–00.00). Weekly self-monitoring assessments	Baseline assessment and weekly self-monitoring assessments were interactive	Text messaging
WRAPP (and linked interventions) ⁹ Bowen <i>et al.</i> , ^{98,99} Williams <i>et al.</i> ¹²¹ and Schonnesson <i>et al.</i> ¹¹⁷	Varied by study: USA (rural areas) ^{98,99,121} and Sweden ¹¹⁷	Varied by study: sexually active, internet-using MSM ¹¹⁷ in rural areas ^{98,121}	Not stated	Content was identified from focus groups and from a web-based assessment. Intervention format was informed by two additional focus groups. The Swedish adaptation ¹¹⁷ was informed by 20 in-depth interviews with Swedish MSM (HIV positive and HIV negative) and a	Online modular HIV risk reduction intervention with informational content tailored for rural MSM and presented as conversations between gay men. Dialogue was interspersed with interactive activities and graphics. The first module primarily addressed HIV prevention during sex and living with HIV, and it featured links to informational websites.	Initially ⁹⁸ included two 20-minute modules completed at least 24 hours apart; users were encouraged to complete all within 7 days. Subsequently, ^{99,117,121} three modules each contained two 20-minute sessions. Initially, modules had to be completed at	Interactive	Internet

continued

TABLE 3 Included intervention descriptions and reports (continued)

Intervention name and study report(s) describing this intervention	Location: country (region)	Target population	Providers and organisation	Intervention development	Intervention aims, components, content and activities	Intervention timing and duration	Interactive or non-interactive?	Technology
				presentation of the intervention to professionals from HIV prevention and treatment organisations. Information tailored to the Swedish context was reviewed by an experienced HIV physician	Author descriptions suggest the second module changed across iterations. It initially ⁹⁸ focused on maintaining a HIV-negative status and addressed safer sex and types and correct use of condoms. In subsequent iterations, ^{99,117,121} this module aimed to increase motivation, and a third module targeting behavioural skills was introduced. Both allowed users to print a summary of their responses to interactive components. The 'motivation' module helped users identify reasons for not using condoms and ways to address these to support the user's pursuit of their life goals. The 'behaviour' module addressed approaches for reducing sexual risk with partners met online or in a bar. A version adapted for Sweden ¹¹⁷ used the Swedish language, was tailored to Swedish health services, and added to the 'knowledge' module information about STIs and Swedish public health legislation	least 48 hours apart and results found that users took an average of 19.39 days to complete them all. ⁹⁹ Subsequently, ¹²¹ each module had to be completed within 14 days; and later, ¹¹⁷ sessions had to be completed 24–48 hours apart		

AIDS, acquired immunodeficiency syndrome; CBT, cognitive-behavioural therapy; LGBT, lesbian, gay, bisexual and transgender; MSM, men who use the internet to seek sex with men; MOTIVES, Mobile Technology and Incentives; nPEP, non-occupational post-exposure prophylaxis; PrEP, pre-exposure prophylaxis; SOLVE, Socially Optimized Learning in Virtual Environments; YMSM, young men who have sex with men.

a As there was no indication that staff responding to questions constituted an intervention component, this intervention was retained as eligible.

b We use 'WRAPP' to refer to the WRAPP intervention itself⁹⁹ and to three versions of this intervention for which author descriptions suggest content was very similar: an unnamed intervention preliminary to WRAPP;⁹⁸ the Hope Project,¹²¹ which extends WRAPP; and SMART, a Swedish adaptation of WRAPP.¹¹⁷

Note

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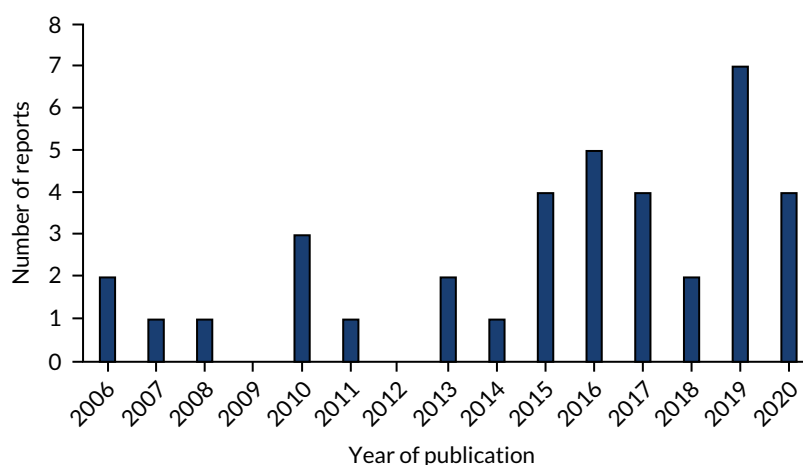


FIGURE 2 Number of included reports, by year of publication.

Intervention development

Most interventions were informed by formative research, consultations and/or pilot testing with participants drawn from the target population (see *Table 3*). For example, gay community representatives provided the scenarios presented in the China–Gate HIV Prevention Program Online Intervention for MSM,¹²⁴ and development of myDEx was informed by input from a sociodemographically diverse youth advisory board of three young MSM.⁹⁷ Gay Cruise developers used intervention mapping, a systematic method for developing interventions informed by evidence, theory and stakeholder input, and piloted materials with 15 professionals and 15 members of the target population.¹⁰⁵ The HealthMindr mobile app was informed by separate focus groups with MSM, HIV testing counsellors and key informants, then tested in focus group discussions.¹¹⁸ Several interventions were informed by or adapted from other existing interventions. For example, the online mindfulness-based cognitive therapy intervention was modelled on an existing mindfulness-based cognitive therapy protocol and drew much of its content from the materials and trainers' manual from that programme,⁹⁶ and Rainbow SPARX was an adaptation for lesbian, gay, bisexual and transgender (LGBT) youth of the computerised cognitive-behavioural therapy (CBT) programme SPARX.¹⁰⁸

Intervention timing and duration

Interventions varied in the timing, intensity and duration of delivery (see *Table 3*). For example, TXT-Auto involved text message delivery five times per day over an 8-week period,^{114,115,132} whereas Gay Cruise involved downloading a game that users could play at their own pace over an indefinite period of time.¹⁰⁵ Three interventions were delivered via smartphone/mobile apps,^{118,119,125,128} which participants were to use over periods ranging from 6 weeks¹¹⁸ to 1 year.¹²⁸ The content of several interventions was delivered weekly over a defined period of time,^{96,104,106,124,127} ranging from 3 weeks (for part II of the China–Gate HIV Prevention Program Online Intervention)¹²⁴ to 1 year [for the Mobile Technology and Incentives (MOTIVES) intervention].¹⁰⁶ When authors reported on the expected or actual amount of time taken for users to work through defined programme content, this ranged from 10 minutes for the tailored version of the Cognitive Vaccine Approach to 3.5 hours for Rainbow SPARX.^{107,108}

Target populations

All included studies met our inclusion criteria stipulating that MSM account for 50% or more of the sample. Of the 23 included interventions, three targeted LGBT or sexual minority youth (aged 13–19,^{107,108} 14–18¹²⁶ and 16–20 years¹¹¹) or young men (aged 13–18 years);¹²⁹ four targeted young adult MSM aged 18–24^{97,101,103,112,113,122,123,130} or 18–39 years;¹⁰⁰ one targeted HIV-negative young adult gay, bisexual and queer men (aged 18–29 years);¹³¹ three targeted MSM^{104,109,110,127} or people more generally¹¹⁹ living with HIV; two targeted single gay men;¹⁰² four targeted MSM/same-sex attracted men generally;^{96,118,124,125,128} two targeted men who use the internet to seek sex with men;^{105,116,120} one targeted sexually active, internet-using MSM,¹¹⁷ with an earlier iteration targeting this population in

rural areas;^{98,121} one targeted Latino/a MSM and transgender women;¹⁰⁶ and one targeted out-of-treatment methamphetamine-using MSM.^{114,115,132}

Geographical location of studies and implementation

Three-quarters (21/28) of included studies took place in the USA.^{96-101,103,104,106,109-116,118-123,126-130,132} Two studies (7%) took place in the Netherlands,^{102,105} and one (4%) took place in each of the following: China,¹²⁴ New Zealand,^{107,108} Singapore,¹³¹ Sweden¹¹⁷ and Taiwan (Province of China)¹²⁵ (Figure 3).

Intervention mode of delivery and interactivity

The 23 included interventions were delivered by a variety of electronic methods (Figure 4). Most were delivered via the internet (n = 15, or 65%),^{96-100,102-105,109-113,116,117,120-124,127,129-131} with others split across the following platforms: smartphone/mobile app (n = 3, or 13%),^{118,119,125,128} text messaging (n = 2, or 9%),^{106,114,115,132} computer download (n = 2, or 9%)^{101,126} and CD-ROM (n = 1, or 4%).^{107,108}

The vast majority of interventions (20/23, or 87%) were interactive,^{96-101,103,105-108,111-113,116-123,128,130} a further three (13%) used participant assessments to inform the delivery of non-interactive content^{102,109,110,114,115,132} and the remaining three (13%) were not interactive.^{102,104,127,131}

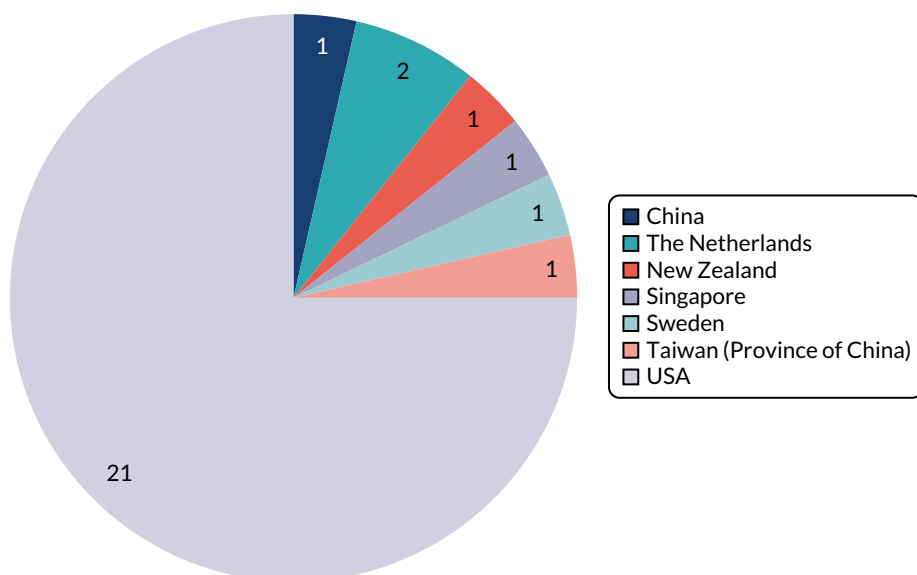


FIGURE 3 Spread of studies by country.

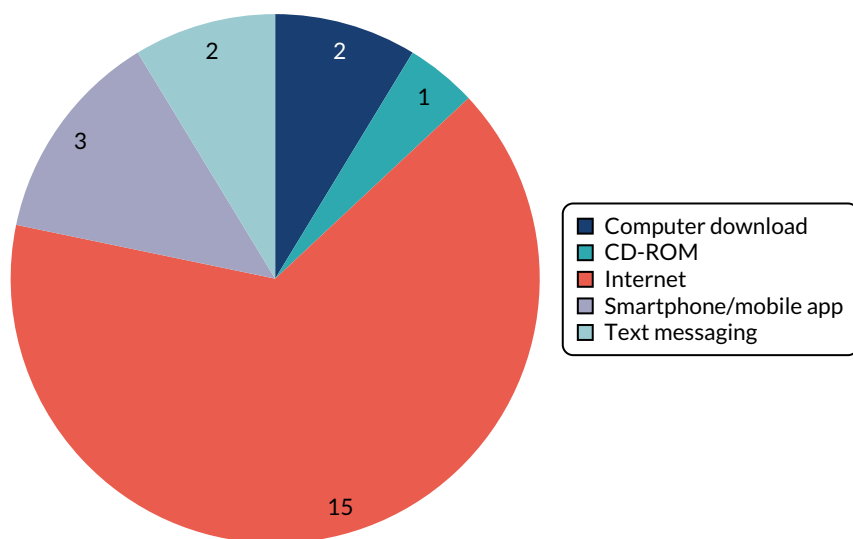


FIGURE 4 Electronic mode of delivery, by intervention.

Chapter 4 Results: typology of intervention approaches

As planned, we identified whether or not interventions were solely focused on the prevention of alcohol or drug use; HIV, STIs and sexual risk behaviour; or mental ill health; and whether or not they had other aims such as access to HIV testing or adherence to HIV treatment. However, we ultimately developed a typology of interventions based on authors' narrative descriptions of intervention methods because the strongest similarities and differences between interventions emerged in relation to the approaches used, and interventions addressing similar outcomes often took different approaches to doing so. We then further categorised each intervention in terms of its targeted health outcomes (Table 4). To determine targeted outcomes, we drew on authors' descriptions of the nature, aims and outcome(s) of an intervention and the outcomes assessed in evaluations.

TABLE 4 Interventions addressing each health outcome, by type

Intervention category	Subcategory			Intervention name [report(s)]	Outcomes addressed		
	1	2	3		Sexual health	Mental health	Substance use
Time-limited/modular	Interactive	Online modular (n = 9)	Cognitive therapy (n = 1)	Online mindfulness-based cognitive therapy (a,bAvellar ⁹⁶)		X	
			Comprehensive sexual education for young people (n = 2)	myDEX (aBauermeister et al. ⁹⁷ /a,b,cBauermeister et al. ¹²³) ^d	X	X	X
				Queer Sex Ed (a,bMustanski et al. ¹¹¹)	X		
			HIV prevention/sexual health (n = 6)	China-Gate HIV Prevention Program	X		
				Online Intervention (a,cCheng et al. ¹²⁴)	X		
				Hot and Safe M4M (a,cCarpenter et al. ¹⁰⁰)	X		
			Keep it Up! (a,b,cMustanski et al., ¹²² a,bGreene et al., ¹⁰³ aMustanski et al. ¹¹² / a,cMustanski et al. ¹¹³ / a,cMadkins et al. ¹³⁰) ^d	X		X	
				MyPEEPS Mobile (aKuhns et al. ¹²⁹)	X		X
				Sexpulse (a,cRosser et al. ¹¹⁶ /aWilkerson et al. ¹²⁰) ^d	X		
WRAPP (a,bBowen et al., ⁹⁸ a,bBowen et al., ⁹⁹ a,bWilliams et al., ¹²¹ a,cSchonnesson et al. ¹¹⁷)	X						

continued

TABLE 4 Interventions addressing each health outcome, by type (continued)

Intervention category	Subcategory			Intervention name [report(s)]	Outcomes addressed		
	1	2	3		Sexual health	Mental health	Substance use
Open-ended	Computer games (n = 4)			Gay Cruise (^a Kok <i>et al.</i> ¹⁰⁵)	X		
				Rainbow SPARX (^{a,b} Lucassen <i>et al.</i> ¹⁰⁸ / ^a Lucassen <i>et al.</i> ¹⁰⁷) ^d		X	
				Role-playing game (^a Coulter <i>et al.</i> ¹²⁶)		X	X
				SOLVE (^{a,c} Christensen <i>et al.</i> ¹⁰¹)	X		
	Non-interactive (n = 4)	Online modular (n = 2)		Cognitive Vaccine Approach, non-tailored (^{a,c} Davidovich <i>et al.</i> ¹⁰²) ^e	X		
				Cognitive Vaccine Approach, tailored (^{a,c} Davidovich <i>et al.</i> ¹⁰²) ^e	X		
	Video series (n = 2)		Sex Positive! (^a Hirshfield <i>et al.</i> ¹⁰⁴ / ^{a,c} Hirshfield <i>et al.</i> ¹²⁷) ^d	X	X	X	
			People Like Us (^a Tan <i>et al.</i> ¹³¹)	X			
	Content organised by assessment (n = 2)	SMS (n = 1)		TXT-Auto (^c Reback <i>et al.</i> ¹¹⁴ / ^{a,c} Reback <i>et al.</i> ¹¹⁵ / ^f Reback <i>et al.</i> ¹³²) ^d	X		X
				Static website (n = 1)	Internet-based safer sex intervention (^c Milam <i>et al.</i> ¹⁰⁹ / ^{a,c} Milam <i>et al.</i> ¹¹⁰) ^d	X	
	General content (n = 4)	Mobile multifeature app (n = 2)		HealthMindr (^{a,b} Sullivan <i>et al.</i> ¹¹⁸ , ^a Jones <i>et al.</i> ¹²⁸)	X		
				Safe Behaviour and Screening (^{a,c} Chiou <i>et al.</i> ¹²⁵)	X		X
		Self-monitoring (n = 1)		Smartphone self-monitoring (^{a,b} Swendeman <i>et al.</i> ¹¹⁹)	X	X	X
SMS (n = 1)			MOTIVES (^a Linnemayr <i>et al.</i> ¹⁰⁶)	X	X	X	
Total (n)					20	7	10

SOLVE, Socially Optimized Learning in Virtual Environments.

a Theory report.

b Process evaluation report.

c Outcome evaluation report.

d Reports separated by a forward slash (/) report on the same research study.

e Davidovich *et al.*¹⁰² report on two similar, but distinct, interventions.

f Economic evaluation report.

Note

Bold type indicates typology categories.

Of the 23 interventions included in the review,⁹⁶⁻¹³² 11 addressed sexual health alone,^{98-102,105,111,116-118,120,121,124,128,131} two addressed mental health alone^{96,107,108} and none addressed substance use alone.

The 10 remaining interventions addressed multiple outcomes of interest for this review: five addressed sexual health and substance use,^{103,109,110,112-115,122,125,129,130,132} one addressed mental health and substance use¹²⁶ and four addressed all three outcomes – sexual health, mental health and substance use.^{97,104,106,119} In total, 20 interventions addressed sexual health,^{97-106,109-125,127-132} seven addressed mental health^{96,97,104,106-108,119,123,126,127} and 10 addressed substance use.^{97,103,104,106,109,110,112-115,119,122,123,125-127,129,130,132}

In the case of the Keep it Up! intervention, which primarily targeted sexual health, five included study reports focused on two versions of the intervention.^{103,112,113,122,130} Of these, one, which reported on version 2.0, identified substance use as a secondary outcome.¹¹² Because both this and the earlier version of Keep it Up! included content addressing substance use in the context of sexual health,^{122,130} we categorised Keep it Up! as addressing both sexual health and substance use.

Types of intervention methods

Interventions fell into two overarching types: time-limited/modular ($n = 17$)^{96-101,103,105,107,108,111-113,116,117,120-124,126,130} and open-ended ($n = 6$).^{102,104,106,109,110,114,115,118,119,125,127,128,131,132} Each contained intervention subtypes.

Time-limited or modular interventions

Seventeen interventions were designed as time-limited or modular interventions, guiding participants sequentially through intervention content from beginning to end.^{96-105,107,108,111-113,116,117,120-124,126,127,129-131} Of these, 14 addressed sexual health,^{97-105,111-113,116,117,120-124,127,129-131} five addressed mental health^{96,97,104,107,108,123,126,127} and five addressed substance use.^{97,103,104,112,113,122,123,126,127,129,130} These interventions could be subdivided into interactive^{96-101,103,105,107,108,111-113,116,117,120-124,126,130} and non-interactive interventions.^{102,104,127,131}

Interactive interventions

The interactive time-limited/modular interventions presented opportunities for users to engage actively with the intervention via features such as activities, exercises, games, quizzes and selecting options within scripted dialogue. Interventions typically included an aspect of tailoring or personalisation, for example providing some activities tailored to the user's readiness to change in Hot and Safe M4M,¹⁰⁰ allowing the user to select a love- or sex-oriented movie to watch in Gay Cruise,¹⁰⁵ providing printable feedback based on user responses in WRAPP⁹⁹ and providing tailored goal-setting recommendations based on a user's risks according to baseline assessments in Keep it Up!¹²² Based on author descriptions, three interventions appeared to include some tailoring of content based on individual reported needs, risks or behaviours,^{97,100,122} while two others referred to feedback that was tailored or personalised,^{99,105,121} but did not specify whether this was based on users' needs, risks, behaviours or other factors such as participant characteristics or interaction with the intervention.

Interactive time-limited or modular interventions fell into two categories: online modular interventions and computer games.

Online modular interventions

The largest category in the typology, comprising nine of the review's interventions, was interactive, modular programmes delivered online.^{96-100,103,111-113,116,117,120-124,129,130} These interventions delivered content in sequential modules via the internet, including, in one case, via e-mail.¹²⁴ Among the online modular interventions, the online mindfulness-based cognitive therapy intervention delivered cognitive therapy via a modular approach for same-sex attracted men.⁹⁶ Two were comprehensive sexual education interventions for young people: Queer Sex Ed targeted youth aged 16–20 years¹¹¹ and myDEx targeted young adults aged 18–24 years.^{97,123} Six focused more narrowly on HIV prevention and sexual health.^{98-100,103,112,113,116,117,120-122,124,129,130}

The timing of module delivery varied for interventions in this category. For example, the seven modules of Keep it Up! were delivered in three sessions with at least 24 hours between them,^{103,122} the online mindfulness-based cognitive therapy⁹⁶ intervention was delivered as eight weekly sessions, and users of Queer Sex Ed¹¹¹ completed the programme's five modules at their own pace.

No online modular interventions targeted substance use alone, and one targeted mental health alone.⁹⁶ The remaining eight targeted sexual health either alone ($n = 5$)^{98-100,111,116,117,120,121,124} or primarily but in conjunction with at least one other outcome ($n = 3$),^{97,103,112,113,122,123,129,130} making online modular interventions the most common type of sexual health intervention included in this review.

Online modular interventions took varied approaches to delivering intervention content. For example, WRAPP modules presented scripted discussions between peers, interspersed with interactive activities;⁹⁹ multimedia Queer Sex Ed modules were guided by an avatar moderator and each module ended with a quiz;¹¹¹ and the online mindfulness-based cognitive therapy intervention included lectures, meditation activities and homework activities.⁹⁶

Computer games

Four interventions were designed as interactive computer games.^{101,105,107,108,126} Three (Gay Cruise,¹⁰⁵ the role-playing game¹²⁶ and SOLVE¹⁰¹) were sexual health^{101,105} or mental health/substance use¹²⁶ interventions that immersed the user in a virtual environment where they interacted with one or more non-playable characters via scripted dialogue options. The fourth (Rainbow SPARX^{107,108}) was a mental health intervention teaching CBT skills. Designed for sexual minority youth, Rainbow SPARX's seven modules were set in a fantasy world where the user completed a mission in each level to collect a gem for their virtual shield and to progress to the next level.

Non-interactive interventions

Four time-limited or modular interventions did not appear to be interactive according to author descriptions.^{102,104,127,131} One subcategory of online modular interventions included both the tailored and non-tailored versions of the Cognitive Vaccine Approach,¹⁰² which targeted sexual health outcomes in the format of an eight-module online intervention. Although similar in structure to the interactive online modular interventions, the report described the delivery of programme messaging but did not refer to interactive components. The other subcategory was video series, which comprised two interventions.^{104,127,131} Targeting sexual health in conjunction with secondary outcomes of mental health and substance use, Sex Positive! comprised a weekly six-part video series following a gay man living with HIV.^{104,127} This core content was followed by four subsequent booster session videos. The People Like Us sexual health intervention was a web-based drama miniseries featuring stories of six ethnically and socioeconomically diverse gay, bisexual and queer men negotiating sexual health, mental health and relationship issues.¹³¹ Community-based organisation representatives appeared at the end of each video, summarising the episode and addressing key points about mental and sexual health.

Open-ended interventions

In contrast to the time-limited/modular interventions, six interventions appeared, according to author descriptions, to be open-ended.^{106,109,110,114,115,118,119,125,128,132} Rather than implying an infinite amount of content, this description merely indicates that these interventions were not designed as fixed and sequenced bodies of learning that all participants were intended to work through. All of these open-ended interventions addressed sexual health: one did so alone;^{118,128} three addressed sexual health and substance use;^{109,110,114,115,125,132} and two addressed sexual health, mental health and substance use.^{106,119}

Two open-ended interventions were delivered via SMS.^{106,114,115,132} Although their content was limited (i.e. there was a finite set of SMS messages that could be delivered), we categorised these as open-ended because author descriptions suggested that they were not designed to guide participants from beginning to end through a sequential intervention. In TXT-Auto,^{114,115,132} users received five messages daily for 8 weeks and a weekly text-based assessment. The messages each user received were tailored

to their risk profile at baseline. In the MOTIVES intervention, participants received a weekly SMS with HIV prevention information, followed 2 days later by a SMS asking a question about this information, as well as a HIV testing reminder message every 2.5 months.¹⁰⁶

Among the open-ended interventions, two determined which core content to deliver based on a user assessment^{109,110,114,115,132} and four did not use this approach.^{106,118,119,125,132}

Content organised by assessment

TXT-Auto^{114,115,132} and the internet-based safer sex intervention^{109,110} both addressed sexual health and substance use and tailored the delivery of core content based on user risk assessments. In the former, participants received a combination of general messages delivered to all users and messages tailored to their sexual health and substance use risk profile, assessed at baseline. In the latter, a user was directed to static websites with messaging tailored to their STI and HIV transmission risk, which was assessed monthly.

General content

Four open-ended interventions comprised general content delivered to all participants.^{106,118,119,125,128} Two addressed sexual health, mental health and substance use;^{106,119} one addressed sexual health and substance use;¹²⁵ and one addressed sexual health alone.^{118,128} The format of these interventions varied. In the SMS intervention MOTIVES, based on behavioural economics, correctly recalling HIV prevention information increased users' chances of winning a prize.¹⁰⁶ The smartphone app HealthMindr included, among other features, resources to create a plan and schedule HIV testing, a feature for ordering condoms and HIV test kits and a quiz to self-assess pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis eligibility.^{118,128} The features of the Safe Behaviour and Screening smartphone app for HIV prevention included a sexual behaviour and drug use log; sexual health, substance use and HIV testing information; and resources and a messaging platform to interact with other users.¹²⁵ In the smartphone self-monitoring intervention, delivered via smartphone app, the user filled in daily and four-times daily surveys and used event-based reporting and text diary entries to self-monitor their behaviours.¹¹⁹ Although these interventions could include elements of tailoring, for example HealthMindr users received bespoke HIV prevention recommendations based on monthly risk assessments, tailoring did not determine delivery of core content.

Feedback from stakeholder consultation on typology of intervention approaches

The types of interventions described were felt, generally, to be relevant to meeting the challenges presented by the syndemic of poor sexual health, poor mental health and substance use among MSM. They were felt to be especially useful for the large group of MSM with less intense needs in these areas, for whom higher-intensity interventions, such as clinical psychology or counselling, might be unsuitable or inaccessible owing to service rationing. A minority of stakeholders felt that these interventions could be a useful supplement to face-to-face interventions for those with more intensive needs.

All stakeholders preferred interventions that provided some degree of personalisation and tailoring to the needs of individuals, ideally based on a risk assessment and providing content most relevant to their profile and/or needs. It was felt that this was critical in maintaining engagement with a diverse group of MSM who could benefit from these approaches. Interventions that were interactive and provided feedback mechanisms were favoured for increasing engagement and a sense of connection.

Open-ended interventions were favoured by some, over time-limited modular interventions, as approaches that would allow participants to select elements to work through that were most pertinent to their needs. These were perceived to increase engagement and, potentially, effectiveness. There was

acknowledgement that, with these approaches, if the content were suitably engaging and the individual perceived benefits to themselves, they would probably engage with much of the content included in the intervention.

Computer game approaches were seen by most stakeholders as patronising and unsuitable, except if these were specifically targeting young MSM or were exceptionally well designed. There was significant concern that these interventions would alienate much of their target population. One stakeholder also raised a concern that computer game approaches could be unethical, as they were an incursion into spaces designed for entertainment and not usually occupied by health promotion initiatives.

Pathways from other existing services to online interventions, and to existing services from online interventions, were felt to be important; participants recommended that interventions should provide multiple referral pathways to face-to-face services, and vice versa. Without these, there was substantial concern that only the most highly motivated would access e-health interventions.

Chapter 5 Results: synthesis of theories of change

About this chapter

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Reports included in the theory of change synthesis

Thirty-three reports were included in the theory of change synthesis, representing 28 unique studies of 23 interventions.^{96-106,108,110-113,115-128,130,131} Seven reports were study protocols.^{97,104,106,112,126,128,129} Two interventions (a tailored and a non-tailored version of the Cognitive Vaccine Approach, both reported by Davidovich *et al.*¹⁰²) shared a single theory of change, resulting in 22 unique theories of change included in the synthesis.

For each intervention theory of change, summaries of that theory of change, the evidence supporting it, how it was developed and the existing scientific theories on which it draws are provided in *Appendix 11*.

Quality of studies

Agreement between independent reviewer assessments on each theory report was good, ranging from agreement on none of the five quality criteria in one case¹²⁰ to agreement on all five in 15 cases^{97,99,101,102,107,110,113,115,117,119,123-125,127,131} with agreement on four or five criteria for more than three-quarters of reports ($n = 26$; 79%).^{97,99,101-104,107,110,112,113,115-119,121-131} See *Appendix 12* for quality assessment results for each theory report. All disagreements on independent quality assessments were resolved by discussion.

Quality varied notably across theory reports and clustered towards low and medium quality, with 14 reports (42%) meeting none or one of the criteria assessed,^{110,112,113,115,116,118,120-122,125,127,129-131} 14 (42%) meeting two or three criteria^{96,98-100,103-106,108,111,117,124,126,128} and only five (15%) meeting four or all five criteria.^{97,101,102,119,123}

Quality varied across the five criteria assessed. Nearly three-quarters of theory reports ($n = 23$; 70%) clearly defined the constructs or concepts that made up the theory of change,^{96-99,101-105,107,111,117,119,121-126,128-131} and about half described a pathway from intervention components to intended outcomes ($n = 16$; 48%).^{96,99-107,117,119,123,124,126,128} Slightly more than one-third clearly described how theoretical constructs were inter-related ($n = 12$; 36%).^{97-102,111,117,119,123,126,128} Only four (12%) described biological, psychological or social processes or mechanisms underlying these inter-relationships, and the same number described how mechanisms and outcomes might vary by context.^{97,102,106,123}

Scientific theories informing intervention design

Authors cited a number of existing scientific theories informing intervention theories of change. Interventions often drew on more than one such theory. The information–motivation–behavioural skills (IMB) model and social cognitive theory were the most commonly cited, with the former informing seven interventions^{97,99,100,102,111–113,117,121–123,125,130} and the latter informing eight.^{98,101,104,105,110,115,118,126–128} The IMB model was initially developed to inform HIV prevention, but has since been advanced as a model for conceptualising individual and social determinants of health behaviours more broadly.¹³³ Social cognitive theory incorporates individual, social and structural factors shaping health behaviours, and techniques for changing health behaviours.¹³⁴ One report citing social cognitive theory also cited its predecessor,¹⁰⁴ social learning theory,¹³⁵ and one report cited the social–personal framework, which the authors described as building on social learning theory.¹²⁹ In addition, the smartphone self-monitoring intervention was underpinned by the theorised role of self-monitoring in supporting self-management,¹¹⁹ and we noted that self-monitoring is a core construct of social cognitive theory.¹³⁶

Other scientific theories of behaviour informed between one and three interventions each: the health belief model,^{102,115} which focuses on the role of individual beliefs about health problems;¹³⁷ the theory of planned behaviour,^{101,102,124} which takes into account individual and social factors and theorises that intentions and perceptions of behavioural control are the direct precursors to behaviour;¹³⁸ and social support theory,¹¹⁵ which theorises that support or perceptions of support from people who are trusted can reduce the stress of, and improve the ability to cope with, difficult events.¹³⁹ Content for the Sexpulse intervention was informed by the sexual health model, which identifies 10 components essential to healthy sexuality,¹⁴⁰ theorising that sexually healthy persons are more likely to make sexually healthy decisions.¹¹⁶ In addition to social cognitive theory, the role-playing game intervention¹²⁶ was informed by stress and coping theory and by the emotional learning framework. In regard to bullied youth, the former posits that youths' appraisals of their experience predict their coping strategies, with those who blame themselves, perceive little control or view bullying as a threat instead of a challenge tending to use non-productive coping strategies.¹²⁶ The emotional learning framework specifies four health-promoting competencies, described as 'awareness of self and others, responsible decision making, positive attitudes and values, and social interaction skills'.¹²⁶

The MOTIVES intervention was rooted in behavioural economics,¹⁰⁶ which examines how actors make decisions other than via conscious reasoning. Two interventions were underpinned by theory on interactions between cognitive and emotional factors: myDEx was informed by a 'dual processing, cognitive–emotional decision making framework',⁹⁷ which recognises that affective states (emotions) and cognitive states (thinking) both influence decision-making, and that the former might be processed more quickly than the latter. The Socially Optimized Learning in Virtual Environments (SOLVE) intervention was informed by learning from neuroscience that highlights the important role that emotions play in decision-making.¹⁰¹

Scientific theories of how behaviour might be actively changed were also cited, such as the transtheoretical model,^{105,110} which maps stages and processes by which people change their behaviours.¹⁴¹ The Hot and Safe M4M intervention incorporated strategies from motivational interviewing by assessing, and delivering exercises based on, participants' 'readiness to change'.¹⁰⁰ Two interventions were rooted in CBT, which examines inter-relationships between cognitions and behaviours and how these may be modified: the online mindfulness-based cognitive therapy intervention integrated mindfulness and CBT approaches⁹⁶ and the Rainbow SPARX intervention delivered CBT using a computer game format.¹⁰⁸

Some study reports suggested potential synergies when interventions were informed by multiple complementary theories. For example, the Cognitive Vaccine Approach drew on elements of the theory of planned behaviour and the health belief model to operationalise the motivation construct in the IMB model,¹⁰² while Reback *et al.*¹¹⁵ noted that the theories informing message content in the TXT-Auto intervention complement each other.

As evidence to support intervention components and theories of change, theory reports often cited evaluations of earlier iterations of the current intervention or of similar interventions, or previous research on the scientific theories in question. When authors discussed how the intervention theory of change was developed, these discussions were commonly informed by formative research,^{105,111,115} existing interventions,⁹⁶ literature on the needs of the target group,^{102,105} components of the scientific theories underpinning the intervention^{102,108,115} or a combination of these.^{102,105,115}

Theory of change synthesis

All intervention theories of change identified intended intervention components, mediators and outcomes that could be incorporated into an intervention-specific theory of change diagram, except for the theory underpinning the internet-based safer sex intervention,¹¹⁰ which did not identify mediators. Two theories of change also identified participant characteristics theorised to moderate the relationship between the intervention and its intended outcomes.^{97,106,123}

Our grouping of theories of change inductively, based on their key constructs, resulted in three groups of intervention theories of change. The largest, the 'cognitive/skills' theory of change grouping, was informed primarily by social cognitive theory and the IMB model.^{97-100,102-105,111-113,117,118,121,122,124,125,129,131} The second grouping drew on two intervention theories of change that were driven primarily by self-monitoring (the 'self-monitoring' theory of change grouping),^{115,119} and the third drew on two intervention theories of change that were based on cognitive therapy approaches (the 'cognitive therapy' theory of change grouping).^{96,107} Five intervention theories of change did not fall within any of these three inductive groupings.^{101,106,110,116,120,126} The 'cognitive therapy' theory of change grouping comprised only mental health interventions. The other two theory of change groupings were not associated with particular intended outcomes.

The intervention typology developed at an earlier stage of the review (see *Chapter 4*) categorised included interventions into two overarching categories: 'time-limited/modular' (guiding participants sequentially through intervention content from beginning to end) and 'open-ended' (not designed as fixed and sequenced bodies of learning that all participants were intended to work through), each of which contained two or three intervention subtypes. Most time-limited/modular interventions ($n = 12$, 71%) used intervention theories of change that fell within the 'cognitive/skills' theory of change grouping.^{97-100,102-105,111-113,117,121-124,127,129-131} Theories of change underpinning open-ended interventions were more varied: among the two interventions in which content was organised by assessment, one fell within the 'self-monitoring' theory of change grouping^{114,115} and the other did not fall within a grouping.^{109,110} Among the four interventions delivering general content, two fell within the 'cognitive/skills' theory of change grouping,^{118,125,128} one fell within the 'self-monitoring' theory of change grouping¹¹⁹ and one did not fall within any grouping.¹⁰⁶ *Appendix 13* shows the theory of change grouping and targeted outcome(s) for each intervention included in the review, categorising interventions by type.

To demonstrate the methodological process of synthesising individual intervention theory of change diagrams to develop overarching theory of change diagrams, *Appendix 8* presents the individual and synthesised theory of change diagrams for one inductive grouping of theories of change.

'Cognitive/skills' synthesised theory of change

We drew on 13 intervention theories of change, which varied in quality from low to high, to develop an initial diagram for the 'cognitive/skills' grouping (*Figure 5*).^{97-100,102-105,111-113,117,118,121-125,127-131} These theories of change underpinned 14 interventions: China-Gate HIV Prevention Program Online Intervention,¹²⁴ Cognitive Vaccine Approach [(1) tailored and (2) non-tailored versions],¹⁰² Gay Cruise,¹⁰⁵ Keep it Up!,^{103,112,113,122} HealthMindr,¹¹⁸ Hot and Safe M4M,¹⁰⁰ myDEX,⁹⁷ MyPEEPS Mobile,¹²⁹ People Like Us,¹³¹ Queer Sex Ed,¹¹¹ Safe Behaviour and Screening,¹²⁵ Sex Positive!¹⁰⁴ and WRAPP.^{98,99,117,121}

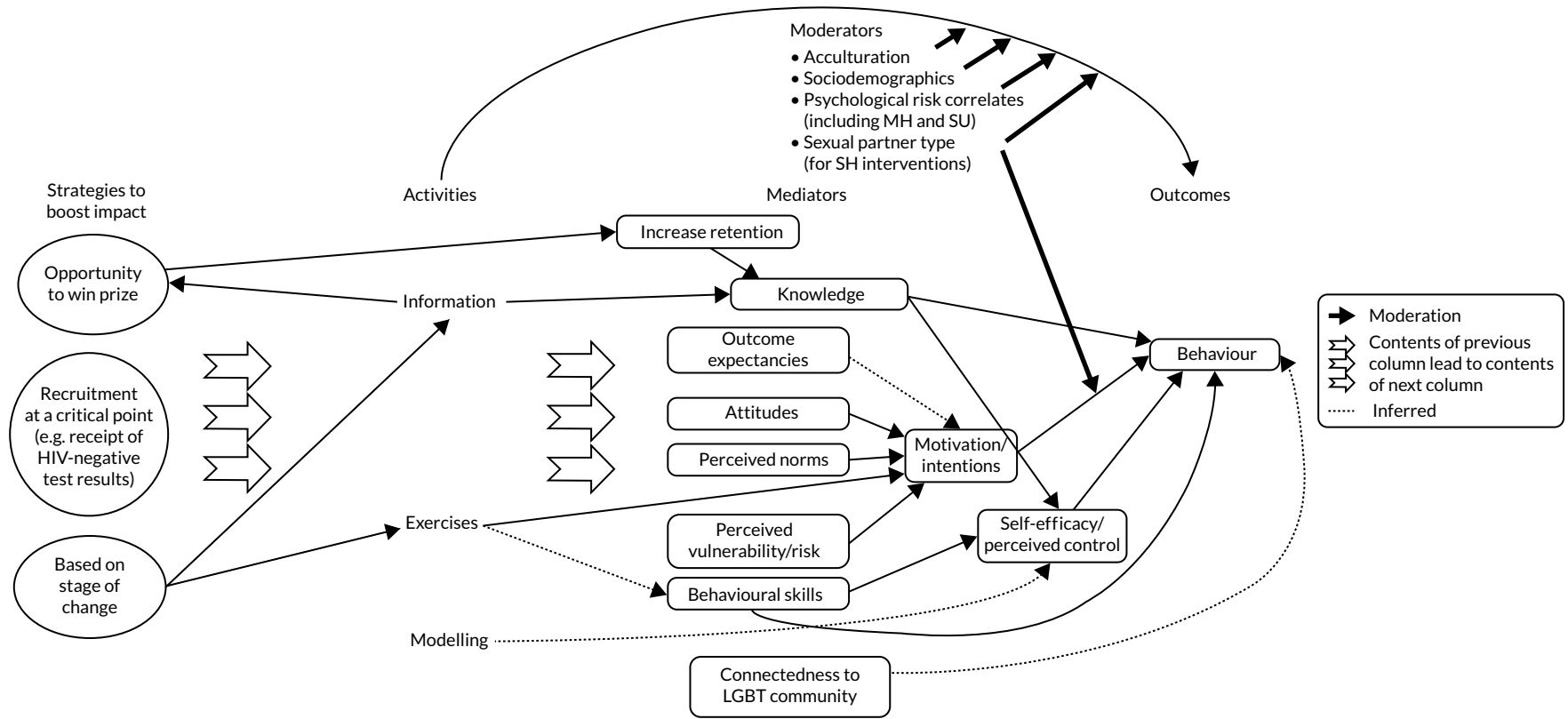


FIGURE 5 'Cognitive/skills' synthesised theory of change. MH, mental health; SH, sexual health; SU, substance use.

Ten of the 13 intervention theories of change in this grouping referenced social cognitive theory^{98,99,104,105,117,118,121,127,128} and/or the IMB model,^{97-100,102,103,111-113,117,121-123,125,130} often in combination with other scientific theories. Three referenced the theory of planned behaviour^{102,124,129} and one referenced no existing scientific theories, but shared key constructs with other intervention theories of change in this grouping.¹³¹ Although other interventions also drew on these scientific theories, the intervention theories of change in this grouping shared, as core components, constructs that are key to these three scientific theories. All interventions represented in this grouping targeted sexual health outcomes, either alone or in combination with substance use or both substance use and mental health. Of the 12 time-limited interventions in this grouping, guiding participants sequentially through intervention content from beginning to end, seven were online modular interventions,^{97-100,103,105,111-113,121-124,129,130} four were non-interactive interventions^{102,104,127,131} and one was a computer game.¹⁰⁵ The remaining two interventions in this grouping were open-ended and of the 'general content' subtype (i.e. with content not organised by an assessment).^{118,125,128}

The MOTIVES intervention¹⁰⁶ and the internet-based safer sex intervention¹¹⁰ theories of change, assessed as being of medium and low quality, respectively, were primarily rooted in different approaches or scientific theories and were therefore not included in the 'cognitive/skills' grouping. However, these theories of change included components both overlapping with and complementing those in the 'cognitive/skills' grouping. Using the line-of-argument approach, we therefore drew on the theories of change underpinning MOTIVES and the internet-based safer sex intervention to augment findings within this grouping, and these additions (theorised moderators and the provision of information based on assessed stage of change) appear in the synthesised theory of change diagram.

Interventions in this grouping provided information and exercises and incorporated techniques to model, or demonstrate, desired behaviours. Included in the exercises are decisional balance exercises, which weigh the pros and cons of a particular behaviour; this recurred as an intervention activity in theory reports.

These activities were theorised to affect mediators including knowledge, outcome expectancies (i.e. positive and negative expectations of a particular behaviour),¹³⁴ attitudes (including internalised homophobia),^{111,131} perceived norms, perceived vulnerability/risk (a construct combining, via reciprocal translation, perceived vulnerability^{102,103,111-113,122,130} and risk perceptions^{105,124,131}) and behavioural skills. In addition, two interventions whose theories of change informed this grouping aimed to affect connectedness to the LGBT community,^{111,131} portrayed as a mediator in the synthesised diagram, although the reports were not explicit about how intervention activities aimed to engender this connectedness or how it might be related to sexual health outcomes.

Individual theories of change differed as to what specific activities led to the development of behavioural skills. We inferred that exercises would develop behavioural skills, indicating this as an inference by use of a dotted line in *Figure 5*, although behavioural skills could be developed through other activities. For example, in the video-based Sex Positive! intervention, characters modelled behaviours and this was theorised to increase self-regulatory skills.¹⁰⁴ Theory reports did not describe clear and recurring pathways from modelling to mediators, but we inferred (denoted by use of a dotted line) from reciprocal translation of recurring descriptions that these aimed to promote self-efficacy.^{104,105}

Although information provision was consistently linked to knowledge, theory reports provided no consensus on the activities that were intended to modify outcome expectancies, attitudes, perceived norms and perceived vulnerability. These mediators are shown in *Figure 5* by the use of three hollow block arrows, indicating that they stem from intervention activities generally. Knowledge and behavioural skills were described as affecting behaviour either directly or via self-efficacy, so both pathways are shown in the synthesised model.

Outcome expectancies tended to be linked to motivation in theory of change descriptions, although the theorised relationship of motivation to other constructs varied. Outcome expectancies were theorised as a component of motivation in the theory of change for the WRAPP intervention⁹⁹ and, although the report for the Sex Positive! intervention does not explicitly link these two constructs, the measures used to assess outcome expectancies in that report reflect users' motivation [e.g. 'I am more likely to have anal insertive sex (top) without a condom while drinking or high'] and intentions (e.g. 'I am more likely to use a condom with men who are HIV-negative or of unknown status').¹⁰⁴ The theory of change for the HealthMindr app highlighted outcome expectancies (referred to as 'outcome expectations')¹¹⁸ as a key mediator without discussing motivation. Given these differences, we drew on line-of-argument synthesis to include outcome expectancies as a mediator and inferred that it influences motivation in the synthesised diagram, indicating this as an inference by use of a dotted line in *Figure 5*.

The concept of self-regulation appeared variously as a mediator underpinning different theories of change. It is not included as a distinct construct in the synthesised diagram because its theorised role was not consistent. Self-regulatory skills were specified in the Sex Positive! intervention's theory of change¹⁰⁴ and are subsumed under behavioural skills in the synthesised diagram. Self-regulation was a key mechanism of change for HealthMindr,¹¹⁸ but did not recur in this way in other intervention theories within the theory grouping.

Motivation and self-efficacy both featured prominently in intervention theories of change within this grouping, often on the pathway between distal mediators and behaviour change. Although some reports suggested that motivation and self-efficacy influence each other in one direction or the other,^{99,100} most did not address their inter-relationship, either portraying the constructs as independent^{111,112} or including only one.^{102,104,105,118} The synthesised theory of change diagram, therefore, portrays both constructs as affecting behaviour independently via a line-of-argument synthesis.

Although some intervention theories of change included either motivation^{124,131} or intentions,^{98-100,117,121} those that included both variably portrayed their relationship as motivation influencing intentions,^{97,123} intentions influencing motivation¹¹¹ or both combined into one construct.^{102,125} Given these differences, we have combined these constructs via reciprocal translation in the synthesised diagram, in which the combined construct of motivation/intentions is theorised to be engendered by exercises and influenced by outcome expectancies, attitudes, perceived norms and perceived vulnerability.

We interpreted the construct of perceived behavioural control^{97,102} to be similar to the concept of self-efficacy because the latter was variously described as including an 'ability to refuse to have anal sex if a condom was unavailable',⁹⁹ 'confidence in practicing safer sex behaviours'¹²² and/or the 'ability to avoid the situational temptation to have unprotected sex'.¹²² Self-efficacy and perceived control were therefore merged via reciprocal translation in the synthesised theory of change diagram.

Theorised moderators of the relationship between intervention activities and outcomes are shown at the top right of *Figure 5*, and include participants' acculturation to the local majority culture; sociodemographic characteristics; psychological risk correlates, including mental health and substance use/abuse; and, for sexual health interventions, sexual partner type (casual encounter, romantic interest, or friends with benefits). In a few cases, theory reports discussed the direction of moderation and/or how these might operate. Bauermeister *et al.*⁹⁷ theorised that MSM's ability to enact sexual risk reduction behaviours might vary by partner type and that MSM experiencing stressors related to being a sexual minority, experiencing psychological distress, or using alcohol or drugs might have less behavioural control, limiting the extent to which the intervention might promote their ability to 'regulate their affective motivations'⁹⁷ and enact sexual risk reduction behaviours. As noted previously, the theory of change underpinning the MOTIVES intervention was primarily rooted in a different approach and did not sit squarely within this grouping, but included components overlapping with and complementing those in this grouping.¹⁰⁶ It was therefore used to further develop this synthesised theory of change via line-of-argument synthesis. Linnemayr *et al.*¹⁰⁶ theorised that participants in the

MOTIVES intervention who were more acculturated to the USA and could more easily communicate with health-care providers might face fewer barriers to HIV testing, thus benefiting less from the intervention.

Finally, some interventions in this grouping,^{100,122} and the two not included in the grouping but augmenting its synthesised theory of change,^{106,110} aimed to boost intervention impact, for example by recruiting participants at a critical biographical point for behaviour change (e.g. on receipt of a HIV-negative test result in the case of the Keep it Up! intervention),¹²² delivering content based on a participant's assessed stage of change^{100,110} or using prize lotteries to incentivise knowledge retention.¹⁰⁶

'Self-monitoring' synthesised theory of change

We defined a grouping focused on 'self-monitoring' (Figure 6) by synthesising theories underpinning the smartphone self-monitoring intervention,¹¹⁹ an open-ended intervention with general content addressing all three health outcomes examined in our review among people living with HIV (with a theory report assessed as being of high quality), and the TXT-Auto intervention,¹¹⁵ an open-ended sexual health and substance use intervention for out-of-treatment men using methamphetamines, with content tailored by a user's risk profile (with a theory of change description assessed as being of medium quality). The theory report for the smartphone self-monitoring intervention offered a more detailed outline of the self-monitoring behavioural change pathway;¹¹⁹ this was incorporated into the synthesised theory of change diagram.

Both interventions in this grouping asked the user questions about their behaviour to prompt self-monitoring, and both were theorised to be driven by self-monitoring as a key mechanism. Frequency of self-monitoring varied by study and outcome, ranging from four times per day¹¹⁹ to weekly.¹¹⁵ The theory report for the smartphone self-monitoring intervention suggested the need for users to first establish criteria for their desired behaviour, such as personal norms or standards, against which they could assess their actual behaviour.¹¹⁹ However, there was no evidence that this was a separate stage of the intervention; therefore, this stage does not appear in the synthesised diagram.

The synthesised theory of change posits that behavioural questions result in self-monitoring, which prompts reflection in terms of pre-established criteria. This reflection is theorised to result in either self-reward or self-critique, generating enhanced self-regulation, a theoretical mediator of behaviour change.

Although both theory reports included in this grouping suggested that processes of change are more complex than depicted in this synthesised theory of change, neither provided further details on other mechanisms. The theory of change underpinning TXT-Auto suggested that the intervention worked via two non-intersecting pathways, one captured in the 'cognitive/skills' synthesised theory of change and one featuring self-monitoring. Arguing that pathways from self-monitoring to behaviour change are underdeveloped, Swendeman *et al.*'s¹¹⁹ research drew on qualitative data from their study to further explicate the theory of change for the smartphone self-monitoring intervention. This was not included in our synthesis, which focused on a priori intervention theories of change, rather than on theories refined through empirical research.

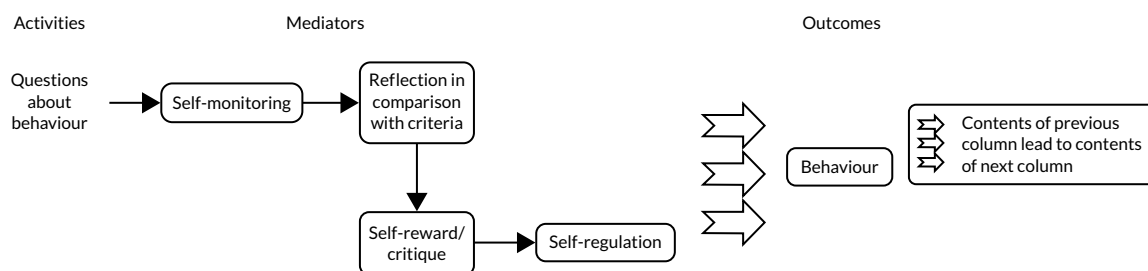


FIGURE 6 'Self-monitoring' synthesised theory of change.

'Cognitive therapy' synthesised theory of change

We drew on theories of change underpinning the online mindfulness-based cognitive therapy intervention,⁹⁶ an online modular intervention for same-sex attracted men, and Rainbow SPARX,¹⁰⁸ a computer game intervention for sexual minority youth, to develop a 'cognitive therapy' theory of change grouping. Descriptions of both interventions' theories of change were assessed as being of medium quality. These interventions were the only two in this review that targeted only mental health outcomes; both interventions drew on cognitive therapy techniques and aimed to reduce depression and improve mental health. CBT skills were at the core of Rainbow SPARX, while the online mindfulness-based cognitive therapy intervention combined mindfulness with cognitive-behavioural techniques. Both interventions aimed to improve emotional health via relaxation training and by addressing negative cognitions (including internalised homophobia), utilising differing pathways for the latter.

The synthesised theory of change diagram (*Figure 7*) depicts activities and mediators stemming from these two approaches. Activities include CBT and mindfulness-based cognitive therapy. Although we do not detail all activities comprising each of these approaches in the synthesised theory of change diagram, we include key components of each: behavioural training (an element of CBT), an emphasis on prioritising 'being' over 'doing' (an element of mindfulness-based cognitive therapy)⁹⁶ and relaxation training (an element of both approaches).

Theory of change descriptions for both interventions referred to recognising, paying attention to or developing awareness of thoughts, feelings and situations, with Rainbow SPARX¹⁰⁷ then challenging negative cognitions and the online mindfulness-based cognitive therapy intervention focusing on accepting and 'letting go' of these negative cognitions.⁹⁶ We use differently shaded block arrows in *Figure 7* to delineate these distinct pathways. Among the negative cognitions to be addressed, both interventions sought to reduce internalised homophobia and mitigate its effects on health.^{96,107} The report for Rainbow SPARX suggested that this was addressed by providing information to help promote young people spending more time with those who accepted them and reducing exposure to homophobic bullying.¹⁰⁷ The report for the online mindfulness-based cognitive therapy intervention did not make clear how this would be achieved.⁹⁶ Descriptions of both interventions' theories of change suggested that the reframing of distressing emotions was theorised as a key mechanism for improving mental health.

Intervention theories of change not included in synthesised models

Although informed by the sexual health model, the theory of change underpinning the online modular sexual health intervention Sexpulse (as described in theory reports assessed as being of low quality) did not specify components or mechanisms and so could not be synthesised.^{116,120}

Four other interventions, with theory reports ranging in quality from low to high, did not fit within any of the three inductive theory of change groupings.^{101,106,110,126} These interventions cut across the targeted health outcomes considered in this review and represented three of the five categories of the intervention typology: computer games,^{101,126} ongoing interventions with content organised by assessment^{109,110} and ongoing interventions with general content.¹⁰⁶ Although some components of their theories of change overlapped with the three groupings described above, theories of change for these interventions featured elements that differentiated them from those included in these groupings. The MOTIVES¹⁰⁶ intervention was based on behavioural economics and the SOLVE intervention was driven by the theorised role of emotions in decision-making, featuring 'shame associated with sexual stigma'¹⁰¹ as a key mediator. Drawing on social cognitive theory, stress and coping theory and the social and emotional learning framework, the role-playing game (described in a theory report assessed as being of medium quality) aimed to improve mental health and reduce substance use via use of productive coping strategies with a focus on help-seeking.¹²⁶ Informed by the transtheoretical model, the theory report (assessed as being of low quality) for the internet-based safer sex intervention¹¹⁰ suggested that the intervention was primarily based on a stages-of-change approach, tailoring content

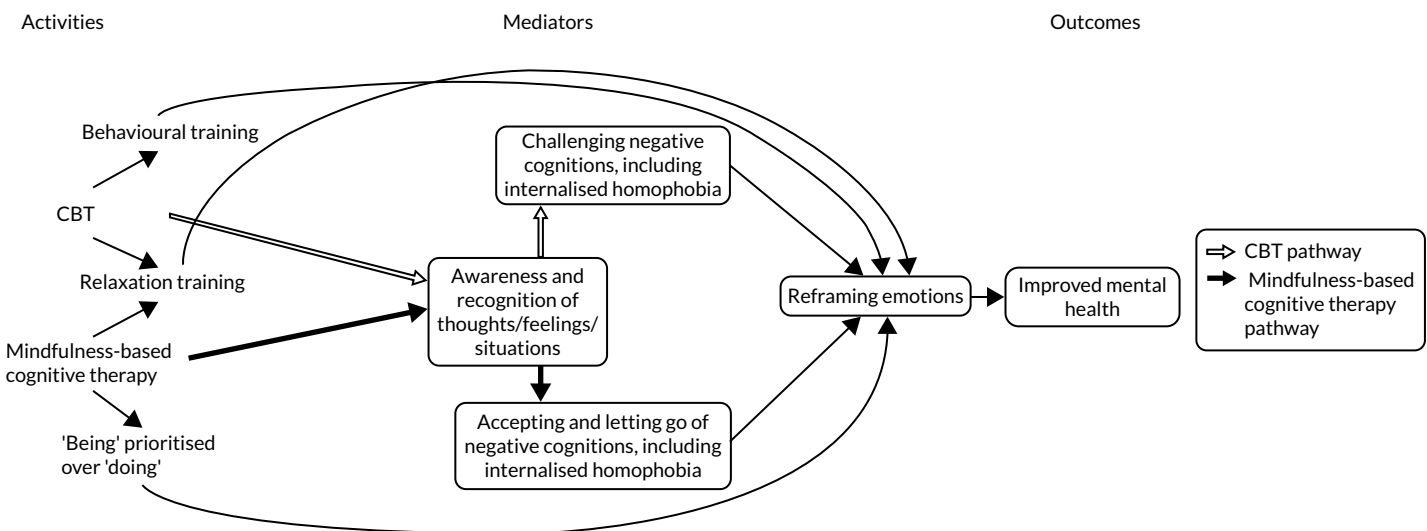


FIGURE 7 'Cognitive therapy' synthesised theory of change.

based on responses to monthly sexual behaviour surveys. Although not included in the grouping, the MOTIVES intervention¹⁰⁶ theory report (assessed as being of medium quality) and the internet-based safer sex intervention¹¹⁰ theory report informed the 'cognitive/skills' synthesised theory of change, as described above.

Feedback from stakeholder consultation on theory of change synthesis

'Cognitive/skills' synthesised theory of change

The 'cognitive/skills' synthesised theory of change resonated most strongly with stakeholders and was thought to be the best reflection of how face-to-face interventions are currently conceptualised in the UK. Recruitment at a critical point in potential participants' lives was felt to be important to the success of interventions. Ensuring that interventions met individuals' needs at various stages of change was also recognised as important, and several stakeholders felt that including prizes would boost engagement.

The mediators and moderators were felt to be well considered and likely to be central to how these types of interventions could be designed and targeted, reflecting much current practice for face-to-face interventions.

'Self-monitoring' synthesised theory of change

At the time of the consultation, the draft 'self-monitoring' synthesised theory of change diagram included an additional activity component, 'define criteria (perceived norms, personal standard)', which was later removed from the final diagram because the intervention theory of change from which it derived did not explicitly include a criteria-setting activity.¹¹⁹ This activity and its relationship to a theorised mediator were shown with dotted lines, denoting that they were inferred from, rather than explicitly described in, the author narrative.¹¹⁹

The 'self-monitoring' synthesised theory of change did not align with stakeholders' views on how best to conceptualise interventions for addressing syndemics among MSM. Stakeholders thought that approaches that relied on this theory of change risked encouraging participants to become focused on self-monitoring and comparing their behaviours with goals implicitly in line with public health and LGBT community injunctive norms more widely. Stakeholders felt that interventions would perform better if the motivation for behaviour change was improvement in well-being, rather than comparison with behavioural norms. Stakeholders were concerned that self-monitoring approaches could amplify existing stigmas surrounding behaviour, especially relating to drug use and sexual activity, with potentially negative impacts on the community as a whole. There was, however, acknowledgement that goal-setting was an important part of existing interventions and should be an integral part of any potential e-health interventions. However, it was felt that this should be a secondary activity or component, rather than the primary focus of an intervention.

'Cognitive therapy' synthesised theory of change

The 'cognitive therapy' synthesised theory of change was felt to be useful in interventions targeting mental health, but less useful for interventions addressing sexual health and substance use. Stakeholders valued the inclusion of CBT and mindfulness approaches among the intervention theories of change reviewed, which are likely to be recognised by the client populations they serve. There were concerns, however, that this model would not apply to sexual health and substance use, and so an intervention based on these theories of change might focus on mental health at the expense of these other health domains.

Chapter 6 Results: synthesis of process evaluations

About this chapter

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Reports included in process evaluation synthesis

Twelve reports on 11 studies of eight unique interventions were eligible for inclusion in the process evaluation synthesis.^{96,98,103,107,108,111,118,119,121-123,130} *Appendix 9* summarises characteristics of included process evaluations and *Table 4* provides information on the health outcomes of interest for this review that were targeted by all included interventions. Included process evaluation reports presented findings on how intervention receipt (but not delivery) varied by characteristics of the intervention,^{96,103,107,108,111,118,119,121-123,130} participants^{96,103,107,108,118,119,121,130} and context,^{98,118,121} but not providers. Included studies reported on interventions that span three intervention types identified in our typology. These include online modular (eight reports,^{96,98,103,111,121-123,130} five interventions) and computer game (two reports,^{107,108} one intervention) interventions, both of which were interactive time-limited interventions, as well as open-ended interventions with general content with core content not tailored by assessment (two reports,^{118,119} two interventions). Three interventions addressed sexual health only,^{98,111,118,121} two addressed mental health only,^{96,107,108} one addressed sexual health and substance use^{103,122,130} and two addressed all three outcomes of interest for this review.^{119,123}

Four interventions targeted sexual minority youth or young adults,^{103,107,108,111,122,123,130} two targeted MSM more generally,^{96,118} one targeted rural MSM^{98,121} and one targeted people living with HIV.¹¹⁹ Five were delivered via the internet,^{96,98,103,111,121-123,130} two via smartphone app^{118,119} and one via computer CD-ROM.^{107,108} Process evaluations for seven of the included interventions took place in the USA^{96,98,103,111,118,119,121-123,130} and one took place in New Zealand.^{107,108}

Direct quotations from participants were limited in the included reports and are therefore limited in our reporting on the themes identified in our analysis.

Quality of studies

Appendix 9 shows the results of our quality assessments of each process evaluation report. Overall, quality varied, with most reports assessed as being of medium or high quality. In terms of the reliability or trustworthiness of their overall findings, four reports were assessed as being of medium quality^{96,111,118,119} and eight as high quality.^{98,103,107,108,121-123,130} In terms of their overall usefulness for addressing our research questions, four were assessed as being of low quality,^{98,111,121,123} three as medium quality^{107,108,122} and five as high quality.^{96,103,118,119,130} Only two reports were assessed as being of high quality in terms of both reliability/trustworthiness and usefulness¹⁰³ and all were assessed as being of medium or high quality in at least one of these two domains.^{96,98,103,107,108,111,118,119,121-123,130}

Quality varied across the six individual criteria feeding into these overall assessments. The vast majority of the included process evaluations took steps to (1) minimise bias and error/increase rigour in sampling ($n = 11$),^{98,103,107,108,111,118,119,121-123,130} (2) minimise bias and error/increase rigour in data collection ($n = 10$)^{96,103,107,111,118,119,121-123,130} and (3) minimise bias and error/increase rigour in data analysis ($n = 10$).^{96,98,103,107,111,119,121-123,130} Nearly all process evaluations reported findings that were grounded in/supported by the data ($n = 11$).^{96,98,103,107,108,111,118,119,121,123,130} Seven reports privileged the perspectives of MSM,^{96,103,107,111,119,122,130} but only four were assessed as having achieved good breadth and depth in their findings.^{96,118,119,130}

Themes emerging from synthesis of process evaluation reports

Appendix 14 shows an example of coding structures developed independently by each of the two reviewers for the process evaluation report on the online mindfulness-based cognitive therapy intervention. *Appendix 15* 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 the receipt of interventions, although the included reports tended to lack breadth of the areas explored and in-depth exploration of the findings that they did report.^{96,103,107,108,111,118,119,121-123,130} However, several subthemes emerged in our analysis across studies.

Ease of use

Across health domains, acceptability was reported as being enhanced when interventions were easy to use and free from technical problems. Few technical problems were reported in studies of open-ended interventions. In studies assessed as being of medium reliability, 10% or fewer smartphone self-monitoring users reported technical difficulties¹¹⁹ and participants reported that the HealthMindr app was easy to use without needing technical assistance.¹¹⁸ However, evidence from studies assessed as being of medium⁹⁶ and high^{98,103,107,121,122,130} reliability assessing online modular^{96,98,103,121,122,130} and computer game interventions¹⁰⁷ suggested that, when users did encounter technical issues, such as freezing¹⁰³ or incompatibility with mobile devices,^{96,130} this was linked with a lower level of acceptability in participant accounts. In a 2007 study of the Hope Project sexual health intervention targeting rural MSM,⁹⁸ features such as sound, animation or graphics were reported as sometimes causing the programme to load too slowly for participants with slower internet speeds, which authors suggested might undermine participation. From studies assessed as being of medium⁹⁶ and high^{107,108} reliability, accompanying materials outside the electronic environment were reported to potentially enhance acceptability, with users appreciating materials that could be printed⁹⁶ and Rainbow SPARX users (sexual minority youth) giving positive feedback on an accompanying notebook that they could keep.^{107,108} Participants were reported to dislike exercises that required using materials that they might not have had readily to hand (e.g. raisins for an online mindfulness-based cognitive therapy intervention exercise).⁹⁶

Intervention content

Clear and comprehensive content

From medium-reliability studies of online modular^{96,103,111} and open-ended (general content) interventions¹¹⁹ across health domains, it was apparent that intervention content that involved clear and comprehensive information was associated with increased acceptability in participant accounts. For example, Queer Sex Ed participants appreciated that this sexual health programme provided comprehensive information on a range of sexual health and relationship topics, rather than focusing

narrowly on STIs.¹¹¹ In studies of other interventions, acceptability was reported to be greater when content was clear and up to date,⁹⁶ whereas content that users found confusing appeared to detract from acceptability.¹¹⁹

Some study participants recommended that specific content be added, including '[taking] into consideration the new PrEP [HIV pre-exposure prophylaxis] medicine and also [giving] realistic happenings without condom use',¹⁰³ and providing information on sexual health for trans people.¹¹¹

Engaging intervention content

Fun¹¹¹ and enjoyable⁹⁶ content was associated with increased acceptability in participant accounts, and the use of different types of content arose as a common theme influencing acceptability in online modular and computer game interventions. For example, in studies assessed as being of medium⁹⁶ and high^{103,107,122,130} reliability that, between them, focused on interventions addressing all three health outcomes, participants tended to give positive feedback on the use of diverse content,^{96,103,130} including animations, videos graphics and games,¹²² as well as on interventions' visual appearances.^{96,107}

In a high-reliability study of Rainbow SPARX, users were reportedly particularly positive about the computer game format and the intervention's 'look and feel',¹⁰⁷ as expressed by one user aged 13 years: 'I liked, like, how it looked really shiny on my computer, and it looked like a completely different world.'¹⁰⁷

Rainbow SPARX users were reported as also liking particular characters who appeared in the game,¹⁰⁷ a theme echoed in a high-reliability study of the online modular Keep it Up! intervention (addressing sexual health and substance use) in which participants reported liking the scenarios and examples presented.¹²² Factors detracting from acceptability included content that participants found boring,^{96,119} repetitive,^{96,119} too easy,¹⁰⁷ too difficult or draining,⁹⁶ 'not soothing',⁹⁶ 'cheesy'¹⁰³ or generally unenjoyable⁹⁶ and videos that users judged to be too long or that featured low-quality sound or dialogue.¹³⁰

Language and tone

Language and tone emerged as important aspects of acceptability across interventions addressing all three health domains and in studies assessed as being of medium^{96,118} and high^{103,107,108,122,130} reliability. Evidence for this theme came from online modular^{96,103,122,130}, computer game^{107,108} and open-ended (general content) interventions.¹¹⁸ Keep it Up! participants liked what authors described as a 'frank, candid, and sex-positive tone',¹⁰³ colloquial language and what one participant described as its 'up-beat manner'.¹²² 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'.¹¹¹ A Keep it Up! user echoed this sentiment, describing the intervention as 'realistic and not condescending or out of touch'.¹³⁰

There were also some challenges in getting the language right for MSM-specific interventions. For example, some users of Rainbow SPARX reportedly suggested that the intervention's sexuality-related terminology could be improved,¹⁰⁷ and some users of the online mindfulness-based cognitive therapy intervention were reported as voicing concerns about the intervention's approach to sexual minorities and a feeling of 'anti-gay sentiment'.⁹⁶ In regard to the online mindfulness-based cognitive therapy intervention, the author's findings suggested that some content might have been overly clinical and miscommunicated the aim of improving overall well-being,⁹⁶ although it was not clear whether participant concerns stemmed primarily from the intervention's content itself or from content about participating in a research study.

Interaction and personalisation

Participants in studies assessed as being of medium¹¹¹ and high^{107,122,130} reliability, assessing online modular^{111,122,130} and computer game¹⁰⁷ interventions, reportedly valued interactive aspects of interventions spanning all three health outcomes. For example, one Keep it Up! participant described the following:¹³⁰

I liked that this program was very interactive. You were required to click on things and drag them places in order to get an answer correct. I feel like this allowed for more enhanced learning and retention of crucial information.

Studies assessed as being of medium^{118,119} and high¹⁰³ reliability reported that individual-level tailoring based on participant assessments could enhance acceptability. For example, 81% of HealthMindr users were reported as finding recommendations based on their responses useful or very useful,¹¹⁸ and smartphone self-monitoring users reportedly recommended adding, what the authors summarised as, 'more in-depth questions to better reflect their experiences'.¹¹⁹

Privacy and intrusiveness

In studies assessed as being of medium reliability, privacy and intrusiveness emerged as important themes influencing acceptability across two open-ended (general content) interventions that, between them, addressed all three health outcomes.^{118,119} Some smartphone self-monitoring users reportedly felt that 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, and therefore intrusive.¹¹⁹ Users expressed concerns about privacy regarding questions about sexual behaviour, including experiences with individual partners.¹¹⁹ The vast majority of HealthMindr app users (86%) reported feeling confident in the app's security, including its personal identification number/password features and the fact that the app's name and icon did obviously relate to HIV prevention.¹¹⁸ At least one smartphone self-monitoring user was reported as being uncomfortable with geolocation tagging of phone survey responses, although the authors noted that participants were instructed on how to disable this feature.¹¹⁹

Pacing and structuring

The pacing and structuring of content influenced acceptability across health domains. In studies assessed as being of medium⁹⁶ and high^{108,122,130} reliability, there was some evidence that a modular, as opposed to single-session, approach to an intervention could reportedly help users absorb content,¹²² although users were reported as tending to like setting their own pace,¹⁰⁸ and one suggested that they would have preferred to complete all modules in one sitting.¹³⁰ Requiring a full week between sessions for the online mindfulness-based cognitive therapy intervention was reported as too long, detracting from acceptability.⁹⁶

Users were reported as liking intervention content that progressed in a cumulative way.⁹⁶ Module order and how far a participant had progressed could also affect acceptability. Findings from a high-reliability study of the three-module Hope Project (targeting knowledge, motivation and behaviour to address sexual health), 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.¹²¹ Assessing level of interest after each module among participants completing all modules, the study also found that participants were more likely to report finding modules very interesting after completing all three, compared with completing only one.¹²¹

Programme length arose as a common theme affecting the acceptability of some online modular interventions, with users of the eight-session online mindfulness-based cognitive therapy intervention,⁹⁶ the seven-module Keep it Up! intervention^{103,122,130} and the five-module Queer Sex Ed intervention¹¹¹

suggesting that these programmes were too long or too time-consuming. Some cited other commitments or being too busy as barriers to completing the interventions.^{96,103} According to one Queer Sex Ed user:¹¹¹

This program was [way] too long. Like really long. My suggestion would be to either break it up into more sections or cut out some videos that only introduced a topic . . . The information was all very necessary, especially for queer kids, but keep attention spans in mind.

Content designed to be relevant to participants' lives and experiences

Across intervention types and health outcomes, participants valued that interventions were designed for people like them. From studies of high reliability, it was apparent that participants valued interventions that presented realistic scenarios and examples and that addressed issues relevant to their own lives.^{103,107,122,130} 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'.¹³⁰

Similarly, another participant thought the realistic scenarios presented by Keep it Up! would be especially helpful for less experienced MSM:¹⁰³

I found the program extremely helpful because it encounters real situation[s] within the community such as hooking up online and or bars. I think it can be of great help to a young crowd that has not much experience into the gay scene.

Users of the Rainbow SPARX and Queer Sex Ed interventions for sexual minority youth reportedly liked that these programmes were 'LGBT-specific',¹¹¹ designed for young people¹⁰⁸ and included "'rainbow' content" tailored to this group.¹⁰⁷ Some reportedly suggested that there was room to go further,¹⁰⁷ for example by removing content on female sexual anatomy for MSM users and adding more trans-specific content.¹¹¹

Online mindfulness-based cognitive therapy intervention users were reported as having mixed views on how effectively this intervention was tailored for people like them.⁹⁶ Some reported appreciating that the programme was designed for men who were attracted to men, whereas others felt that the intervention 'did not have much value in the context of their lives'.⁹⁶ Some users of Rainbow SPARX reported that tailoring could be further enhanced by including more sexuality-specific content.¹⁰⁷

Perceived usefulness of the intervention

Gaining knowledge and skills

In studies assessed as being of medium⁹⁶ and high^{103,107,108,111,121,123,130} reliability, across several online modular and computer game interventions that, between them, addressed all three health outcomes, participants frequently indicated the importance of perceiving that the intervention was useful in terms of its aiming to increase knowledge and skills.^{95,96,102,103,106-108,110,111,120,121} Where users were reported as highlighting particular topics as useful to address, these included information about depression,¹⁰⁸ drugs, alcohol, STI transmission and HIV;¹³⁰ skills and knowledge for improving relationships;^{103,111} 'mindfulness or other psychological skills or knowledge';⁹⁶ and relaxation and CBT techniques.¹⁰⁷ Queer Sex Ed users were reported as liking that the intervention aimed to support communication and closeness with their partners, helping (as one participant described) to '... open up doors to healthy communication'.¹¹¹

Opportunities for self-monitoring and self-reflection

Findings from the evaluation of the open-ended 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 with the comparison group's biweekly web-based approach. One user described the benefits this way:¹¹⁹

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.

Similarly, users of the online modular Keep it Up! and online mindfulness-based cognitive therapy interventions, and of the open-ended smartphone self-monitoring intervention, which between them addressed all three health outcomes, reportedly highlighted the opportunities for introspection and self-reflection that these interventions presented.^{96,103,119,122,130} As a smartphone self-monitoring intervention user said:¹¹⁹

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.¹¹⁹ A Keep it Up! user described how observing the characters in the intervention helped him reflect on his own behaviours:¹²²

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, were reported as valuing the opportunity for self-expression that the intervention offered, as described by one participant: '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'.¹¹⁹

Specific intervention features

The two studies of interventions of the 'open-ended' type, which between them addressed all three health outcomes considered in this review, reported on the acceptability of particular programme features.

Smartphone self-monitoring users reportedly highlighted the role of both daily surveys and the programme's reminder function in supporting their need to take medication at the right times.¹¹⁹ Regarding the features of the HealthMindr app, more than 80% of participants used the 'ordering' feature, with nearly two-thirds ordering condoms and more than half ordering at-home HIV test kits, and 70% used a tool to create a HIV testing plan.¹¹⁸ User data also showed engagement with PrEP contents, with approximately 40% viewing PrEP information and smaller proportions screening themselves for eligibility (approximately 25%) and using a map of PrEP providers (approximately 15%). Participants were less likely to use non-occupational post-exposure prophylaxis (nPEP) features, with around 25% viewing information on nPEP and less than 10% using a screening tool to assess their eligibility for nPEP.

Participant characteristics affecting intervention engagement and receipt

Evaluations of four online modular^{96,121,130} and open-ended (general content)¹¹⁸ interventions (two targeting sexual health only,^{118,121} one targeting mental health only⁹⁶ and one targeting sexual health and substance use¹³⁰) quantitatively explored the relationship between participant characteristics and intervention engagement.

A medium-reliability study of the HealthMindr sexual health mobile phone app found no differences in the time spent on the app by participant location (comparing different cities in the USA), age, race/ethnicity or knowledge of local HIV testing,¹¹⁸ 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 or lower levels of education.¹³⁰ A study assessed as being of medium reliability found no significant variation in retention for the eight-session modular mental health online mindfulness-based cognitive therapy intervention by age, SES, ethnicity, internalised homonegativity or experience of homophobic bullying.⁹⁶ A study assessed as being of high reliability found no differences between participants completing one versus all three modules of the Hope Project (an extension of the WRAPP sexual health intervention, targeting rural MSM) by age, ethnicity, marital status, sexual orientation, education or student status, but did find higher completion rates among higher-earning participants.¹²¹

Madkins *et al.*¹³⁰ conducted a high-reliability assessment of intervention receipt among different users of the Keep it Up! intervention, which was developed with the engagement of a diverse group of young MSM and designed for young MSM of all racial groups.¹²² Researchers found several differences in the acceptability of the Keep it Up! intervention by race/ethnicity, education level, age and city in the USA.¹³⁰ 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 than other non-white users. In the overall sample, users with high school-level education or lower rated the intervention more highly than those with a higher level of education. Exploring the interaction of race/ethnicity and education level, the study found that white users with higher levels of education reported lower acceptability, while no such differences were found among black, Latino or other non-white users. Older users and those in Atlanta tended to rate modules more highly than those in New York.

Exploring intervention receipt qualitatively, a study with high reliability found that, for Rainbow SPARX, a computer game intervention addressing mental health among sexual minority youth aged 13–19 years, some older users reported that some aspects were too easy and the programme ‘babied’ them.¹⁰⁷ Acknowledging the challenge of designing a programme appropriate for a range of young people, one participant, aged 19 years, said:¹⁰⁷

[S]ome things were a little easy . . . Overall it wasn't difficult to figure out what you needed to do. Those . . . 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 suggested that how users experience e-health interventions could also vary by individual circumstances beyond sociodemographic factors. For young people who were also receiving external support (typically in-person therapy), Lucassen *et al.*¹⁰⁸ found, in a high-reliability study, that Rainbow SPARX could play a unique role by complementing that support. In a medium-reliability study, Swendeman *et al.*¹¹⁹ found that the smartphone self-monitoring intervention, addressing all three health outcomes, could either support users' antiretroviral therapy maintenance or promote recognition of patterns of non-adherence, depending on a user's current level of adherence.

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 2007⁹⁸ and 2010¹²¹ studies of two iterations of the WRAPP sexual health intervention, which targeted rural MSM in the USA. Bowen *et al.*⁹⁸ found that users with dial-up, compared with high-speed, internet connections were more likely to report taking too long to load programme graphics, while Williams *et al.*¹²¹ found no differences among participants completing one versus all three modules by type of internet connection.

Feedback from stakeholder consultation on synthesis of process evaluations

Stakeholders' comments regarding process evaluation focused on four topics: context; usability/acceptability; content, language and tone; and privacy/intrusiveness.

Context

E-health interventions were felt by stakeholders to be broadly acceptable among MSM across geographical contexts. This varied by region, with stakeholders in London and Cardiff identifying larger groups of MSM whom they thought could benefit than stakeholders in Scotland and the north of England. This was largely due to regional variations in perceived health service availability compared with the level of need, alongside preferences for service types. Stakeholders from London identified the region as one with a high level of needs and greater demand than could be met by existing health services, thus increasing the potential utility of e-health interventions. Services in Cardiff were similarly felt to be insufficiently developed to meet existing needs.

There were concerns that poor access to broadband/the internet were issues that would negatively affect uptake in Scotland and the north of England.

It was felt that these interventions had significant potential in the UK, given funding constraints in sexual health and increasing imperatives around self-management.

Usability/acceptability

In line with process evaluation findings, stakeholders felt that it was critical to the success of e-health interventions for MSM that interventions were well-designed with minimal technical problems. There was a strong feeling that, should even minimal problems arise, it would have a profound impact on intervention engagement and effectiveness. Significant concern was expressed around the level of funding required to develop a suitable platform to deliver these interventions.

Content, language and tone

Stakeholders recognised that, in line with the process evaluation findings, appropriate content was central to the success of e-health interventions. The tone of the interventions was felt to be important in engaging a diverse group of MSM; matching intervention language to colloquial language used by MSM was felt to be essential. Furthermore, in line with the process evaluation findings, a candid tone and sex positivity were valued. Involvement of potential users in setting the tone and direction of these interventions was highlighted as an important component of formative development.

In addition, all stakeholders stressed the need for e-health interventions to be available in a range of languages to meet the needs of a broad range of MSM from migrant communities. This was regarded as particularly important given the higher engagement in sex work of MSM from Latin American and eastern European countries, recognising significant crossover between issues pertaining to sex work, mental health, substance use and sexual health.

Privacy and intrusiveness

Significant concerns regarding privacy and intrusiveness did not emerge among stakeholders. With regard to evaluations, as opposed to interventions, there was some concern about the burden of data collection for participants and concerns that it could negatively affect acceptability of similar interventions in the UK. Stakeholders felt that the number of data required to conduct rigorous evaluation might lead to a disjointed experience for service users, and that some may have concerns about confidentiality. In addition, one participant raised as a concern the number of data that might be collected and not used.

Chapter 7 Results: synthesis of outcome evaluations

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Reports included in the outcome evaluation synthesis

We included 14 outcome evaluations of 13 interventions described across 16 reports, published between 2006 and 2020.^{99-102,109,110,113-117,122-125,127} Of these, 14 reports were eligible for inclusion in the outcome evaluation synthesis,^{99-102,110,113,115-117,122-125,127} and two were abstracts^{109,114} presenting findings identical to those presented in included papers.^{110,115} All included studies were randomised trials allocating individuals. Of the 14 included trials and included arms within those trials, 13 compared interventions with no-treatment or attention-only controls^{100-102,110,113,115-117,122-125,127} (which receive the same degree of engagement as intervention participants but no other intervention contents) and two compared active interventions.^{99,102} Comparing two intervention arms and one control arm, the report by Davidovich *et al.*¹⁰² fell into both categories. Thirteen eligible studies reported sexual health outcomes,^{99-102,110,113,115-117,122-125,127} two reported substance use outcomes alongside sexual health outcomes^{115,125} and none reported mental health outcomes.

See *Table 2* for a list of all reports included in the outcome evaluation synthesis, *Appendix 10* for characteristics of included outcome evaluations and *Table 4* for the health outcomes examined in this review that were targeted by each intervention.

Risk of bias and quality of studies

The risk-of-bias assessment covered a range of domains, as prescribed by the Cochrane Collaboration risk-of-bias tool.⁶³ Risk-of-bias judgments are presented for active versus control trials and, subsequently, for active versus active trials.

Appendix 10 shows the results of the risk-of-bias assessment for each outcome evaluation study, and *Figure 8* shows a risk-of-bias graph by domain.

Synthesis of studies comparing active intervention with control arm

The narrative synthesis included 13 trials^{100-102,110,113,115-117,122-125,127} comparing interventions with no-treatment or attention-only controls. Two studies^{113,125} reported outcomes for HIV infections, three studies^{110,113,125} reported outcomes for STIs and 12 studies^{100-102,113,115-117,122-125,127} included outcomes for sexual risk behaviour. Two studies^{115,125} reported outcomes for drug use. No included outcome evaluations reported outcomes for alcohol use, depression or anxiety. Only one study, Cheng *et al.*,¹²⁴ reported outcomes by equity-relevant characteristics. See *Tables 5-8* for overviews of measures used in included outcome evaluations.

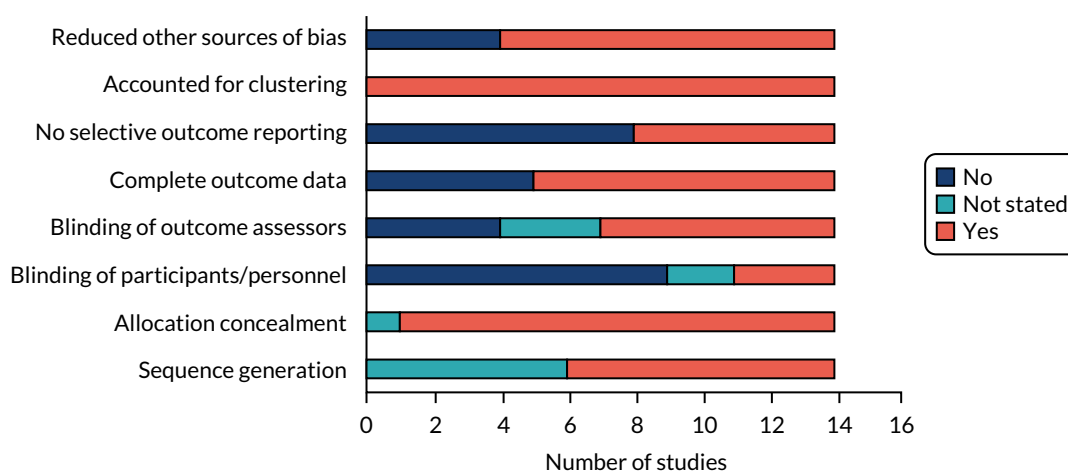


FIGURE 8 Possible sources of bias, by intervention. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

Risk of bias of active intervention versus control arm trials

Sequence generation

Of the 13 trials included, eight^{100,101,113,116,122-125} had adequate sequence generation and five^{102,110,115,117,127} did not state how sequence generation was undertaken. In most cases, sequence generation was undertaken using computerised methods, given that interventions were delivered electronically. However, one study included rolling of dice corresponding to a random number table.¹²⁵ Several studies reported using randomisation or minimisation stratified by factors such as race or age.^{100,113,122}

Allocation concealment

Of the 13 trials included, only one did not state how allocation concealment was undertaken.¹¹⁵ The remaining 12 trials provided information on how allocation was concealed; in all cases it was concealed by automatic online randomisation.^{99-102,110,113,116,117,122-125,127}

Blinding of participants and personnel

Three trials reported blinding of participants and study personnel in respect of treatment allocation.^{113,122,125} One trial did not report information with which to make a judgement.¹²⁷ Nine trials did not include blinding of participants, personnel, or both.^{100-102,110,115-117,123,124} In three trials, neither participants nor personnel were blinded.^{110,115,117} In five trials personnel were not blinded.^{100-102,110,123} In two trials, participants were not blinded.^{116,124}

Blinding of outcome assessors

Seven trials reported blinding of outcome assessors.^{100,102,110,113,122,123,125} In two trials,^{110,113} this was because the key outcomes were biological in nature. In the remaining five trials,^{100,102,122,123,125} outcomes were self-reported but participants were blinded. Four trials stated that outcome assessors were not blinded.^{115-117,124} This was because outcomes were self-reported and participants were not blinded in these trials. Two trials did not provide enough information to judge blinding of outcome assessors.^{101,127}

Complete outcome data

Nine trials^{110,113,115,116,122-125,127} presented complete outcome data, whereas four trials^{100-102,117} did not. Complete outcome data were defined as balanced retention in study arms with attrition of < 30%. Of the four trials without complete outcome data, all had high levels of attrition; two trials^{102,117} also had notably imbalanced attrition between arms.

No selective outcome reporting

Seven trials^{100,101,110,113,117,123,127} had evidence of selective outcome reporting, whereas six trials^{102,115,116,122,124,125} did not. Of the trials with evidence of selective outcome reporting, one¹¹⁷ did not present analysis for outcomes because of sample size; three^{100,101,110} did not present findings in sufficient detail to estimate effectiveness; and a further three^{113,123,127} did not report outcomes that were in the protocol for each trial.

Accounted for clustering

None of the trials was cluster randomised; thus, there was no need to adjust for clustering.

Reduction of other sources of bias

Three trials did not reduce other sources of bias, in every case arising from unclear or inappropriate analysis methods.^{101,110,117} Ten trials^{100,102,113,115,116,122–125,127} reduced other sources of bias by using a combination of geographically diverse recruitment and multiple methods of sample recruitment. Specifically, Bauermeister, *et al.*,¹²³ Carpenter *et al.*,¹⁰⁰ Cheng *et al.*,¹²⁴ Chiou *et al.*,¹²⁵ Mustanski *et al.*,¹¹³ Hirshfield *et al.*¹²⁷ and Rosser *et al.*¹¹⁶ each used geographically diverse samples with respect to the country where the trial was undertaken. Davidovich *et al.*,¹⁰² Reback *et al.*,¹¹⁵ Rosser *et al.*,¹¹⁶ Hirshfield *et al.*¹²⁷ and Mustanski *et al.*^{113,122} each used multiple methods of recruitment.

Effects on human immunodeficiency virus infections

Two studies presented estimates for HIV infection: Chiou *et al.*,¹²⁵ which presented short-term (< 3 months) estimates, and Mustanski *et al.*,¹¹³ which presented mid-term (3 months–1 year) estimates (Table 5). Across studies, there was no consistent evidence of interventions reducing new HIV infections, although sparse events and short time scales may have precluded clearer evidence of an effect.

Study-level results

Chiou *et al.*¹²⁵ reported three new HIV infections ($n = 130$) in the group that received Safe Behaviour and Screening, an open-ended intervention with general content, compared with two infections ($n = 135$) in the control group. At 6 months post randomisation (i.e. at post-intervention follow-up), this yielded an incidence rate ratio of 1.56 [95% confidence interval (CI) 0.26 to 9.56]. Evaluating the Keep It Up! time-limited, interactive online modular intervention, incident HIV diagnoses at 12 months post randomisation (6 months post intervention) in Mustanski *et al.*¹¹³ were not different in the intervention arm (nine diagnoses over 384 person-years), compared with the control arm (eight diagnoses over 410 person-years).¹¹³

Meta-analysis

Effect sizes for HIV infection are presented in Figure 9 and drew from two studies, each contributing one effect size.^{113,125} We undertook an overall analysis, rather than analyses by time, as only one effect size from each follow-up category was included. Included interventions did not have an overall impact on HIV infections, with an increase in incidence of HIV infections equivalent to 0.12 standard deviations, but with a wide estimated CI that included the point of no effect (95% CI -0.34 to 0.59). Heterogeneity was not meaningfully present in this meta-analysis ($I^2 = 0\%$). Certainty in the assessment

TABLE 5 Measures used in evaluations reporting HIV infection as an outcome

Intervention	Measure	Notes
Keep it Up! ¹¹³	Incident HIV infections (over 12 months)	Self-reported test result
Safe Behaviour and Screening ¹²⁵	Incident HIV infections (6-month follow-up, post intervention)	Self-reported test result

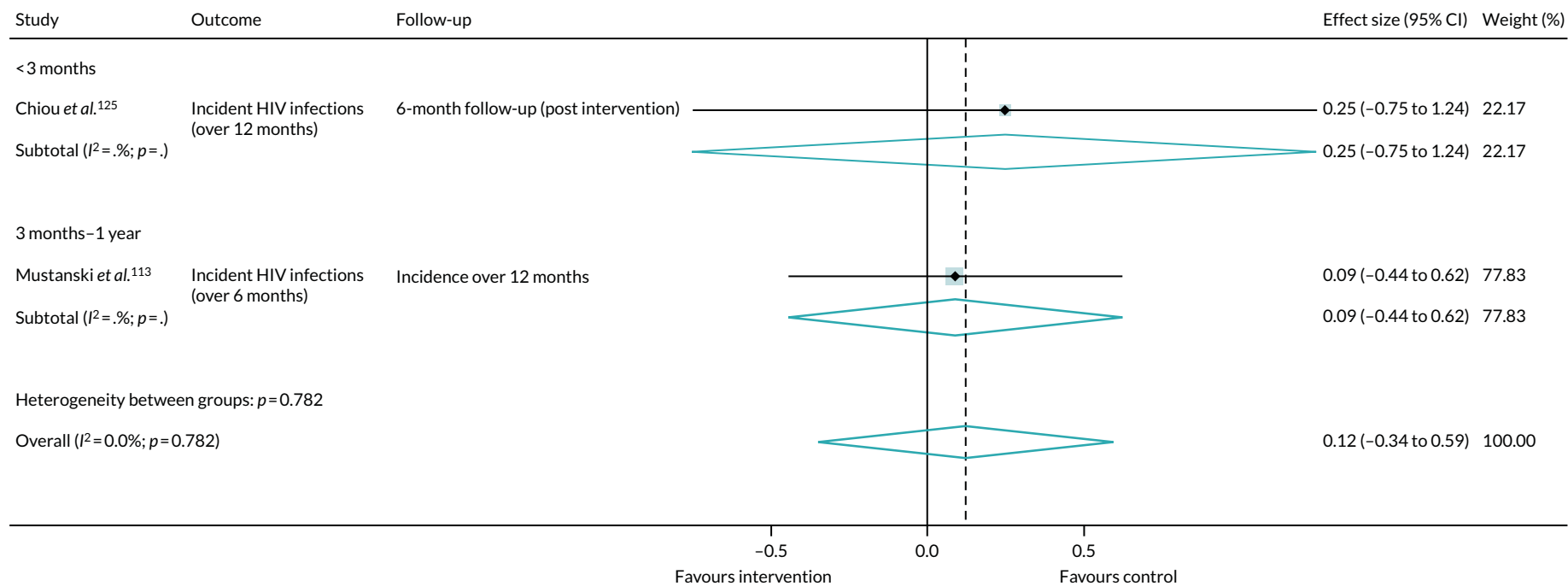


FIGURE 9 Effect sizes and meta-analysis for HIV infections in included studies. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

of the evidence ranged from very low to low because of the risk of bias (selective outcome reporting) and the imprecision of effect estimates (see *Grading of Recommendations Assessment, Development and Evaluation analysis* for detailed reporting on the level of certainty for outcomes reported).

Effects on sexually transmitted infections

Three studies presented estimates for STIs: Chiou *et al.*,¹²⁵ Milam *et al.*¹¹⁰ and Mustanski *et al.*¹¹³ (Table 6). Of these, Chiou *et al.*¹²⁵ and Milam *et al.*¹¹⁰ presented short-term results, whereas Mustanski *et al.*¹¹³ presented mid-term results. There was no evidence of short-term impacts on incident STIs, whereas there was some evidence, albeit from one study, of mid-term impacts on incident STIs.

Short-term results

At 6 months post randomisation (i.e. at post intervention), Chiou *et al.*¹²⁵ reported four incident syphilis infections in the group ($n = 130$) receiving the Safe Behaviour and Screening open-ended general content intervention, compared with three incident syphilis infections in the control group ($n = 135$). This translated to an incidence rate ratio of 1.39 (95% CI 0.31 to 6.37). Evaluating an open-ended intervention with content organised by assessment, Milam *et al.*¹¹⁰ reported rates of any incident bacterial STIs (syphilis, gonorrhoea or chlamydia) over 12 months, which was the intervention period. In the intervention group ($n = 90$), 27 participants reported incident STIs, whereas in the control group ($n = 89$), 22 participants reported incident STIs. These proportions (30% vs. 25%) were not statistically significantly different ($p = 0.50$), nor was the distribution of visits with new STIs per subject different between arms ($p = 0.57$). A logistic regression that controlled for STI diagnosis, meth use and use of antiretroviral therapies as baseline covariates yielded an odds ratio (OR) of 1.35 (95% CI 0.68 to 2.70).

Mid-term results

Assessing the online modular intervention Keep it Up!, Mustanski *et al.*¹¹³ reported results for several STIs, both individually and as a composite outcome, at 12 months post randomisation (6 months post intervention). Analyses included between 356 and 359 intervention participants (359 for urethral STIs, 356 for rectal STIs) and 374 control participants. Findings were principally reported as risk ratios (RRs), and suggested a statistically significant 40% difference in risk of any STI diagnosis (RR 0.60, 95% CI 0.38 to 0.95). Findings for individual STIs were not significant: urethral chlamydia (RR 0.60, 95% CI 0.13 to 2.34), urethral gonorrhoea (RR 0.35, 95% CI 0.01 to 4.33), rectal chlamydia (RR 0.61, 95% CI 0.34 to 1.06) or rectal gonorrhoea (RR 0.91, 95% CI 0.40 to 2.05). Another analysis of the outcome drew on a matched-pair analysis and estimated a within-subject reduction in risk of 68% for any STIs (95% CI 0.40 to 0.83).

Meta-analysis

Effect sizes for STIs are presented in Figure 10 for outcomes at < 3 months post intervention and in Figure 11 for outcomes between 3 months and 1 year post intervention. In both plots, negative effect

TABLE 6 Measures used in evaluations reporting STIs as an outcome

Intervention	Measure	Notes
Internet-based safer sex intervention ¹¹⁰	Incident STIs (over 12 months)	Clinical testing (syphilis, chlamydia and gonorrhoea)
Keep it Up! ¹¹³	Urethral chlamydia (over 12 months)	Clinical testing
	Urethral gonorrhoea (over 12 months)	Clinical testing
	Rectal chlamydia (over 12 months)	Clinical testing
	Rectal gonorrhoea (over 12 months)	Clinical testing
	Any STI (over 12 months)	Positive clinical test for urethral or rectal chlamydia or gonorrhoea
Safe Behaviour and Screening ¹²⁵	Incident syphilis (6-month follow-up, post intervention)	Self-reported test result

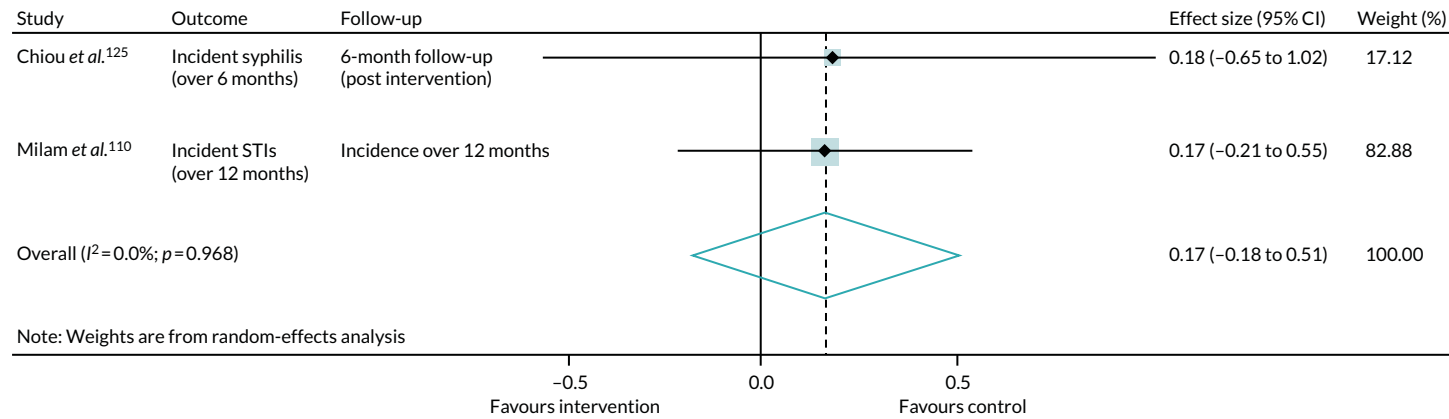


FIGURE 10 Effect sizes and meta-analysis for STIs in included studies, < 3 months post intervention. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

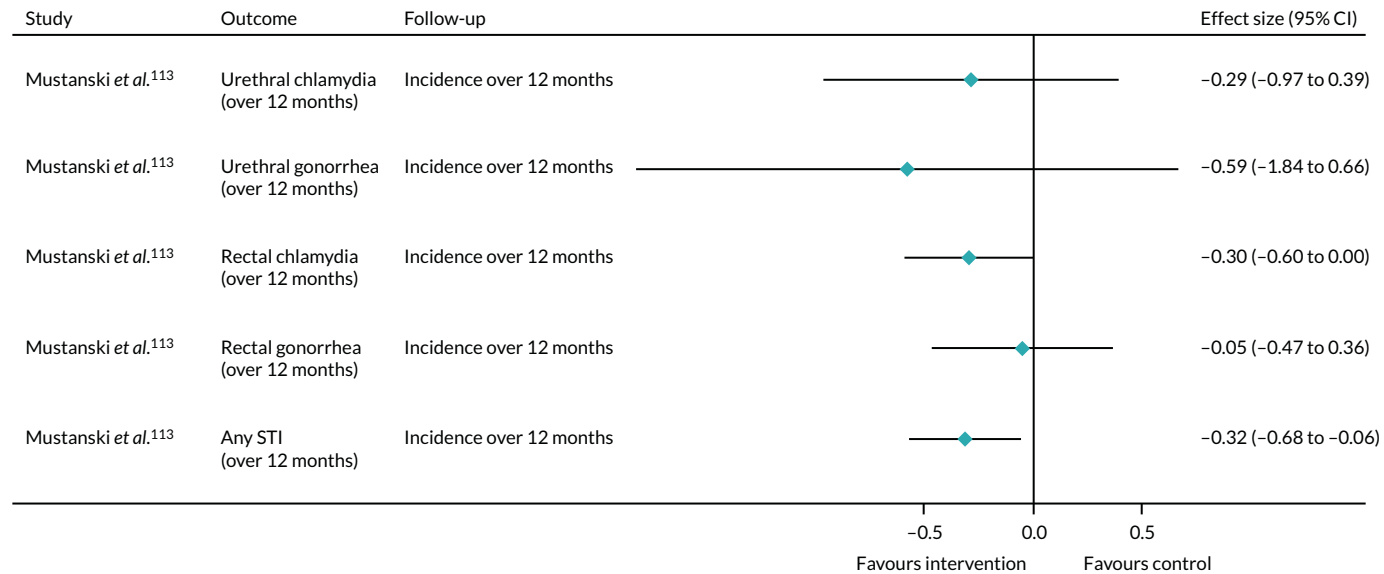


FIGURE 11 Effect sizes for STIs in included study, 3 months to 1 year post intervention. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

sizes represent benefits. A meta-analysis of effect sizes with follow-up of < 3 months included two effect sizes from two studies^{110,125} and also suggested a non-significant increase in the number of STIs in the intervention group, compared with the control group ($d = 0.17$, 95% CI -0.18 to 0.52), with heterogeneity not meaningfully present in this meta-analysis ($I^2 = 0\%$).^{110,125} The certainty of evidence was very low as a result of risk of bias (details of randomisation, selective outcome reporting) and imprecision of effect estimates. The overall analysis across short- and medium-term follow-ups and intervention types drew on three studies^{110,113,125} contributing seven effect sizes, and suggested a small and non-significant increase in STIs in the intervention group, compared with the control group ($d = 0.07$, 95% CI -0.79 to 0.94) and low heterogeneity ($I^2 = 16\%$). We did not meta-analyse effect sizes with follow-ups of 3 months to 1 year as only one study would have contributed to this.¹¹³

Effects on sexual risk outcomes

A total of 11 studies presented estimates for sexual risk outcomes (Table 7).^{100,102,110,113,115,116,122-125,127} Nine studies^{100,101,113,115,116,122,123,125,127} presented short-term results, whereas six studies^{102,113,115,116,124,127} presented mid-term results. One study¹¹⁷ intended to present short-term results relating to sexual risk outcomes, but did not estimate an effect because of an unexpectedly low sample size. The primary method of analysis in Reback *et al.*¹¹⁵ was a longitudinal regression model, and we present these estimates as well. There was some indication of short-term impacts on sexual risk in included interventions, but no such effect was apparent in mid-term results.

Short-term results

Effect estimates presented for short-term results fell into four categories: condomless sex (at the time of the included studies' publication this was usually referred to as unprotected sex acts), condom use, seroconcordant sex acts and sex acts under the influence of drugs.

TABLE 7 Measures used in evaluations reporting sexual risk outcomes

Intervention	Measure	Notes
China-Gate HIV Prevention Program ¹²⁴	CAI in previous 3 months (6-month follow-up)	
Cognitive Vaccine Approach ¹⁰²	Condom use (6-month follow-up), tailored intervention	Dichotomised to always or not always using condoms with steady partner
	Negotiated safety (6-month follow-up), tailored intervention	Dichotomised to practising or not practising negotiated safety with steady partner; negotiated safety defined as CAI between partners who are both HIV negative, agree to be monogamous or have no CAI with other partners and agree to tell each other if they do have an episode of CAI with another partner
	Condom use (6-month follow-up), non-tailored intervention	Dichotomised to always or not always using condoms with steady partner
	Negotiated safety (6-month follow-up), non-tailored intervention	Dichotomised to practising or not practising negotiated safety with steady partner; negotiated safety defined as CAI between partners who are both HIV negative, agree to be monogamous or have no CAI with other partners and agree to tell each other if they do have an episode of CAI with another partner

continued

TABLE 7 Measures used in evaluations reporting sexual risk outcomes (continued)

Intervention	Measure	Notes
Hot and Safe M4M ¹⁰⁰	Insertive CAI, positive/unknown serostatus (3 months post baseline)	Number of acts
	Receptive CAI, positive/unknown serostatus (3 months post baseline)	Number of acts
	CAI, positive/unknown serostatus (3 months post baseline)	Number of acts
	Insertive CAI, any partner (3 months post baseline)	Number of acts
	Receptive CAI, any partner (3 months post baseline)	Number of acts
	CAI, any partner (3 months post baseline)	Number of acts
	Insertive condomless oral intercourse, positive/unknown serostatus (3 months post baseline)	Number of acts
	Receptive condomless oral intercourse, positive/unknown serostatus (3 months post baseline)	Number of acts
	Insertive condomless oral intercourse, any partner (3 months post baseline)	Number of acts
Keep it Up! ¹²²	Receptive condomless oral intercourse, any partner (3 months post baseline)	Number of acts
	Condom failures (12-week follow-up)	Condom failure (e.g. condom breaking during sex) assessed on Likert scale
	Total number of CAI acts in previous 6 weeks (12-week follow-up)	
Keep it Up! ¹²³	Condom use errors (12-week follow-up)	Condom use errors (e.g. using oil-based lubricant) assessed on Likert scale
	Any CAI (3-month follow-up post baseline)	Dichotomised based on partner-level reports
	Any CAI in previous 3 months (6-month follow-up post baseline)	Dichotomised based on partner-level reports
MyDEX ¹²³	Any CAI in previous 3 months (12-month follow-up post baseline)	Dichotomised based on partner-level reports
	Insertive CAI (90-day follow-up)	Dichotomised
	Receptive CAI (90-day follow-up)	Dichotomised
	Serononconcordant receptive CAI (90-day follow-up)	Dichotomised; serostatus based on whether or not participants knew whether or not partners were on PrEP (if HIV-negative) and/or virally suppressed (if HIV-positive)
Safe Behaviour and Screening ¹²⁵	Serononconcordant insertive CAI (90-day follow-up)	Dichotomised; serostatus based on whether or not participants knew whether partners were on PrEP (if HIV negative) and/or virally suppressed (if HIV positive)
	Condom use during anal intercourse in previous 3 months (6 months post intervention)	Percentage of encounters
Sex Positive! ¹²⁷	CAI, serodiscordant partners (3-month follow-up post baseline)	Based on last encounter with each of up to three most recent anal intercourse partners; serodiscordant partners were known to have a HIV-negative status. Estimates are change scores

TABLE 7 Measures used in evaluations reporting sexual risk outcomes (continued)

Intervention	Measure	Notes
Sexpulse ¹¹⁶	CAI, serodiscordant partners in previous 3 months (12-month follow-up post baseline)	Based on last encounter with each of up to three most recent anal intercourse partners; serodiscordant partners were known to have a HIV-negative status. Estimates are changes scores
	CAI, unknown serodiscordant partners (3-month follow-up post baseline)	Based on last encounter with each of up to three most recent anal intercourse partners. Estimates are change scores
	CAI, unknown serodiscordant partners in previous 3 months (12-month follow-up post baseline)	Based on last encounter with each of up to three most recent anal intercourse partners. Estimates are change scores
	CAI in the previous 90 days (3 months post baseline)	Number of partners
	CAI in the previous 90 days (6 months post baseline)	Number of partners
	CAI in the previous 90 days (9 months post baseline)	Number of partners
	CAI in the previous 90 days (12 months post baseline)	Number of partners
TXT-Auto ¹¹⁵	Episodes of CAI with exchange partner in previous 30 days (8 weeks post baseline)	
	Episodes of CAI with exchange partner in previous 30 days (3 months post baseline)	
	Episodes of CAI with exchange partner in previous 30 days (6 months post baseline)	
	Episodes of CAI with exchange partner in previous 30 days (9 months post baseline)	
	Episodes of CAI with casual partner in previous 30 days (8 weeks post baseline)	
	Episodes of CAI with casual partner in previous 30 days (3 months post baseline)	
	Episodes of CAI with casual partner in previous 30 days (6 months post baseline)	
	Episodes of CAI with casual partner in previous 30 days (9 months post baseline)	
	Episodes of CAI with methamphetamines in previous 30 days (8 weeks post baseline)	
	Episodes of CAI with methamphetamines in previous 30 days (3 months post baseline)	
	Episodes of CAI with methamphetamines in previous 30 days (6 months post baseline)	
	Episodes of CAI with methamphetamines in previous 30 days (9 months post baseline)	
	Episodes of sex with methamphetamines in previous 30 days (8 weeks post baseline)	
Episodes of sex with methamphetamines in previous 30 days (6 months post baseline)		

continued

TABLE 7 Measures used in evaluations reporting sexual risk outcomes (continued)

Intervention	Measure	Notes
	Episodes of sex with methamphetamines in previous 30 days (9 months post baseline)	
	Episodes of CAI with anonymous partner in previous 30 days (8 weeks post baseline)	
	Episodes of CAI with anonymous partner in previous 30 days (3 months post baseline)	
	Episodes of CAI with anonymous partner in previous 30 days (6 months post baseline)	
	Episodes of CAI with anonymous partner in previous 30 days (9 months post baseline)	
	Episodes of CAI with main partner in previous 30 days (8 weeks post baseline)	
	Episodes of CAI with main partner in previous 30 days (3 months post baseline)	
	Episodes of CAI with main partner in previous 30 days (6 months post baseline)	
	Episodes of CAI with main partner in previous 30 days (9 months post baseline)	

Condomless sex

Six studies^{100,113,115,116,122,123} presenting short-term results for condomless sex yielded inconsistent evidence as to the effectiveness of interventions on this outcome. First, considering evaluations of time-limited interactive online modular interventions, in their evaluation of the myDEX intervention, Bauermeister *et al.*¹²³ found that, at 90 days post randomisation (i.e. at post intervention), intervention recipients ($n = 95$) had significantly lower odds than attention control recipients ($n = 28$) of any condomless receptive anal intercourse during the prior 3 months (OR 0.43, 95% CI 0.20 to 0.94). The reduction was lower in magnitude and non-significant for any condomless insertive anal intercourse (OR 0.64, 95% CI 0.28 to 1.44). However, at 3 months post baseline, Carpenter *et al.*¹⁰⁰ did not find that the Hot and Safe M4M intervention generated significant differences between groups on any CAI, condomless insertive anal intercourse, condomless receptive anal intercourse, condomless insertive oral intercourse or condomless receptive oral intercourse (intervention group, $n = 59$; control group, $n = 53$).¹⁰⁰ Specific significance tests per outcome were not provided, although we were able to calculate standardised mean differences (see Figure 12 for specific estimates), none of which suggested a significant impact of the intervention. In the first evaluation of the Keep it Up! intervention, Mustanski *et al.*¹²² found that, at 12 weeks post intervention, those who received the intervention had a lower rate of CAI acts of borderline statistical significance (rate ratio 0.56; $p = 0.04$, $n = 63$). However, in the second evaluation of Keep it Up!,¹¹³ there was no significant difference between groups for any CAI acts, number of male CAI partners overall or number of casual CAI partners at 3 months post randomisation (intervention group, $n = 367$; control group, $n = 410$), although specific significance tests were not reported for these outcomes. Calculated standardised mean differences between groups on reports of any CAI did not suggest a significant difference ($d = -0.10$, 95% CI -0.26 to 0.06). Finally, Rosser *et al.*¹¹⁶ estimated that the Sexpulse intervention reduced the number of male CAI partners by 16.8% at 3 months post baseline, although this effect was only marginally significant (95% CI 0.691 to 1.000, intervention group, $n = 267$; control group, $n = 293$).¹¹⁶

Considering time-limited interactive computer games, a study by Christensen *et al.*¹⁰¹ examined the mediating impact of shame on the number of unprotected anal intercourse events in the preceding 3 months in the SOLVE intervention at 3 months post baseline (intervention group, $n = 437$; control group, $n = 484$). Estimates of the intervention's total impact on CAI were not presented, but the significant reported indirect effect on CAI through shame suggests a significant total effect of the intervention on CAI. However, these estimates are not directly comparable to the other tests of intervention impact presented here.

Turning to open-ended interventions with content organised by assessment, Reback *et al.*¹¹⁵ did not undertake end point-specific tests for CAI outcomes; however, we calculated that the intervention did not reduce episodes of CAI (i.e. the number of times that people had CAI) with main partners, anonymous partners, partners for transactional sex or casual partners at 8 weeks or 3 months post baseline (Figure 12 presents specific estimates: at 8 weeks, intervention group, $n = 82$; control group, $n = 79$; at 3 months, intervention group, $n = 82$; control group, $n = 83$). There was some signal of a harmful effect in terms of the intervention group having a higher number of CAI episodes with casual partners at 8 weeks post baseline, but this may have been due to substantial baseline imbalance.

Condom use

Two studies^{122,125} presented short-term results for condom use and together suggested an inconsistent indication of effectiveness on this outcome. At 6 months post baseline, Chiou *et al.*¹²⁵ found that the Safe Behaviour and Screening open-ended intervention with general content increased the proportion of anal intercourse encounters in which condoms were used by 20.7% [standard error (SE) 0.058; $p = 0.001$, intervention group, $n = 130$; control group, $n = 135$]. Similarly, in the first evaluation of the Keep it Up! time-limited interactive online modular intervention, Mustanski *et al.*¹²² showed that the intervention reduced the number of condom use errors ($d = -0.19$; $p = 0.56$) and condom failures ($d = -0.22$; $p = 0.30$), but not significantly so. This analysis included 50 intervention and 52 control participants.

Human immunodeficiency virus serononconcordant sex

Three studies presented short-term results for HIV serononconcordant sex acts with other men, and yielded mixed evidence on the effectiveness of time-limited/modular interventions for this outcome.^{100,123,127} First considering time-limited interactive online modular interventions, in their evaluation of the myDEx intervention, Bauermeister *et al.*¹²³ found that, at 90 days post randomisation (i.e. at post intervention), intervention recipients ($n = 95$) had lower odds than attention control recipients ($n = 28$) of any condomless receptive anal intercourse with serodiscordant or serunknown partners not known to be on PrEP or virally suppressed during the preceding 3 months, but not significantly so (OR 0.44, 95% CI 0.15 to 1.31); a similar pattern was found for insertive anal intercourse (OR 0.49, 95% CI 0.17 to 1.33).¹²³ However, at 3 months post baseline, Carpenter *et al.*¹⁰⁰ found that the Hot and Safe M4M intervention generated greater reductions in all CAI events with partners of positive or unknown serostatus [group by time $F_{7,59}$, degrees of freedom (df) = 1101; $p = 0.007$], including condomless insertive anal intercourse (group by time $F_{7,24}$, df = 1101; $p = 0.008$), but not condomless receptive anal intercourse (group by time $F_{1,35}$, df = 1101; $p = 0.248$). The intervention group also reported reduced condomless insertive oral intercourse events (group by time $F_{7,45}$, df = 1101; $p = 0.007$) and reduced condomless receptive oral intercourse events with partners of positive or unknown serostatus (group by time $F_{8,45}$, df = 1101; $p = 0.004$), with analyses drawing on 59 intervention group and 53 control group participants.¹⁰⁰

Turning to time-limited non-interactive video series interventions, Hirshfield *et al.*¹²⁷ found that, at 3 months post baseline, the Sex Positive! intervention did not reduce either the number of CAI partners known to be serodiscordant (adjusted standardised $\beta = 0.003$, 95% CI -0.168 to 0.178) or the number of CAI partners not known to be seroconcordant (adjusted standardised $\beta = -0.073$, 95% CI -0.332 to 0.051).

Sex acts under the influence of drugs

Reback *et al.*¹¹⁵ was the only study to present short-term results for this category of sexual risk outcomes, evaluating an intervention with open-ended content organised by assessment. We calculated

differences using end-point means. At neither 8 weeks post baseline ($d = 0.23$, 95% CI -0.08 to 0.54 , intervention group, $n = 82$; control group, $n = 79$) nor 3 months post baseline ($d = 0.08$, 95% CI -0.23 to 0.38 , intervention group, $n = 82$; control group, $n = 83$) was there a significant difference between groups for episodes of sex while on methamphetamines.

Mid-term results

Effect estimates presented for mid-term results fell into four categories: condomless sex, condom use, seroconcordant sex acts and sex acts under the influence of drugs.

Condomless sex

Four studies presenting mid-term results for condomless sex yielded inconsistent evidence as to the effectiveness of interventions on this outcome.^{113,115,116,124} First, considering a time-limited interactive online modular intervention, in the evaluation of the China-Gate HIV Prevention Program,¹²⁴ at 6 months post baseline, intervention participants were less likely than control participants to report CAI in the previous 3 months, with a risk difference of 9.3% (95% CI 1.1% to 17.5%, intervention group, $n = 501$; control group, $n = 485$); estimates using multiple imputation to include the entire sample (intervention group, $n = 550$; control group, $n = 550$) generated a similar estimate (8.9%, 95% CI 1.2% to 16.6%). In the second evaluation of Keep it Up!, there was no significant difference between groups for the numbers of male casual CAI acts and the number of CAI partners at 6 or 12 months post randomisation, although specific significance tests were not reported for these outcomes.¹¹³ However, at 12 months post randomisation, intervention participants were 17% less likely to report any CAI in the previous 3 months (95% CI 0.70 to 0.99, intervention group, $n = 366$; control group, $n = 391$). Rosser *et al.*¹¹⁶ estimated that the Sexpulse intervention did not reduce the number of male CAI partners at 12 months post baseline (incidence rate ratio 0.998, 95% CI 0.952 to 1.046, intervention group, $n = 276$; control group, $n = 278$). We also calculated that there was no evidence of a significant effect at 6 months ($d = -0.13$, 95% CI -0.29 to 0.04) or 9 months ($d = -0.10$, 95% CI -0.27 to 0.06) post baseline.

Turning to open-ended interventions with content organised by assessment, Reback *et al.*¹¹⁵ did not undertake end point-specific tests for CAI outcomes; however, we calculated that the intervention did not reduce episodes of CAI with main partners, anonymous partners, partners for transactional sex or casual partners at 6 or 9 months post baseline (see *Figure 13* for specific estimates; at 6 months: intervention group, $n = 83$; control group, $n = 78$; at 9 months: intervention group, $n = 85$; control group, $n = 84$).

Condom use and seroconcordant sex acts with other men

Davidovich *et al.*¹⁰² presented mid-term results for condom use with no evidence of effectiveness, whereas two studies^{102,127} presenting mid-term results for seroconcordant sex acts with other men yielded inconsistent evidence as to the effectiveness of interventions on this outcome. In a time-limited non-interactive online modular intervention termed the Cognitive Vaccine Approach, intervention participants receiving the tailored intervention ($n = 128$) were significantly more likely than control participants ($n = 140$) to practise negotiated safety (seroconcordant CAI, or no condom use only in the context of monogamous relationships) than to have CAI with partners of unknown HIV concordance (OR 10.50, 95% CI 1.19 to 92.72); however, intervention participants receiving the non-tailored intervention did not show a significant difference on this outcome compared with control recipients (OR 1.62, 95% CI 0.14 to 19.07).¹⁰² In this same study, intervention participants did not have odds of condom use that were significantly different from those of the control participants at 6 months post baseline. This was the case comparing either the tailored version of the intervention (OR 1.66, 95% CI 0.68 to 4.02) or the non-tailored version ($n = 107$) of the intervention (OR 0.55, 95% CI 0.22 to 1.37) with control ($n = 140$), with OR values > 1 suggesting increased condom use. However, it should be noted that, in this analysis, negotiated safety, condom use and other CAI were mutually exclusive categories estimated as part of a multinomial regression model. In addition, Hirshfield *et al.*¹²⁷ found that, at 12 months post baseline, the Sex Positive! time-limited non-interactive video series intervention

did not significantly reduce either the number of CAI partners known to be serodiscordant (adjusted standardised $\beta = -0.073$, 95% CI -0.332 to 0.051) or the number of CAI partners not specifically known to be seroconcordant (adjusted standardised $\beta = -0.084$, 95% CI -0.399 to 0.045).

Sex acts under the influence of drugs

Reback *et al.*¹¹⁵ was the only study to present mid-term results for this category of sexual risk outcomes, for an intervention with open-ended content organised by assessment. We calculated differences using end-point means. At neither 6 months post baseline ($d = -0.10$, 95% CI -0.41 to 0.21 , intervention group, $n = 83$; control group, $n = 78$) nor 9 months post baseline ($d = -0.18$, 95% CI -0.48 to 0.13 , intervention group, $n = 85$; control group, $n = 84$) was there a significant difference between groups for episodes of sex while using methamphetamines.

Overall results

Reback *et al.*¹¹⁵ used, as their primary method of analysis, a longitudinal regression model with a continuous variable for follow-up (range 0–4), with the test of intervention effectiveness being the interaction between intervention condition and time. In the regression models presented, the interactions between allocation to TXT-Auto and time were not significant for episodes of CAI with main partners ($\beta = -0.16$, 95% CI -0.31 to 0.003), episodes of CAI with casual partners ($\beta = -0.01$, 95% CI -0.06 to 0.03), episodes of CAI with anonymous partners ($\beta = -0.05$, 95% CI -0.10 to 0.003) or episodes of CAI with partners for transactional sex ($\beta = -0.03$, 95% CI -0.18 to 0.11). Similarly, the regression model for episodes of sex while using methamphetamines did not yield a significant interaction ($\beta = -0.05$, 95% CI -0.11 to -0.009). This coefficient is interpreted as the change between groups between follow-up periods in standard deviations. Thus, those allocated to TXT-Auto had a faster reduction in risk in all outcomes, but this difference in rate of change was not significant.

Equity-relevant characteristics

Only Cheng *et al.*¹²⁴ presented results broken down by equity-relevant characteristics in relation to the evaluation of the interactive online modular China-Gate HIV Prevention Program. On the primary outcome, CAI in the previous 3 months, there was no evidence of effect modification by annual income ($p = 0.445$); however, there was significant effect modification by educational attainment ($p = 0.012$), with those in the category of least education enjoying a greater benefit than those with a university education or above (difference in effects 2.6%).

Meta-analysis

Effect sizes for sexual risk outcomes are presented in *Figure 12* for outcomes of < 3 months post intervention (short term) and in *Figure 13* for outcomes between 3 months and 1 year post intervention (mid-term). In both plots, negative effect sizes represent benefits. A meta-analysis drawing on 32 effect sizes from eight studies^{100,113,115,116,122,123,125,127} with < 3 months' follow-up found a suggestion of effectiveness, albeit not statistically significant ($d = -0.14$, 95% CI -0.30 to 0.03) with substantial heterogeneity ($I^2 = 61\%$). The certainty of evidence for this meta-analysis was graded as very low because of risk of bias (details of randomisation, selective outcome reporting), inconsistency of studies, and publication bias arising from the non-inclusion of two studies.^{101,117} A meta-analysis drawing on 22 effect sizes from six studies^{102,113,115,116,124,127} with 3 months to 1 year of follow-up suggested a significant impact on reducing sexual risk ($d = -0.12$, 95% CI -0.19 to -0.05), but with low heterogeneity ($I^2 = 27\%$). The certainty of evidence for this meta-analysis was graded as low because of risk of bias (details of randomisation, selective outcome reporting).

We then pooled estimates regardless of follow-up time. Based on 54 effect sizes from 10 studies,^{100,102,113,115,116,122–125,127} interventions significantly reduced sexual risk compared with control groups ($d = -0.15$, 95% CI -0.26 to -0.05). This meta-analysis had substantial heterogeneity ($I^2 = 56\%$). To explore this heterogeneity, we compared interactive interventions^{100,113,115,116,122–125} with non-interactive interventions.^{102,127} A random-effects meta-regression did not suggest that this characteristic accounted for heterogeneity with non-interactive interventions not meaningfully worse than interactive interventions ($\beta = 0.12$, 95% CI -0.66 to 0.89).

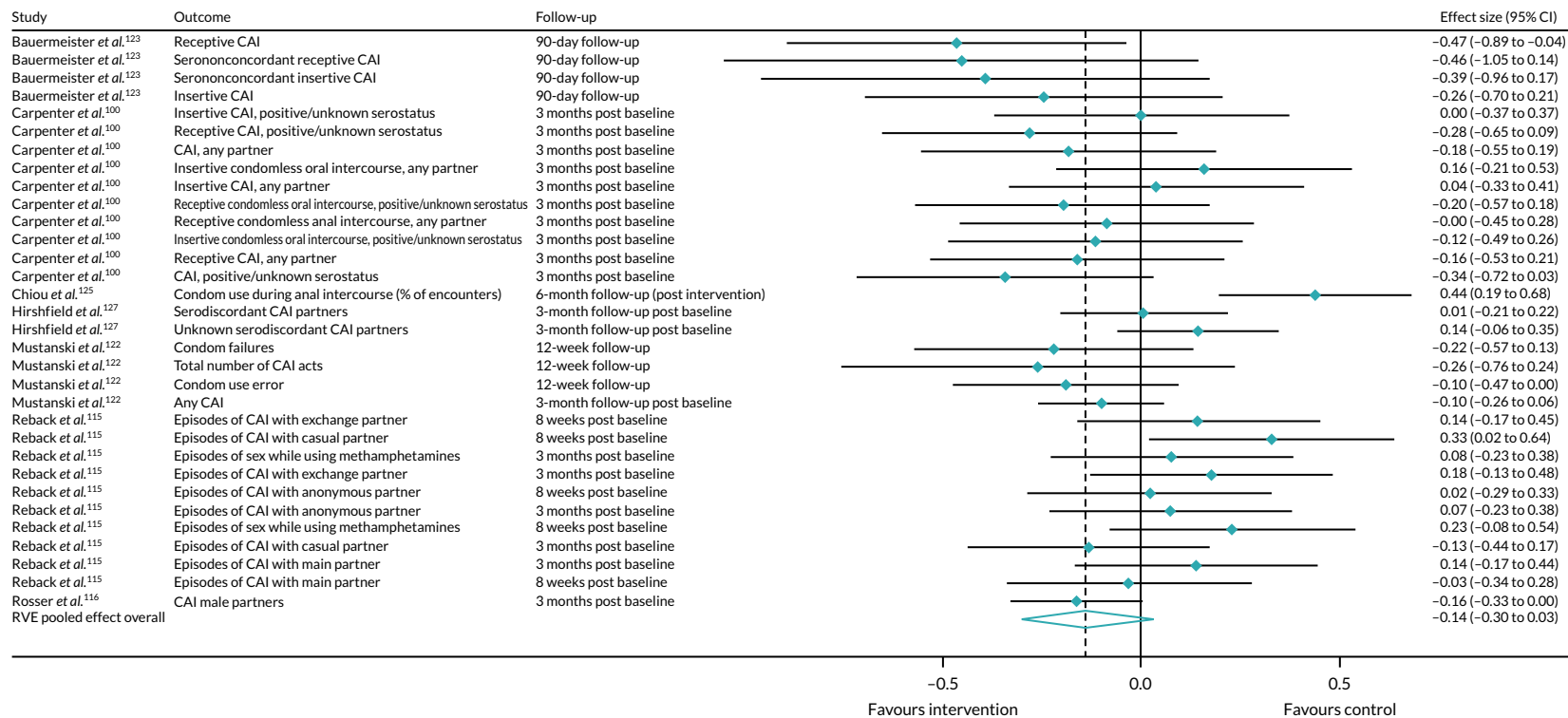


FIGURE 12 Effect sizes and meta-analysis for sexual risk outcomes in included studies, < 3 months post intervention. RVE, robust variance estimation. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

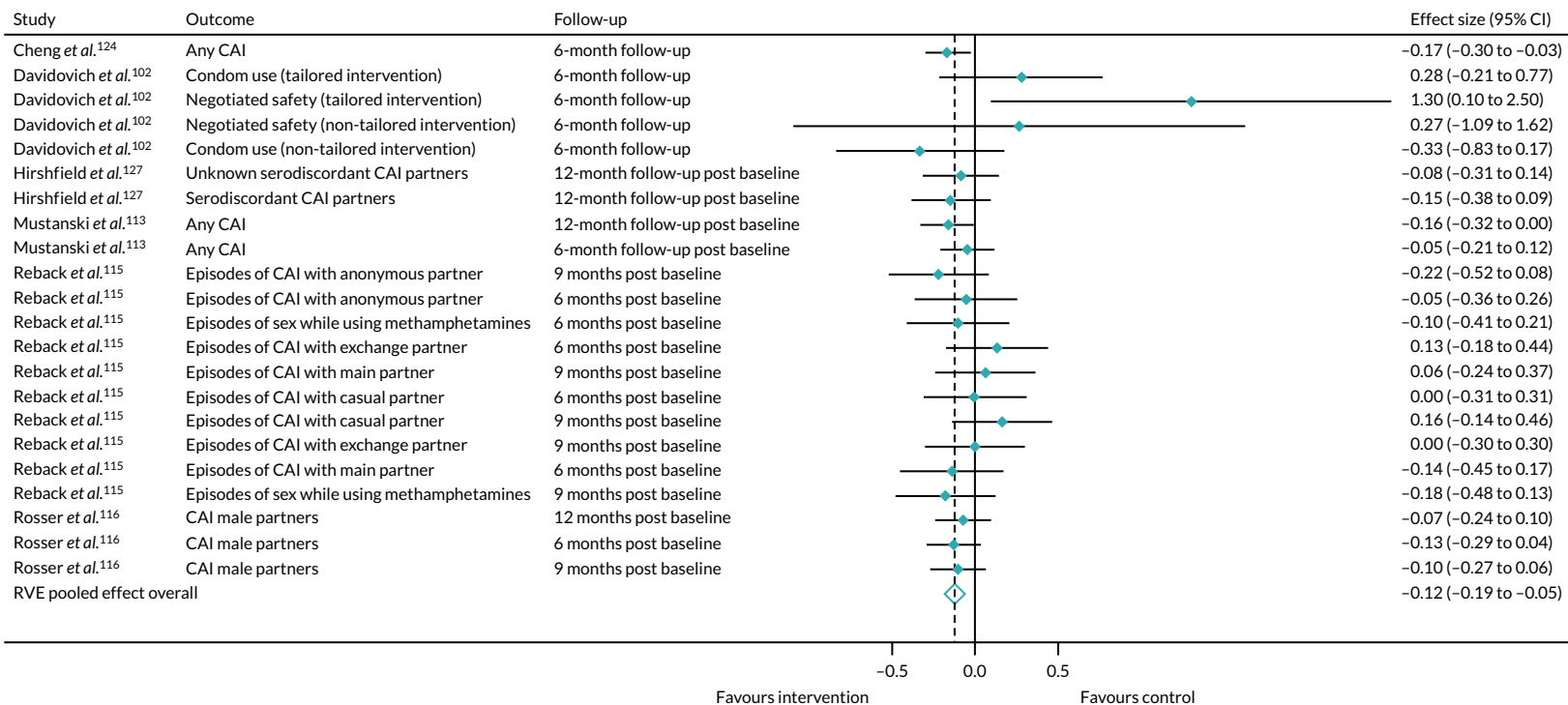


FIGURE 13 Effect sizes and meta-analysis for sexual risk outcomes in included studies, 3 months to 1 year post intervention. RVE, robust variance estimation. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

Effects on alcohol and drug use

Two studies presented estimates for drug use: Chiou *et al.*¹²⁵ and Reback *et al.*¹¹⁵ (Table 8), both focused on open-ended interventions. Neither quantified outcomes on alcohol use specifically. Although both studies presented short-term results, only Reback *et al.*¹¹⁵ presented mid-term results. However, the primary method of analysis in that study was a longitudinal regression model; we present these estimates as well. Across studies, there was no consistent evidence of effectiveness of interventions in reducing drug use.

Short-term results

After 6 months of app use (i.e. at 6 months post randomisation), Chiou *et al.*¹²⁵ found that the Safe Behaviour and Screening open-ended intervention with general content reduced drug use, as measured on a five-point Likert scale ($\beta = -1.19$, SE 0.204; $p < 0.001$; intervention group, $n = 130$; control group, $n = 135$). We used estimates from table 2 in Reback *et al.*¹¹⁵ to compare the TXT-Auto intervention, an open-ended intervention with content organised by assessment, with the assessment only (AO) condition on the outcome of days of methamphetamine use. Neither at the post-intervention follow-up at 8 weeks post randomisation ($d = 0.15$, 95% CI -0.16 to 0.45 ; intervention group, $n = 83$; control group, $n = 79$) nor at 3 months post randomisation ($d = -0.03$, 95% CI -0.34 to 0.28 ; intervention group, $n = 82$; control group, $n = 83$) was there evidence of a difference between the conditions. Statistical heterogeneity precluded meta-analysis of results, and certainty of the assessment of evidence was graded as being very low because of risk of bias (details of randomisation), inconsistency of studies and imprecision of effect estimates.

Mid-term results

We similarly estimated mid-term effects in Reback *et al.*¹¹⁵ for the outcome of days of methamphetamine use. At 6 months post randomisation, there was no evidence of a difference between the TXT-Auto intervention and the AO condition on this outcome ($d = 0.23$, 95% CI -0.07 to 0.54 ; intervention group, $n = 83$; control group, $n = 78$). A similar estimate was produced at 9 months post randomisation ($d = 0.28$, 95% CI -0.02 to 0.59 ; intervention group, $n = 85$; control group, $n = 84$). Both estimates suggested a possible, although not significant, intervention effect of increased days of methamphetamine use in the intervention arm; however, authors noted that this could have been due to baseline imbalance between arms.

Overall results

Reback *et al.*¹¹⁵ used, as their primary method of analysis, a longitudinal regression model with a continuous variable for follow-up (range 0–4), with the test of intervention effectiveness being the interaction between intervention condition and time. In the regression model presented, the interaction between allocation

TABLE 8 Measures used in evaluations reporting alcohol and drug use outcomes

Intervention	Measure	Notes
Safe Behaviour and Screening ¹²⁵	Recreational drug use in previous 3 months (6-month follow-up post intervention)	Asked about various recreational drugs (not all of which were specified in the report, but among which alcohol was included) and assessed on Likert scale
TXT-Auto ¹¹⁵	Days of methamphetamine use in previous 30 days (8 weeks post baseline)	
	Days of methamphetamine use in previous 30 days (3 months post baseline)	
	Days of methamphetamine use in previous 30 days (6 months post baseline)	
	Days of methamphetamine use in previous 30 days (9 months post baseline)	

to TXT-Auto and time was not significant ($\beta = 0.01$, 95% CI -0.04 to 0.06). This coefficient is interpreted as the change between groups between follow-up periods in standard deviations. The main effect for time was significant, suggesting a decrease in days of methamphetamine use between follow-ups of 0.10 standard deviations ($\beta = -0.10$, 95% CI -0.14 to -0.06). Thus, those allocated to TXT-Auto had a slower rate than the control group of decrease in days of methamphetamine use of 0.01 standard deviations, but this difference in rate of change was not significant.

Meta-analysis

Effect sizes for alcohol and drug use are presented in *Figure 14* for outcomes of < 3 months post intervention and in *Figure 15* for outcomes between 3 months and 1 year post intervention. In both plots, negative effect sizes represent benefits. We do not present a pooled effect size for these estimates as meta-analyses included both substantial heterogeneity ($I^2 = 95\%$ both overall and only including effect sizes of up to 3 months' follow-up) and too few studies to explore this heterogeneity.

Grading of Recommendations Assessment, Development and Evaluation analysis

Findings from a GRADE analysis of included outcomes are presented in *Table 9*. The evidence generated a score of low or very low confidence for most outcomes. This was primarily because of risk of bias and imprecision in the evidence.

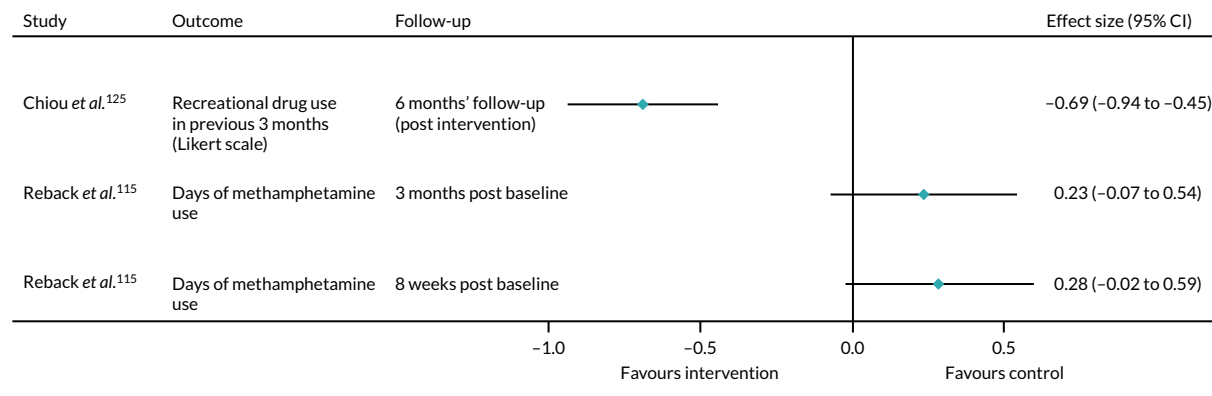


FIGURE 14 Effect sizes for alcohol and drug use in included studies, < 3 months post intervention. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

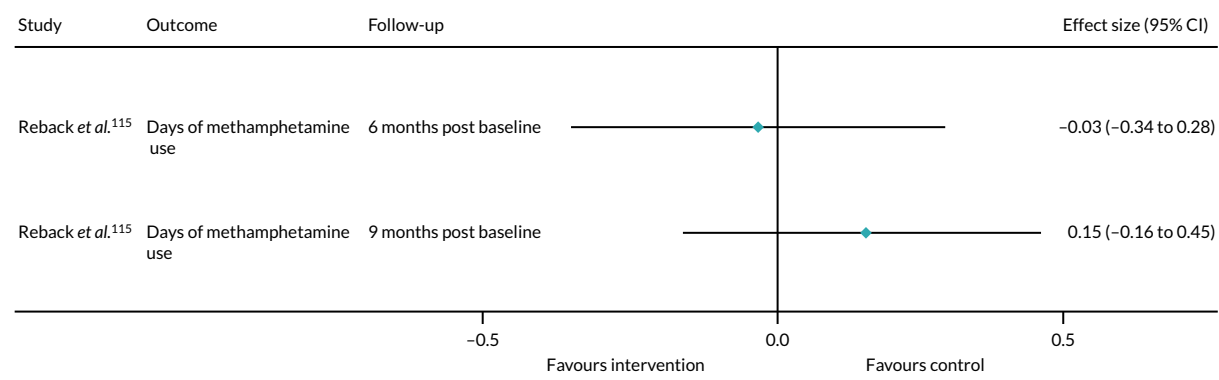


FIGURE 15 Effect sizes for drug use in included studies, 3 months to 1 year post intervention. This figure has been adapted with permission from Melendez-Torres *et al.*⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>.

TABLE 9 The GRADE analysis by outcome for studies assessing active intervention vs. control arm

Certainty assessment									
Studies (n)	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Summary of effects	Certainty	Importance
Drug use (short term)									
2	Randomised trials	Serious ^a	Very serious ^b	Not serious	Very serious ^c	None	Estimates could not be pooled owing to high heterogeneity and few effect sizes	⊕○○○ Very low	Critical
Drug use (mid-term)									
1	Randomised trials	Serious ^a	Not serious	Not serious	Very serious ^c	None	Estimates drew from one study, Reback <i>et al.</i> ¹¹⁵ This study did not provide evidence of effectiveness	⊕○○○ Very low	Critical
HIV infections (short term)									
1	Randomised trials	Not serious	Not serious	Not serious	Very serious ^c	None	Estimates drew from one study, Chiou <i>et al.</i> ¹²⁵ This study did not provide evidence of effectiveness	⊕⊕○○ Low	Critical
HIV infections (mid-term)									
1	Randomised trials	Serious ^d	Not serious	Not serious	Very serious ^c	None	Estimates drew from one study, Mustanski <i>et al.</i> ¹¹³ This study did not provide evidence of effectiveness	⊕○○○ Very low	Critical
STIs (short term)									
2	Randomised trials	Very serious ^{a,d}	Not serious	Not serious	Very serious ^c	None	A pooled estimate of both studies suggested a non-significant increase in STIs as a result of interventions ($d = 0.17$, 95% CI -0.18 to 0.52)	⊕○○○ Very low	Critical
STIs (mid-term)									
1	Randomised trials	Serious ^d	Not serious	Not serious	Not serious	None	Estimates drew from one study, Mustanski <i>et al.</i> ¹¹³ The pooled outcome of 'any STI' suggested a significant reduction in risk of STIs (RR 0.32, 95% CI 0.40 to 0.83)	⊕⊕⊕○ Moderate	Critical

Certainty assessment									
Studies (n)	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Summary of effects	Certainty	Importance
Sexual risk behaviour (short term)									
8	Randomised trials	Very serious ^{a,d}	Serious ^e	Not serious	Not serious	Publication bias strongly suspected ^f	Pooled estimates suggested a non-significant decrease in sexual risk behaviour ($d = -0.14$, 95% CI -0.30 to 0.03)	⊕○○○ Very low	Critical
Sexual risk behaviour (mid-term)									
6	Randomised trials	Very serious ^{a,d}	Not serious	Not serious	Not serious	None	Pooled estimates suggested a significant reduction in sexual risk behaviour ($d = -0.12$, 95% CI -0.19 to -0.05)	⊕⊕○○ Low	Critical
<p>a Details about randomisation were missing from at least one study. b Heterogeneity was extremely high (> 90%). c CIs are wide for all effect estimates. d There was some evidence of selective outcome reporting. e Heterogeneity was high (> 50%). f Several studies could not be included because of inadequate outcome reporting.</p> <p>Note This table has been adapted with permission from Melendez-Torres <i>et al.</i>⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/.</p>									

Synthesis of studies comparing active interventions

Two studies included comparisons between active interventions.^{99,102} Both studies reported sexual risk outcomes only, and only Davidovich *et al.*¹⁰² presented extractable outcome data. As a result, a meta-analysis was not undertaken.

Risk of bias of trials comparing active interventions

Sequence generation

Neither of the two trials presenting active versus active comparisons presented enough information to judge sequence allocation.^{99,102}

Allocation concealment

Both trials reported information that suggested that allocation was sufficiently concealed, owing to online randomisation.^{99,102}

Blinding of participants and personnel

Davidovich *et al.*¹⁰² stated that participants were blinded but study personnel were not. Bowen *et al.*⁹⁹ did not present enough information to judge the blinding of participants or personnel.

Blinding of outcome assessors

Davidovich *et al.*¹⁰² was rated as having a low risk in this domain because, even though outcomes were self-reported, participants were blinded. Bowen *et al.*⁹⁹ did not present enough information to judge this item.

Complete outcome data

Both trials had high levels of attrition (> 30%) and imbalanced attrition between arms.^{99,102}

No selective outcome reporting

Davidovich *et al.*¹⁰² reported all stated outcomes and was thus rated as being at low risk of bias for this domain. Bowen *et al.*⁹⁹ was rated as being at high risk of bias for this domain as no concrete estimates for between-group differences were presented.

Accounted for clustering

Neither study required accounting for clustering.

Reducing other sources of bias

Davidovich *et al.*¹⁰² was rated as being at low risk of bias for this domain as the trial included multiple methods of recruitment. Bowen *et al.*⁹⁹ was rated as being at high risk of bias for this domain as no clear evidence of effectiveness or ineffectiveness was presented in this trial.

Narrative summary of trials comparing active interventions

Davidovich *et al.*¹⁰² included a three-arm trial testing tailored and non-tailored versions of their time-limited non-interactive online modular interventions against a no-treatment control group. We calculated that participants receiving the tailored intervention ($n = 128$) were more likely than participants receiving the non-tailored intervention ($n = 107$) to report, at 6 months post baseline, the practice of negotiated safety (defined above), compared with CAI with other partners (OR 6.50, 95% CI 2.49 to 16.90), and the practice of condom use, compared with CAI (OR 2.98, 95% CI 1.74 to 5.12).

In their evaluation of time-limited interactive online modular interventions, Bowen *et al.*⁹⁹ tested the impact of ordering modules with content about HIV knowledge, content about risk in casual or new partnerships and content about contexts of risk on the proportion of anal intercourse partners with whom a condom was used every time. At post intervention, there was no statistical difference between modules on sexual risk, but specific group differences were not presented.

Chapter 8 Results: synthesis of cost-effectiveness evidence

Reports included in the economic evaluation synthesis

Only one economic evaluation report was eligible for inclusion in the review,¹³² which reported on the TXT-Auto intervention. Targeting sexual health and substance use outcomes, TXT-Auto was an open-ended intervention with core content organised by user assessment. Characteristics of the included study are reported in *Table 10*.

TABLE 10 Summary of economic evaluation characteristics

Item	Description
<i>Programme: TXT-Auto (Reback et al.¹¹⁵)</i>	
Research question	What were the costs to the health-care sector for benefits achieved through the application of theory-based, interactive text messages, with and without real-time interactive peer text conversations, among non-treatment-seeking, methamphetamine-using MSM?
Intervention	TXT-Auto: for 8 weeks, participants received five automatically transmitted unidirectional text messages a day and a once-weekly assessment on methamphetamine use and HIV sexual behaviours in the previous 7 days
Comparator(s) and whether or not this represents standard practice in the UK	TXT-PHE: peer health educators engaged in bidirectional interactive text messaging conversations with participants; participants also received five automatically transmitted unidirectional text messages a day, as well as a once-weekly assessment on methamphetamine use and HIV sexual behaviours in the previous 7 days AO comparator: participants received only the once-weekly assessment on methamphetamine use and HIV sexual behaviours in the previous 7 days Note that neither of the above is standard practice in the UK
Base-case population characteristics and analysed subgroups	MSM aged 18–65 years reporting methamphetamine use and CAI with a non-primary partner in the previous 3 months, who had access to a mobile phone with unlimited texting service, and who were not enrolled or seeking enrolment in a programme for methamphetamine use, and not considered to have a serious psychiatric condition. No subgroups were analysed in the economic evaluation
Form of economic evaluation	Cost-effectiveness analysis
If cost–utility analysis, were QALYs reported	NA
Primary outcome measure(s) for the economic evaluation	<ul style="list-style-type: none"> • Number of self-reported days of methamphetamine use in the previous 30 days • Number of episodes of sex while on methamphetamines in the previous 30 days • Number of self-reported episodes of CAI with any partner • Risk behaviours were reported at 8 weeks and at 3, 6 and 9 months following baseline. Interpolation occurred for the months not specifically reported to obtain an estimate of the total number of risks acts over the 9 months and converted this to an average number of risk behaviours per month from baseline to month 9. This monthly average was subtracted from the figure reported in the baseline for risk behaviours over the prior month to measure incremental improvement in outcomes

continued

TABLE 10 Summary of economic evaluation characteristics (continued)

Item	Description
Methods used to value health states and other benefits	Health outcomes were not valued
Methods and sources of information used to estimate resource use	Costs of delivery were collected retrospectively using a modified UNAIDS template from a health-care system perspective. Monthly costs of the ongoing programme were calculated based on programme expenditures from February 2014 to January 2015. Costs for facilities, other office and medical costs, and the programme director were obtained from administrative records. The costs for the director included salary, benefits and retirement contributions. In the base-case analysis, these costs are evenly split among the three study arms. A sensitivity analysis did not allocate facility or director costs to the comparator condition. Costs were price-adjusted back to year 1 of the study (2014), using the medical care component of the consumer price index. The cost of the text messaging platform was allocated based on the proportions of messages received per arm
Did the study include start-up provider costs?	No
Did the study include ongoing provider costs?	Yes
Did the study include provider costs per contact?	Yes. These were calculated by first calculating the monthly average costs for each arm by dividing its total monthly cost by the average number of participants per month. TXT-Auto averaged 10.2 participants per month. Monthly cost per participant was multiplied by 2 to account for the 2-month enrolment period. In the base-case analysis, the average intervention cost per participant in the TXT-PHE arm was US\$3478
Did the study include costs to patients?	Yes, but these were reported as minimal
Currency and price year	Costs were expressed in US dollars and price-adjusted back to year 1 of the study (2014), using the medical care component of the consumer price index
Details of model used and key structural issues and assumptions	No decision modelling was performed
Justification for model used	NA
Base-case time horizon	9 months
Base-case discount rates for costs and benefits	NA
Statistical test(s) and CI(s) for stochastic data	Not reported
Sensitivity analyses	One sensitivity analysis did not allocate facility or director costs to the comparator condition. Another tested the effect of using reported risk behaviours at 9 months vs. using average monthly risk behaviours. This raised the cost of the two texting arms and reduced the cost of the comparator. This moderated some of the outcome effects, but showed the same pattern as the base-case analysis. Other one-way sensitivity analyses were undertaken, but they appear to have been based on average costs and effects, rather than ICERs
Base-case ICER	<ul style="list-style-type: none"> Sex on methamphetamine: US\$426 per episode averted CAI: US\$37 per episode averted
ICERs for specified subgroups	Not reported
Author conclusions	Both intervention arms outperformed the comparator in reducing HIV risk behaviours, but the TXT-Auto arm dominated the TXT-PHE arm in achieving greater reductions in days of methamphetamine use and episodes of CAI at lower cost. Sensitivity analyses showed that results were robust to a number of changes in assumptions

NA, not applicable; PHE, peer health educator; QALY, quality-adjusted life-year; UNAIDS, Joint United Nations Programme on HIV/acquired immunodeficiency syndrome.

Quality of study

We assessed the quality of the included economic evaluation on 10 main items, each of which contained between two and six sub-items for a total of 31 sub-items (see *Appendix 16*). Reviewer agreement was high, with the two reviewers agreeing on 25 of the 31 sub-items (81%) and all of the main items. The study was judged as meeting five main quality items: well-defined question in answerable form, comprehensive description of competing alternatives, the effectiveness of the programme was assessed, costs and consequences were valued credibly and an incremental analysis of costs and consequences of alternatives was performed. The quality criterion of costs and consequences adjusted for differential timing was judged to be inapplicable to the study. The study was judged as not meeting four of the main quality items: all important and relevant costs and consequences for each alternative identified, costs and consequences measured accurately in appropriate physical units, allowance made for uncertainty in estimates of costs and consequences and discussion of results includes all issues of concern to users.

Summary of this study

The included study (see *Table 10*) assessed the cost-effectiveness of two text-based interventions to reduce the frequency of methamphetamine use and HIV sexual risk behaviours among MSM: (1) an interactive messaging service delivered by peer health educators with an automated text messaging service (TXT-PHE); and (2) an automatic text-based messaging service without peer interaction (TXT-Auto). It is the latter intervention that met the inclusion criteria for this systematic review. Both interventions were compared with a weekly assessment of risk behaviours that did not include a text-based messaging element (AO).

The evaluation involved a RCT conducted in the USA, which enrolled participants between March 2014 and January 2016.

The economic evaluation was a cost-effectiveness analysis with outcomes expressed in terms of numbers of episodes of CAI with any partner (which was not reported in the previous outcome evaluations), days of methamphetamine use (for which there was not a significant difference between arms, as reported in the previous outcome evaluation) and episodes of sex while using methamphetamines (for which, as described above, the previous outcome evaluation reported a difference favouring TXT-Auto, but only at $p < 0.1$ significance), all within the previous 30 days. The analysis was from a health services cost perspective over a 9-month time horizon (the duration of follow-up of the RCT), with costs expressed in US dollars at 2014 prices. Although the analysis was based on the results of the RCT, the costs were stated to have been collected retrospectively. They included the costs of providing facilities/offices, medical resources and general administration of the texting services. The economic evaluation did not include any decision modelling, which is a quantitative method of synthesising information from different sources and extrapolating results into the longer term.

In the base-case analysis, TXT-Auto was reported to have cost an additional US\$426 per reduction in episodes of sex while using methamphetamines, compared with AO, although the authors acknowledged that there was not a statistically significant difference between the two conditions. The economic evaluation also reported that the cost to achieve a reduction in days of methamphetamine use was actually higher for TXT-Auto group than for the AO control group. The economic evaluation reported that TXT-Auto was more cost-effective than the AO control in reducing episodes of CAI with any partner, reporting that the cost per difference in CAI with any partner between the two conditions was US\$37 per episode averted, but did not provide an estimate of the significance uncertainty of the difference between the conditions in CAI with any partner. Several one-way sensitivity analyses were conducted around intervention costs and changes in risk behaviour. However, the impact of these changes on the base-case ICERs were not directly reported; they relate only to the average treatment costs and effects. A probabilistic sensitivity analysis was not undertaken.

Critical appraisal of this study

A strength of the analysis is that it was based on results from a reasonably well-conducted RCT. However, it contains a number of problematic issues that limit its usefulness in terms of a UK decision-making context. First, the control arm was not judged to be reflective of routine UK practice, meaning that it is difficult to interpret the ICERs, even if the study had been judged as technically strong. Second, no attempt was made to extrapolate the trial results beyond the 9-month follow-up period using modelling techniques. This can be particularly important in the context of infectious diseases because there is a possibility of a prevention benefit, as well as a benefit to participants directly. A related issue is that the results were reported as incremental costs per reduced episode of CAI and reduced episodes of sex while on methamphetamines in the previous 30 days. Even though the base-case ICERs are low in monetary terms (e.g. US\$37 per episode of CAI averted), it would have been preferable to have attempted to express health benefits in terms of a generic outcome measure such as a quality-adjusted life-years, that is to have estimated and valued the potential longer-term health benefits of reduced risk behaviours, and to have expressed them using a metric for which willingness-to-pay thresholds have been estimated. The RCT did not collect information on HIV or any type of infection incidence. Thus, even though TXT-Auto was associated with a lower incidence of CAI than AO, the impact of this benefit on health is unknown. Most of these effects were significant only at $p < 0.1$, and so were not considered significant effects in our synthesis of outcomes. Thus, if a probabilistic sensitivity analysis had been conducted, it could not have led to complete certainty in terms of decision-making at any willingness-to-pay level. An assessment of the uncertainty around the base-case cost-effectiveness analysis using a deterministic approach is an important component of any economic evaluation. The deterministic sensitivity analysis reported in the economic evaluation is of poor quality in that it was limited to a few cost and effect parameters; it contained only one-way analyses; and the direct impact of alternative parameter values was not reported for the actual base-case ICERs, but only for the average treatment costs and effects. It also appears as though only a proportion of costs attributable to each treatment option have been included in the ICER calculations, although it is unclear why. If the total cost of the treatment arms had been included, as is more normal practice, the ICER values would have been higher than those reported. In summary, as there is weak evidence to suggest that TXT-Auto reduced the number of episodes of CAI and other outcomes, it is difficult to know whether or not it is a cost-effective use of resources based on the results from this analysis. At best, however, the results suggest that its cost-effectiveness is uncertain.

Chapter 9 Stakeholder consultation on dissemination and knowledge transfer

Overall impressions of the effectiveness of e-health interventions

Stakeholders felt that it was encouraging that intervention effects were apparent on mid-term sexual risk behaviour outcomes. It was felt that mid- and long-term behaviour change were the most important in the context of e-health interventions, and that, although short-term benefits were also desirable, lasting change was critical to success. One stakeholder noted that the significant mid-term impacts may have been due to trials with longer follow-up (and their associated interventions) being of higher quality than those with shorter follow-up, perhaps biasing the results.

Significant concerns were expressed about the lack of studies reporting on mental health and alcohol use outcomes. Both of these were felt to be a very high priority for further development work, especially in the context of COVID-19, as stakeholders observed increases in client need in both areas. This need was difficult to meet as it manifested alongside new ways of working to observe social distancing rules. In addition, the data on outcomes relating to use of other drugs were felt to be insufficient to draw firm conclusions on intervention effectiveness, especially given that one study by Reback *et al.*¹¹⁵ reported some evidence of possible intervention effects on increased days of use of methamphetamines in one intervention arm. Stakeholders were encouraged by the analysis that showed a significant reduction in STI diagnosis in Mustanski *et al.*¹¹³

Enthusiasm for the results from the systematic review was moderate and tempered by inconsistency in outcomes and by outcomes for which there were no data. It was noted that randomised trials of these types of interventions are uncommon and that those from the voluntary sector especially would look to other types of evidence (largely observational evidence and grey literature) to inform programming. This was perhaps due to the voluntary sector prioritising interventions that are a more obvious fit from an organisational perspective and because the voluntary sector as a whole does not put the same emphasis on RCT evidence as academia and clinical services do, and are more likely to rely on their professional judgement as expert practitioners. It was therefore felt that additional observational evidence from other sources might be more pertinent, especially for the outcomes for which evidence was thin or did not exist.

Modular interventions were seen to be the most promising and likely to be accessible to a wider range of MSM. These were also described as easiest to adapt in response to local context, so that they might be useful across all parts of the UK. Video games were the least preferred intervention; one stakeholder noted that they were very expensive to develop and that issues with their performance would be a barrier to retaining participants, creating a barrier to change. In addition, they were not felt to be appealing to a wide range of MSM and would become obsolete extremely quickly. Apps were felt to be useful in the context of interventions that promote self-monitoring. Text-based interventions were felt to be appropriate if less engaging.

Concern was raised by one stakeholder about the lack of cost-effectiveness data. Based on their professional experience, e-health interventions are often used as a cost-saving measure, but end up costing far more than necessary because the sectors that produce and deliver them have a poor understanding of commissioning and developing such technologies. As a result, it was felt that the cost-effectiveness of such interventions may turn out to be suboptimal.

All stakeholders had concerns that the evidence base around the effectiveness of these interventions might not translate well to the UK, given that only one study was from Europe and the rest were from the USA and Asia. It was felt that the differences in culture, as well as health and economic systems, might affect how such interventions perform.

Views on further development and evaluation

Despite the limitations of the evidence base, all stakeholders felt that it was worthwhile to develop an e-health intervention for further evaluation. For some stakeholders, the evidence base was sufficient to warrant further exploration, whereas, for others, this judgement was based on professional opinion, as the review did not provide what they felt to be compelling evidence of effectiveness. Stakeholders judged that data from this review did not indicate the appropriateness of immediate scale-up.

All stakeholders stated that any intervention developed, and its associated evaluation, should focus on the range of outcomes included in the review, and that interventions should address these in a holistic manner. Mental health was felt to be a very high priority, alongside sexual risk behaviours and drug and alcohol use. It was noted that the context of post-COVID-19 pandemic service delivery will be especially supportive of e-health interventions as much delivery of services has moved online and people have become more comfortable and engaged with these approaches. Two stakeholders (one from clinical services and one from the voluntary sector) felt that a longer follow-up time in any future evaluation would be most useful to inform decision-making. Three stakeholders (one from clinical services and two from the voluntary sector) stressed that co-design with intended beneficiaries would be important for developing relevant, accessible interventions.

If evaluation were to be through a randomised trial, all stakeholders felt that this should compare two interventions with each other, rather than have a no-treatment control group, or consider another design where all receive the intervention. None would feel comfortable in directing individuals to a RCT with a control arm involving no treatment when an individual needed support. It was noted that this approach would be considered unethical. Given the variation in usual treatment available locally because of the UK commissioning system, stakeholders in general felt that it was better to compare interventions with one another. It was also felt that any further trial should include a large sample size and an evaluation of cost-effectiveness, which would include the set-up, as well as the running, costs of e-health interventions.

Views on dissemination

The results were felt to be of perhaps limited utility to the wider voluntary sector. The type of evidence included (RCTs) was seen to be important, but not necessarily where organisations look when programming. A key benefit of voluntary sector service provision was felt to be that organisations can be nimble in their approaches and can quickly adapt evidence-based interventions and modify them rapidly in response to feedback during implementation and service delivery. The long time frames associated with RCTs (and systematic reviews of them) meant that this evidence often was not immediately useful and that an organisation had moved on to other approaches to behaviour change and other outcomes before trials had reported. For example, voluntary sector provision had moved away from a primary focus on promoting condom use towards more multifaceted interventions focused on biomedical approaches, such as PrEP and treatment as prevention, and on promoting HIV testing.

Chapter 10 Discussion

About this chapter

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Summary of key findings

Typology of intervention approaches

We developed a typology of interventions that categorised those included in the review by the structure of their content delivery, and identified two overarching types of interventions: time-limited or modular, which guided participants sequentially through intervention content from beginning to end, and open-ended, which were not designed as fixed and sequenced bodies of learning that all participants were intended to work through. Within these we identified five core categories. The three time-limited/modular categories comprised computer games and online modular interventions, both interactive and non-interactive. The two open-ended categories comprised interventions with content organised by participant needs, based on assessment, and those with generic content delivered to all participants. There was no clear pattern of particular intervention types addressing one or other of our outcomes, except that both open-ended interventions with content organised by assessment addressed sexual health and substance use and no open-ended interventions addressed mental health.

In our stakeholder consultations, all participants preferred interventions that provided some degree of personalisation and tailoring to the specific needs of individuals, ideally based on a risk assessment and providing content most relevant to their profile and/or needs. Stakeholders felt that this was critical in maintaining engagement with a diverse group of MSM who could benefit from these approaches. Interventions that were interactive and provided feedback mechanisms were favoured for increasing engagement and a sense of personal connection. Computer game approaches were seen by most stakeholders as patronising and unsuitable, except if these were specifically targeting young MSM or were exceptionally well designed. There was significant concern that these interventions would alienate much of their target population.

Theory of change synthesis

For this review, we synthesised the theories of change underpinning e-health interventions targeting sexual health outcomes, substance use and mental ill health among MSM. We developed a novel approach to doing so by using diagrams, rather than narrative themes, to summarise theories of change within and across interventions.

Although we have previously conducted reviews synthesising intervention theories of change using line-by-line coding of descriptive text,^{77,78} we found that this approach did not readily capture the often precisely described and complex inter-relationships between theoretical constructs presented in the body of literature for this review. Theories of change included in our past reviews, which addressed the integration of health and academic education⁷⁸ and positive youth development interventions,⁷⁷ were relatively simple and were either not significantly informed by existing scientific theories⁷⁸ or informed by theories that are not typically portrayed visually.⁷⁷ In contrast, theories of change underpinning the e-health interventions included in this review were more complex, more explicitly theorised and largely drew on existing scientific theories that are typically conceptualised in terms of diagrams indicating relationships between theoretical constructs, with constructs widely recognised and understood and therefore not always discussed at length. We found that, although thematic analysis is a good way of rendering explicit what is implicit, it is less appropriate when the literature itself is more explicit. We therefore developed a novel method of theory synthesis in which we created diagrammatic summative logic models of intervention theories of change. By inductively grouping these models according to their core constructs and using meta-ethnographic approaches, we identified three emergent theoretical approaches underpinning the included interventions and we created synthesised models of each approach. We have thus synthesised theories of change underlying interventions with similar approaches. These summarise and integrate existing theories of change rather than providing a novel overarching theory of change for such interventions.

Social cognitive theory and the IMB model featured most prominently in intervention theories of change, informing a small majority. Although reports cited a number of other existing scientific theories, each informed only a few interventions at most. In the 'cognitive/skills' synthesised theory of change, based on theory of change descriptions assessed as ranging from low to high quality, information and exercises were theorised to influence behavioural skills directly and via various cognitive factors relating to motivation/intention and self-efficacy/perceived control. All interventions represented in the 'cognitive/skills' grouping of theories of change targeted sexual health outcomes, either alone or in combination with substance use or both substance use and mental health. The synthesised theory of change also suggests that particular strategies can boost intervention impact, whereas other factors relating to the participant or (for sexual health interventions) to their type of partner (e.g. casual encounter, romantic interest or friend with benefits) moderate impact. In our consultations, this theory of change grouping resonated most strongly with stakeholders and was considered to be the best reflection of how face-to-face interventions with MSM are currently conceptualised in the UK.

Although represented in fewer interventions, two other distinct theory of change groupings emerged. The 'self-monitoring' grouping, based on theory of change descriptions assessed as being of low and high quality, focused more narrowly on the role of self-monitoring in triggering reflection, self-reward/critique and behavioural self-regulation. Interventions in the self-monitoring group of theories of change addressed all three domains of health outcomes for this review. Theory reports suggested that this synthesised diagram represents the basic components of more complex cognitive pathways¹¹⁹ and can sit alongside other distinct mechanisms of behaviour change in intervention theories of change.¹¹⁵ Underpinning interventions focused solely on mental health and based on theory of change descriptions assessed as being of medium quality, the 'cognitive therapy' grouping is rooted in cognitive therapy techniques, which can be augmented by mindfulness. In this approach, activities promoted awareness and recognition of a participant's thoughts, feelings and situations and, via either challenging or accepting negative cognitions, aimed to reframe negative emotions to improve mental health.

In our stakeholder consultations, the ‘cognitive therapy’ theory of change was felt to be useful in interventions specifically targeting mental health, but less useful for interventions addressing sexual health and substance use.

Intervention theories of change included in this review were informed by scientific theories that have been associated with greater impacts in reviews of e-health interventions specifically, including the transtheoretical model^{45,142} and the theory of planned behaviour,¹⁴² although these approaches underpinned a minority of interventions. Several also featured modelling and self-monitoring, and behaviour change techniques,¹⁴³ which some evidence suggests might be effective in e-health interventions.^{142,144}

As is common with e-health behavioural interventions,^{55,142} the theories of change underpinning interventions in this review tended to rely on individually focused psychological theories of behaviour or behaviour change. Although these are unlikely to address structural factors contributing to the syndemic among MSM such as marginalisation, homophobia and discrimination,^{22,145} the accessibility and anonymity of e-health interventions offer one approach to reducing barriers to service access stemming from stigma and discrimination¹⁴⁶ and might form an important element of a broader mix of interventions addressing individual and structural factors.

Furthermore, we found that included interventions drawing on multiple theoretical approaches^{96,97,101,108,111,131} took into account sexual minority-related stressors. One accounted for such stressors as a theorised moderator of intervention impact,⁹⁷ whereas others aimed to increase connectedness to the LGBT community^{111,131} and reduce internalised homophobia^{96,108,111,131} and associated shame¹⁰¹ to reduce sexual risk^{101,111,131} and improve mental health.^{96,108} However, theory reports included little discussion of the relationships between these constructs, limiting our ability to explicate their roles in the synthesised theories of change.

It was notable that some existing scientific theories that informed theories of change were theories of behaviour change (e.g. CBT theory) whereas others were theories of behaviour and its determinants (e.g. the health belief model). Authors generally did not report drawing on scientific theories oriented more explicitly towards selecting strategies for enacting behaviour change, such as the behaviour change wheel¹⁴⁷ or the elaboration likelihood model.¹⁴⁸ Intervention developers might usefully draw on such models.

Our theory synthesis aimed to develop overarching theories of change for different subtypes of e-health interventions to address sexual health outcomes, substance use and mental ill health among MSM, which we hope will help inform future intervention studies. Intervention developers might also draw on existing scientific theories that aim to integrate existing scientific theories of behaviour and behaviour change, such as plans–responses–impulses–motives–evaluation (PRIME) and capability, opportunity, motivation and behaviour models.^{147,149} Because we found that similar theories of change could underpin interventions addressing the different outcomes constituting the ‘syndemic’ affecting MSM, this provides some confidence that interventions can be theorised and developed that aim to address these interventions in combination.

Intervention, participant and contextual characteristics affecting intervention receipt

One-third of reports included in the overall review reported process evaluation data. All but one process evaluation took place in the USA. 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.^{119,123} Some interventions employed personal tailoring, an approach that has been associated with effective e-health behaviour change interventions.^{45,144}

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.^{150–153} There was some suggestion that slower internet speed could reduce acceptability of a multimedia intervention among rural MSM in the USA, who are less likely than non-rural residents to have high-speed internet at home.¹⁵⁴ We did not find evidence that the factors that process evaluations identified as affecting acceptability varied by intervention type or by outcomes addressed.

In terms of intervention characteristics, as with e-health interventions among general populations,¹⁵³ 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. In line with these findings, stakeholder consultations suggested that well-designed interventions with minimal technical problems were critical to the success of e-health interventions for MSM. There was a strong feeling among stakeholders that even minimal technical issues would have a profound impact on intervention engagement and effectiveness.

Privacy also emerged as an important aspect of acceptability in our review, suggesting that, with respect to e-health interventions addressing sexual health, detailed partner-level questions on sexual behaviour could feel intrusive and that features protecting app access and obscuring the manifest purpose of apps (for sensitive health domains) promote acceptability. The importance of privacy is also supported by existing evidence on behaviour change interventions for MSM¹⁵⁵ and general populations.¹⁵³

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 increase loading times for users with slower internet connectivity. Although modular approaches could support users to absorb programme content cumulatively, interventions that were too long detracted from acceptability and some users preferred that little or no time be required between sessions. The ideal number and duration of modules are likely to 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 studies of e-health behavioural interventions for other populations.^{144,152,156} Participants valued interventions that 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.^{56,157} When interventions targeted sexual minority groups more broadly, some participants 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'¹²² and sex-positive language. A candid tone and sex positivity were also highlighted in stakeholder consultations as important in engaging a diverse group of MSM, and matching intervention language to colloquial language used by MSM was felt to be essential. Stakeholders highlighted involvement of potential users in setting the tone and direction of these interventions as an important component of formative development.

Findings from our review 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,¹⁰⁷ suggests that this is an important area to explore during the pilot phase of intervention development.

As with studies of e-health interventions for general populations,^{150,153} 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.

Although reviews of e-health interventions for general populations report higher use and engagement among participants with higher levels of education,^{150,152,153} our findings suggest that in the context of a generally high use of electronic devices among MSM,⁴⁷ 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.¹³⁰ Similarly, findings on the greater acceptability of the Keep it Up! intervention among black, Latino and other non-white users, compared with white users, suggest that e-health interventions can be developed to enhance inclusive acceptability among racially and ethnically diverse users.¹³⁰ There was otherwise little evidence of engagement varying by sociodemographic factors, although findings on SES were mixed^{96,121} and Madkins *et al.*¹³⁰ found that overall, and among white Keep it Up! users, those with lower levels of education reported higher intervention acceptability. Qualitative data suggest that e-health interventions can play a role in complementing external mental health support among MSM^{107,119} and that interventions targeting all adolescents might struggle to pitch content appropriately across this age range.¹⁰⁷

Outcome data synthesis

Our systematic review of intervention effectiveness included 14 trials, of which 13 included active versus control comparisons. Trials included substance use, HIV, STIs and sexual risk behaviour outcomes, but not mental health outcomes. Substance use outcomes did not include alcohol use. Furthermore, all outcome estimates drew from ≤ 12 months of follow-up post intervention. A further two trials^{99,102} presented active versus active comparisons. Neither trial found a difference between tested interventions on sexual risk outcomes, and thus are not discussed further. The evaluation of the China-Gate HIV Prevention Program found a small but significant increase in benefits among participants with the least education, compared with those with university education or above;¹²⁴ this is notable in the light of the process evaluation of Keep it Up!, which found that users with lower levels of education and white users reported higher intervention acceptability overall (but not non-white users).¹³⁰ However, equity-relevant characteristics, for example moderation of intervention effectiveness by income, ethnicity and other social variables, were not meaningfully addressed by this body of evidence.

In active versus control comparisons, analysis for HIV infection drew on two studies, one with a short-term follow-up¹²⁵ and one with a mid-term follow-up.¹¹³ Neither study suggested that an e-health intervention was effective at reducing infections, although short follow-up times and low event rates precluded meaningful comparison. The GRADE profile suggested that the certainty of these findings was low or very low. Analyses for STIs were similarly scant, drawing on two trials in the short term^{110,125} and one trial in the mid-term¹¹³ follow-up. Although a pooled analysis of short-term follow-ups suggested no impact of interventions on incident STIs with very low precision,^{110,125} the one trial informing the mid-term follow-up¹¹³ did suggest a meaningful and statistically significant reduction in incident STIs, with corresponding moderate certainty.

The largest analyses assessed sexual risk behaviour outcomes. Although the GRADE profile suggested that the certainty of conclusions was very low or low, primarily because of risk of bias in the included trials and possible publication bias, pooled estimates from mid-term follow-ups drawing on six trials suggested a small and statistically significant impact of e-health interventions in reducing sexual risk behaviour ($d = -0.12$). A pooled estimate from short-term follow-ups drawing on eight trials did not reach statistical significance, but suggested a trend towards reductions in sexual risk behaviour of similar magnitude ($d = -0.14$). These findings are in line with those from a 2019 review⁵⁵ which concluded that e-health interventions targeting HIV/STI prevention among MSM could affect behaviours in the near term, but found few studies assessing change at 12 months, only one of which demonstrated a significant effect at that time point. We tested whether or not interactivity of interventions related to intervention effectiveness on sexual risk behaviours; however, a meta-regression did not suggest significant differences between interventions on the basis of this characteristic.

Findings for drug use drew on two studies with short-term follow-ups,^{115,125} which could not be meta-analysed because of extreme heterogeneity, and one study with mid-term follow-up.¹¹⁵ Together these studies did not present consistent evidence of effectiveness, with only one of these studies¹²⁵ reporting evidence of a short-term impact from the Safe Behaviour and Screening open-ended intervention with general content on reduced recreational drug use. Furthermore, the GRADE profile for both analyses suggested that the certainty of the evidence was very low.

We found only two studies that examined the effects of e-health interventions on outcomes that spanned sexual health and drug use, with Reback *et al.*¹¹⁵ reporting no effects on sexual risk behaviour, but effects on one measure of drug use, and Chiou *et al.*¹²⁵ reporting effects on measures of sexual risk behaviour and drug use, but not HIV infections or STIs. This lack of evidence for the effects of interventions that address more than one of the outcomes constituting the syndemic affecting MSM means that further trials will be required of interventions addressing such outcomes.

Economic evaluation synthesis

Our search identified only one economic evaluation eligible for inclusion in this review.¹³² This study suggested that the intervention may have been cost-effective in reducing episodes of CAI, but this finding was undermined by the lack of probabilistic sensitivity analyses examining the large degree of uncertainty around these results.

Deviations from the protocol

Appendix 4 summarises deviations from the protocol, most of which were minor, and the rationale for each. Deviations in the search included minor changes to the databases searched and the way in which search results were electronically managed. At the request of the funder, we conducted an updated search in April 2020, which was not included in the original protocol. Deviations in the theory synthesis included using a diagrammatic approach rather than line-by-line coding of descriptive text and, following on from this change, presenting an example of our approach to theory synthesis in the form of individual and overarching theory of change diagrams, rather than tables showing first-, second- and third-order constructs. Deviations in the outcome evaluation synthesis included (in addition to pooling outcomes by follow-up time in the meta-analysis, as initially planned) pooling outcomes across follow-up times, when appropriate, and narratively presenting findings by intervention type then follow-up time, rather than follow-up time then intervention type. In addition, stakeholder consultations were held as individual interviews rather than group discussions.

Limitations

Search and study selection

The original review searches involved multiple sources and methods, and aimed to maximise sensitivity. However, the updated searches were necessarily narrower because of the limits imposed by the COVID-19 pandemic. However, the sources that yielded all of the included study reports found as a result of the original electronic searches were included in the updated searches, so we think it unlikely that any studies were missed because of this reduced scope.

Typology of intervention approaches

We took an inductive approach to developing the typology of included interventions, which we grouped according to the structure of content delivery. Grouping based on other characteristics, such as delivery platform (e.g. SMS, mobile app), might be equally valid, and other reviewers might have developed a different typology of interventions. Categorising interventions based on behaviour change approaches such as the level of tailoring¹⁴⁴ or interactivity or the use of modelling¹⁴³ could also be useful approaches, but this was not possible because of inconsistent levels of detail available for different interventions.

Theory of change synthesis

Our synthesis was limited by the quality of the existing theory reports, which sometimes did not describe clear pathways from intervention activities to intended outcomes. In some cases, reviewers inferred relationships between theory of change constructs (which are made clear in our theory of change diagrams) and, in others, the relationships between specific activities, mediators and outcomes could not be determined. Although our approach to theory synthesis enabled us to systematically explore constructs and the relationships between them across intervention theories of change, synthesised diagrams do not capture aspects that theory reports suggest influenced theories of change when their role was not clear enough to be included in intervention-specific diagrams.

Our assessment of reported theories of change did not include assessment of the parsimony of theories of change, because we have found in past reviews that this is very difficult to consistently operationalise as a criterion of quality assessment; however, this is an important feature of theories of change. We also did not aim to systematically assess the evidence base for each of the scientific theories underpinning the intervention theories of change, because this was outside the scope of this review and would require assessing not only the evidence for the scientific theory, but also the evidence for the application of that theory to the outcomes targeted in the intervention theories of change it underpins.

Process evaluation synthesis

Our process evaluation synthesis was limited by the size and quality of eligible reports. Most were assessed as being of 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.

Although the vast majority of interventions targeted MSM only and all were evaluated principally among MSM, three were assessed among samples that also included cisgender women.^{107,108,111,119} Author narratives and quantitative data did not always disaggregate MSM from other participants, raising the possibility that specific findings from these three studies might reflect data from other groups. The process evaluation of the smartphone self-monitoring intervention was the sole study contributing to findings on intervention benefits of self-monitoring and self-expression.¹¹⁹ Although the intervention targeted people of all genders and sexual identities living with HIV, > 80% of study participants identified as male and > 80% identified as gay or bisexual.¹¹⁹ In two studies, just under half of participants identified as female,^{107,108,111} 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.

Outcome data synthesis

The meta-analysis drew on evidence of variable quality, with limited scope for meta-analyses. We were unable to account for heterogeneity between studies where this was present because of either scarcity of evidence or limitations of our evidence base. We were unable to undertake NMA, and most meta-analyses had too few studies to make meta-regression (e.g. comparing intervention type on outcomes) meaningful. In our analysis of sexual risk outcomes, which was the one model for which we were able to undertake meta-regression, we were unable to explain heterogeneity. Meta-regressions by outcome type to determine differential effectiveness on outcomes within sexual risk would have been uninterpretable because of the statistical methods used for meta-analysis, and because of multiple studies reporting outcomes across several domains. Probable publication and selective reporting biases across studies meant that several estimates of intervention effectiveness from included studies could not be included in our meta-analyses; in at least one case, outcomes stated in a trial protocol were not published in the main trial report. Finally, we were unable to locate evidence for some scoped outcomes.

Economic evaluation synthesis

The synthesis of economic evaluations was limited to one study¹³² eligible for inclusion in this review, which provided only limited information because of the uncertainty of its estimates.

Conclusion

Implications for research

Prior to this review, evidence suggested that e-health interventions are a feasible and acceptable approach for reaching MSM with targeted health interventions, particularly for men with lower-intensity needs or where access to face-to-face provision is limited.¹⁴⁶ Previous evidence drawn from the general population or populations other than MSM suggests that e-health interventions might be effective in reducing sexual risk behaviour^{43,45} and substance use³⁴ and addressing common causes of mental ill health,³⁵⁻⁴¹ but effectiveness for MSM had not been adequately synthesised.

Our synthesis of theories of change identified three distinct theory of change pathways underpinning existing e-health interventions for MSM targeting sexual health, substance use and mental health outcomes, two of which underpin interventions targeting all three of these outcomes. Our review of theories of change 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 the syndemic of sexual risk, substance use and poor mental health affecting some MSM. The synthesised theories of change are non-exclusive and may be combined to inform development of an e-health intervention holistically addressing this syndemic of multiple, often co-occurring, health issues among MSM. Although the 'cognitive therapy' synthesised theory of change is applicable only to interventions addressing mental health, the 'cognitive/skills' and 'self-monitoring' synthesised theories of change are relevant to all of the outcomes examined in this systematic review. Our synthesised theories of change could be augmented by use of the scientific theories on which they are based to inform a nuanced understanding of these theoretical underpinnings and how they can be most usefully applied in specific interventions. In the case of the 'cognitive/skills' synthesised theory of change, this would probably involve selecting a subset of mediators on which to focus, because a single intervention would not be expected to address the full range of constructs presented in this synthesised theory of change.

The findings suggest that the quality of existing theory reports is low to medium, with limited discussion of the inter-relationships between theoretical constructs and little attention to how mechanisms might vary by context. Improving the quality of theory reports would enable a better understanding of how interventions are intended to work and the evidence supporting this. It would also facilitate evaluations by identifying appropriate mediators and moderators of effects, the use of which could help outcome assessment to identify which components are triggering which mechanisms of change, and to what effect among which of its users.¹⁵⁸ We suggest that intervention developers provide clear theories of change for their interventions, informed by existing scientific theories of behaviour and behaviour change relevant to the approach of the intervention and to the outcomes it seeks to address. Such theories of change can ensure that intervention activities align with their intended outcomes, and can ensure that evaluations are focused on the most appropriate measures of implementation, mediators and outcomes, and consider how mechanisms might vary by context and/or population.

The synthesis of process evaluations suggests that e-health interventions offer a feasible and acceptable approach to promoting the health of MSM, and allow MSM to access health promotion interventions privately, anonymously and at times that they find convenient. This synthesis identified several factors shaping the receipt of e-health interventions by MSM, which applied across interventions addressing substance use, mental ill health and sexual risk. These included ease of use, clear and comprehensive

content, fun and enjoyable content, appropriate language and tone, interaction and personalisation, privacy and lack of intrusiveness, appropriate pacing and structure, content relevant to participants' lives and relevance of intervention goals. Other factors should be considered carefully in designing interventions for MSM, including ensuring that language and tone are affirming of sexual minority identities and that content reflects the reality and experiences of MSM. The findings suggest that e-health interventions are acceptable for MSM across sociodemographic groups, although 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, including ethnicity and level of education, should be explored in future research, and new interventions should be rigorously piloted to refine aspects affecting usability and acceptability.^{55,150}

This review found that participants valued interventions that addressed the reality of their lives and the inter-relationships between the different domains of health, and the consultation with stakeholders found unanimous agreement among clinical and voluntary sector stakeholders that new interventions should holistically address the range of outcomes included in the review. Therefore, the findings suggest that e-health interventions simultaneously addressing sexual health, substance use and mental health might be particularly acceptable. The findings on the factors promoting acceptability of interventions can inform the development of future 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. Those developing e-health interventions for MSM should use co-production and testing processes that ensure that the above factors are addressed and that interventions are acceptable. This approach is supported by findings from stakeholder consultations, which emphasised the importance of co-design for developing interventions that are relevant and accessible to MSM. 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 whenever possible, which would shed further light on factors affecting how they are delivered and received.¹⁵⁸

We were interested in studies of interventions to address outcomes in the different domains of sexual health, substance use and mental health either in combination or separately. Studies addressing the domains in combination would indicate whether or not there is already good evidence for 'holistic' e-health interventions to address this syndemic of interclustered outcomes. Studies addressing them separately would provide some indication of the potential for developing and testing such a holistic intervention, particularly if no such holistic interventions have been evaluated to date. We found no outcome evaluations of holistic interventions addressing all of the outcome domains of interest. We found only two studies that examined the effects of e-health interventions on outcomes that spanned sexual health and drug use, with one¹¹⁵ reporting no effects of an e-health intervention on sexual risk behaviour, but an effect on one measure of drug use, and another¹²⁵ reporting effects on measures of sexual risk behaviour and drug use, but not HIV infections or STIs. We found no evaluations of e-health interventions reporting effects for other combinations of outcome domains.

The quality and quantity of evidence supporting the effectiveness of e-health interventions for most of the outcomes that we set out to analyse was generally low or, in the case of alcohol or mental health outcomes, non-existent. The wide CIs surrounding many effect estimates suggest that many trials involved insufficiently large samples. Even when meta-analyses drew on multiple studies, issues with included trials precluded certainty in the evidence presented. Moreover, despite substantial heterogeneity in meta-analyses for sexual risk behaviour outcomes, we were unable to explain this heterogeneity. Although there was some evidence for intervention effects on sexual behaviours, there was inconsistent evidence regarding effectiveness preventing STIs and drug use, and no evidence for effectiveness preventing HIV infections.

Another key gap in this systematic review related to the inclusion of outcomes that accurately reflect current knowledge about minimising sexual risk. For example, a focus on condom use does not reflect that risk for HIV can be managed through effective biomedical means, such as adherence to HIV treatment for people living with HIV, or PrEP for those who are HIV negative. It is likely that interventions designed in the current context would more explicitly acknowledge biomedical approaches to managing risk.

One of the questions we set out to address in this systematic review was if the existing evidence suggests that our scoped outcomes could coherently, feasibly and effectively be addressed by a single health intervention addressing the syndemic of sexual risk, substance use and poor mental health affecting some MSM. It is clear, based on the meta-analyses presented, that the evidence does not, as yet, suggest that this is the case. This is largely because the majority of interventions were focused on individual, not syndemic, outcomes, as well as because of the patchy effects for outcomes that were assessed. Only two interventions^{115,125} assessed effects on substance use outcomes alongside sexual risk behaviour outcomes; for trials that otherwise reported outcomes over multiple categories, this was between sexual risk behaviour and either HIV or other STIs. No studies reported outcomes for depression or anxiety, despite poor mental health being a key syndemic condition, nor did any studies report outcomes relating to alcohol use, despite this being the most commonly used intoxicant in developed country settings.

Given the lack of evidence for e-health interventions to reduce risk across different outcomes, we cannot currently recommend scale-up of any e-health intervention aiming to address these outcomes synergistically. Given the lack of rigorous evidence for the effects of e-health interventions on certain outcomes (HIV and STIs, substance use and mental health in particular), a priority for future research is rigorously conducted studies of e-health interventions focused on these outcomes. Such studies may focus on a single domain of outcomes (e.g. mental health or alcohol use). However, given the syndemic of inter-related outcomes affecting some MSM, our findings that e-health interventions addressing diverse outcomes are often underpinned by similar theories of change and that several factors shape MSM's receipt of such interventions applied across targeted health outcomes, our view is that it would be legitimate for future studies that focus primarily on one main domain of effects (e.g. alcohol use) to examine secondary outcomes in other domains (e.g. mental health) or to include multiple primary outcomes focused on these different domains. This could provide a more rapid means of identifying the potential for e-health interventions to address these syndemic multiple outcomes. Future trials of e-health interventions should also include several considerations. First, given the complete lack of evidence in this area, trials should consider how to address poor mental health among MSM, with a focus on how determinants of poor mental health among MSM relate to other outcomes considered here (sexual ill health and substance use) and to other antecedents (e.g. stigma). Second, trials should address a range of substance use behaviours that are syndemically linked to other relevant outcomes (mental well-being and sexual health), including alcohol use. Third, trials should involve interventions drawing on common and complementary theories of change to address multiple outcomes, and develop and test intervention content in collaboration with MSM. Fourth, trials should incorporate follow-up long enough, and sample sizes large enough, to detect a meaningful impact on HIV and other STIs, given the time needed to detect meaningful differences in HIV incidence. Fifth, trials should incorporate rigorous process and economic evaluations. Sixth, trials should ensure that interventions are not inequality-generating and that this is examined empirically by involving representative, diverse samples of MSM and examining how any intervention effects are moderated by factors such as gender identity, ethnicity, baseline health status and SES. This is important because interventions may unintentionally exacerbate inequalities between groups as a result of, for example, differential access to mental or sexual health services or substance use services. Seventh, to generate a joined-up, comprehensive e-health intervention that targets multiple outcomes, intervention evaluations should seek to generalise both mechanisms and components that are successfully used to achieve change in one outcome over multiple outcomes. Finally, e-health interventions are, of necessity, individualistic and inaccessible to men with limited internet access, and so should be complemented by other interventions, including community and structural interventions, addressing the broader upstream influences on the health of MSM.

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Rebecca Meiksin (<https://orcid.org/0000-0002-5096-8576>) (Research Fellow in Social Science) managed the study; led data extraction, quality assessment and synthesis of theory and process data; and was involved in data extraction and quality assessment of outcome data.

GJ Melendez-Torres (<https://orcid.org/0000-0002-9823-4790>) (Professor of Clinical and Social Epidemiology) led quantitative analyses, data extraction, quality assessment and synthesis of evidence from outcome evaluations.

Alec Miners (<https://orcid.org/0000-0003-1850-1463>) (Associate Professor in Health Economics) advised on the methods of quality appraisal and synthesis for cost-effectiveness evidence and led these components.

Jane Falconer (<https://orcid.org/0000-0002-7329-0577>) (Professional Services User Support Librarian) planned and implemented the searches, managed and deduplicated the found references and wrote up the results of these.

T Charles Witzel (<https://orcid.org/0000-0003-4262-261X>) (Assistant Professor) advised on the conduct and write-up of the research, in particular leading and contributing to drawing together the findings from each synthesis to determine the value of developing or optimising an e-health study among UK MSM. He also led the conduct and write-up of the PPI components.

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Chris Bonell (<https://orcid.org/0000-0002-6253-6498>) (Professor of Public Health Sociology) was the principal investigator and directed the review, overseeing all stages and components. He was directly involved with other investigators in screening; data extraction; quality assessment; and synthesis of theory, qualitative and economic evaluation evidence. He oversaw searching, as well as the synthesis of statistical evidence.

All authors contributed to the review methods and all contributed to, read and approved the final manuscript.

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Data-sharing statement

All available data underpinning this report can be obtained from the corresponding author.

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Appendix 1 Search string for preliminary search in PubMed

About this appendix

This appendix shows the search string used in a preliminary search used to inform the development of a more sophisticated search strategy. The preliminary search was conducted in PubMed on 29 November 2016 and returned 2110 references.

TABLE 11 Search string for preliminary search

Population	Intervention
MSM	Ehealth
"Men who have sex with men"	E-health
Gay	"E health"
Bisexual	App
Homosexual	Internet
Homosexuality [MeSH]	Online
Transgender	Web
Transexual	Phone
Transmen	"Text message"
Transwomen	"New media"
	"Social media"
	Telemedicine [MeSH]

MeSH, medical subject heading.

Appendix 2 Full search terms and strategies: initial search

About this appendix

This appendix provides full details of all search strings used for bibliographic databases, trials registers and Google, with dates and number of references returned and notes explaining any unusual search techniques or syntax. The EndNote X9 import order is provided, as the deduplication technique keeps the first uploaded copy of the reference by default.

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In all searches, numbers in parentheses at the end of each row show the number of hits retrieved.

OvidSP MEDLINE

Database name	MEDLINE
Database platform	OvidSP
Dates of database coverage	Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to 22 October 2018
Date searched	23 October 2018
Searched by	Jane Falconer
Number of results	4701
EndNote import order	1
Number of results once duplicates removed	4596
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. Homosexuality/ (12,169)
2. Homosexuality, Male/ (13,445)
3. exp "Sexual and Gender Minorities"/ (3131)
4. Bisexuality/ (3695)
5. Transsexualism/ (3421)
6. gender identity/ (17,248)
7. Health Services for Transgender Persons/ (92)
8. exp Sex Reassignment Procedures/ (550)
9. homosexual*.ti,ab. (13,006)
10. gay.ti,ab. (9392)
11. "men who have sex with men".ti,ab. (9288)
12. MSM.ti,ab. (8276)
13. bisexual*.ti,ab. (7793)
14. gbMSM.ti,ab. (42)
15. (transgender* or trans-gender*).ti,ab. (3923)
16. (transsexual* or trans-sexual*).ti,ab. (2333)
17. (transm#n or trans-men or trans-man).ti,ab. (209)
18. (transwom#n or trans-wom#n).ti,ab. (220)
19. (transfemale? or trans female?).ti,ab. (19)
20. trans people.ti,ab. (82)
21. trans person.ti,ab. (3)
22. tgm.ti,ab. (334)
23. tgw.ti,ab. (180)
24. gender identity.ti,ab. (2272)
25. cross gender.ti,ab. (256)
26. sex reassignment.ti,ab. (516)
27. gender reassignment.ti,ab. (270)
28. gender dysphoria.ti,ab. (646)
29. gender transition.ti,ab. (89)
30. queer.ti,ab. (905)
31. sexual-minorit*.ti,ab. (1751)
32. gender-minorit*.ti,ab. (304)
33. LGBT*.ti,ab. (1350)
34. or/1-33 [MSM] (62,357)
35. exp telemedicine/ (23,614)
36. ccbt.ti,ab. (144)
37. (ehealth or e-health or electronic health*).ti,ab. (15,158)
38. (etherap* or e-therap* or electronic therap*).ti,ab. (426)
39. (eportal or e-portal or electronic portal).ti,ab. (1012)
40. telehealth*.ti,ab. (3111)
41. telemed*.ti,ab. (9034)
42. telemonitor*.ti,ab. (1239)
43. telepsych*.ti,ab. (514)
44. teletherap*.ti,ab. (1309)
45. icbt.ti,ab. (539)
46. (mhealth or m-health).ti,ab. (2109)
47. or/35-46 [GENERAL E-HEALTH] (45,055)
48. cell phone/ (7494)
49. wireless technology/ (2864)
50. exp microcomputers/ (19,620)
51. cellphone.ti,ab. (178)
52. computer*.ti,ab. (277,170)
53. (ipad or i-pad).ti,ab. (1036)
54. (iphone or i-phone).ti,ab. (634)

55. (ipod or i-pod).ti,ab. (287)
56. mobile*.ti,ab. (84,502)
57. phone*.ti,ab. (30,951)
58. smartphone.ti,ab. (5396)
59. technolog*.ti,ab. (394,411)
60. telephon*.ti,ab. (54,456)
61. wifi.ti,ab. (281)
62. wireless.ti,ab. (11,091)
63. or/48-62 [HARDWARE] (817,195)
64. electronic mail/ (2459)
65. text messaging/ (2040)
66. exp videoconferencing/ (1572)
67. exp internet/ (70,489)
68. mobile applications/ (3439)
69. virtual reality/ (502)
70. android.ti,ab. (1874)
71. (app or apps).ti,ab. (22,044)
72. blog*.ti,ab. (1537)
73. cyber*.ti,ab. (5586)
74. (email* or e-mail*).ti,ab. (13,513)
75. facebook.ti,ab. (2501)
76. instagram.ti,ab. (215)
77. instant messag*.ti,ab. (247)
78. internet*.ti,ab. (43,734)
79. media-based.ti,ab. (796)
80. media-deliver*.ti,ab. (51)
81. messag* service?.ti,ab. (1044)
82. (multimedia or multi-media).ti,ab. (4808)
83. new-media.ti,ab. (621)
84. (online* or on-line*).ti,ab. (114,701)
85. podcast*.ti,ab. (618)
86. reddit.ti,ab. (56)
87. social network* site*.ti,ab. (944)
88. sms.ti,ab. (4906)
89. snapchat.ti,ab. (31)
90. social-medi*.ti,ab. (9271)
91. software.ti,ab. (138,893)
92. telecomm*.ti,ab. (3877)
93. text-messag*.ti,ab. (3005)
94. texting.ti,ab. (667)
95. twitter.ti,ab. (2077)
96. video-based.ti,ab. (1897)
97. virtual*.ti,ab. (113,968)
98. vlog*.ti,ab. (29)
99. web*.ti,ab. (125,844)
100. www.ti,ab. (1454)
101. youtube.ti,ab. (1273)
102. or/64-101 [SOFTWARE OR MEDIA] (565,472)
103. "Cell Phone Use"/ (56)
104. 47 or 63 or 102 or 103 [ALL EHEALTH] (1,310,855)
105. 34 and 104 [MSM AND EHEALTH] (5016)
106. limit 105 to yr = "1995 -Current" (4709)
107. remove duplicates from 106 (4701).

OvidSP EMBASE

Database name	EMBASE
Database platform	OvidSP
Dates of database coverage	1980 to 2018 Week 43
Date searched	23 October 2018
Searched by	Jane Falconer
Number of results	5995
EndNote import order	2
Number of results once duplicates removed	2289
Search strategy notes	<p>Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard</p> <p>The remove duplicates function is available only for sets smaller than 6000 results. Thus the search is split into two by publication year, deduplicated, then recombined</p>

1. homosexuality/ (19,219)
2. male homosexuality/ (2517)
3. men who have sex with men/ (7328)
4. "sexual and gender minority"/ (615)
5. bisexuality/ (5368)
6. bisexual male/ (931)
7. "men who have sex with men and women"/ (137)
8. lgbt people/ (548)
9. exp transgender/ (3497)
10. exp gender dysphoria/ (4375)
11. exp gender identity/ (14,861)
12. sex reassignment/ (861)
13. sex transformation/ (1777)
14. homosexual*.ti,ab. (12,953)
15. gay.ti,ab. (9984)
16. "men who have sex with men".ti,ab. (11,527)
17. MSM.ti,ab. (11,841)
18. bisexual*.ti,ab. (8136)
19. gbMSM.ti,ab. (38)
20. (transgender* or trans-gender*).ti,ab. (4793)
21. (transsexual* or trans-sexual*).ti,ab. (2709)
22. (transm#n or trans-men or trans-man).ti,ab. (212)
23. (transwom#n or trans-wom#n).ti,ab. (299)
24. (transfemale? or trans female?).ti,ab. (31)
25. trans people.ti,ab. (116)
26. trans person.ti,ab. (4)
27. tgm.ti,ab. (518)
28. tgw.ti,ab. (205)
29. gender identity.ti,ab. (2844)
30. cross gender.ti,ab. (307)
31. sex reassignment.ti,ab. (732)

32. gender reassignment.ti,ab. (436)
33. gender dysphoria.ti,ab. (911)
34. gender transition.ti,ab. (106)
35. queer.ti,ab. (849)
36. sexual-minorit*.ti,ab. (1772)
37. gender-minorit*.ti,ab. (301)
38. LGBT*.ti,ab. (1514)
39. or/1-38 [MSM] (66,718)
40. telemedicine/ (19,391)
41. telehealth/ (4137)
42. teleconsultation/ (8399)
43. tediagnosis/ (185)
44. telemonitoring/ (2361)
45. telepsychiatry/ (498)
46. telerehabilitation/ (451)
47. teletherapy/ (553)
48. ccbt.ti,ab. (190)
49. (ehealth or e-health or electronic health*).ti,ab. (20,111)
50. (etherap* or e-therap* or electronic therap*).ti,ab. (495)
51. (eportal or e-portal or electronic portal).ti,ab. (1488)
52. telehealth*.ti,ab. (3775)
53. telemed*.ti,ab. (12,026)
54. telemonitor*.ti,ab. (1849)
55. telepsych*.ti,ab. (638)
56. teletherap*.ti,ab. (873)
57. icbt.ti,ab. (738)
58. (mhealth or m-health).ti,ab. (2097)
59. or/40-58 [GENERAL E-HEALTH] (58,989)
60. wireless communication/ (4277)
61. exp computer/ (115,875)
62. exp mobile phone/ (20,327)
63. cellphone.ti,ab. (300)
64. computer*.ti,ab. (319,679)
65. (ipad or i-pad).ti,ab. (2095)
66. (iphone or i-phone).ti,ab. (1259)
67. (ipod or i-pod).ti,ab. (509)
68. mobile*.ti,ab. (109,204)
69. phone*.ti,ab. (45,140)
70. smartphone.ti,ab. (7140)
71. technolog*.ti,ab. (512,082)
72. telephon*.ti,ab. (74,258)
73. wifi.ti,ab. (393)
74. wireless.ti,ab. (12,569)
75. or/60-74 [HARDWARE] (1,066,069)
76. e-mail/ (17,382)
77. text messaging/ (3615)
78. videoconferencing/ (3024)
79. blogging/ (243)
80. webcast/ (306)
81. internet/ (99,317)
82. social media/ (12,737)
83. mobile application/ (6807)
84. virtual reality/ (13,570)

85. multimedia/ (3452)
86. android.ti,ab. (2943)
87. (app or apps).ti,ab. (29,207)
88. blog*.ti,ab. (2318)
89. cyber*.ti,ab. (7042)
90. (email* or e-mail*).ti,ab. (26,860)
91. facebook.ti,ab. (3856)
92. instagram.ti,ab. (281)
93. instant messag*.ti,ab. (305)
94. internet*.ti,ab. (58,473)
95. media-based.ti,ab. (885)
96. media-deliver*.ti,ab. (66)
97. messag* service?.ti,ab. (1181)
98. (multimedia or multi-media).ti,ab. (6952)
99. new-media.ti,ab. (760)
100. (online* or on-line*).ti,ab. (156,283)
101. podcast*.ti,ab. (1020)
102. reddit.ti,ab. (65)
103. social network* site*.ti,ab. (1165)
104. sms.ti,ab. (6486)
105. snapchat.ti,ab. (51)
106. social-medi*.ti,ab. (11,103)
107. software.ti,ab. (230,877)
108. telecomm*.ti,ab. (3531)
109. text-messag*.ti,ab. (3872)
110. texting.ti,ab. (881)
111. twitter.ti,ab. (2849)
112. video-based.ti,ab. (2544)
113. virtual*.ti,ab. (132,277)
114. vlog*.ti,ab. (24)
115. web*.ti,ab. (156,968)
116. www.ti,ab. (2602)
117. youtube.ti,ab. (1721)
118. or/76-117 (784,782)
119. "cell phone use"/(192)
120. 59 or 75 or 118 or 119 (1,736,639)
121. 39 and 120 (6294)
122. limit 121 to yr = "1995 - 2000" (194)
123. limit 121 to yr = "2000 - Current" (5959)
124. remove duplicates from 122 (193)
125. remove duplicates from 123 (5853)
126. 124 or 125 (5995).

OvidSP Global Health

Database name	Global Health
Database platform	OvidSP
Dates of database coverage	1910 to 2018 Week 41

Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	1893
EndNote import order	3
Number of results once duplicates removed	302
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexuality/ (9990)
2. homosexual men/ (626)
3. men who have sex with men/ (4048)
4. bisexuality/ (1459)
5. homosexual*.ti,ab. (5063)
6. gay.ti,ab. (2891)
7. "men who have sex with men".ti,ab. (6433)
8. MSM.ti,ab. (5424)
9. bisexual*.ti,ab. (2975)
10. gbMSM.ti,ab. (16)
11. (transgender* or trans-gender*).ti,ab. (997)
12. (transsexual* or trans-sexual*).ti,ab. (121)
13. (transm#n or trans-men or trans-man).ti,ab. (13)
14. (transwom#n or trans-wom#n).ti,ab. (46)
15. (transfemale? or trans female?).ti,ab. (8)
16. trans people.ti,ab. (19)
17. trans person.ti,ab. (0)
18. tgm.ti,ab. (70)
19. tgw.ti,ab. (30)
20. gender identity.ti,ab. (228)
21. cross gender.ti,ab. (13)
22. sex reassignment.ti,ab. (16)
23. gender reassignment.ti,ab. (14)
24. gender dysphoria.ti,ab. (26)
25. gender transition.ti,ab. (13)
26. queer.ti,ab. (122)
27. sexual-minorit*.ti,ab. (608)
28. gender-minorit*.ti,ab. (85)
29. LGBT*.ti,ab. (240)
30. or/1-29 [MSM] (16820)
31. telemedicine/ (989)
32. ccbt.ti,ab. (3)
33. (ehealth or e-health or electronic health*).ti,ab. (1627)
34. (etherap* or e-therap* or electronic therap*).ti,ab. (104)
35. (eportal or e-portal or electronic portal).ti,ab. (5)
36. telehealth*.ti,ab. (297)
37. telemed*.ti,ab. (660)

38. telemonitor*.ti,ab. (42)
39. telepsych*.ti,ab. (36)
40. teletherap*.ti,ab. (19)
41. icbt.ti,ab. (5)
42. (mhealth or m-health).ti,ab. (429)
43. or/31-42 [GENERAL E-HEALTH] (3327)
44. exp computer hardware/ (1594)
45. mobile telephones/ (1917)
46. cellphone.ti,ab. (49)
47. computer*.ti,ab. (19,654)
48. (ipad or i-pad).ti,ab. (97)
49. (iphone or i-phone).ti,ab. (35)
50. (ipod or i-pod).ti,ab. (24)
51. mobile*.ti,ab. (17,268)
52. phone*.ti,ab. (4425)
53. smartphone.ti,ab. (565)
54. technolog*.ti,ab. (64,507)
55. telephon*.ti,ab. (10,965)
56. wifi.ti,ab. (21)
57. wireless.ti,ab. (515)
58. or/44-57 [HARDWARE] (111,543)
59. computer software/ (3864)
60. exp internet/ (7284)
61. social media/ (1071)
62. android.ti,ab. (426)
63. (app or apps).ti,ab. (1458)
64. blog*.ti,ab. (193)
65. cyber*.ti,ab. (376)
66. (email* or e-mail*).ti,ab. (1796)
67. facebook.ti,ab. (429)
68. instagram.ti,ab. (30)
69. instant messag*.ti,ab. (28)
70. internet*.ti,ab. (7794)
71. media-based.ti,ab. (185)
72. media-deliver*.ti,ab. (7)
73. messag* service?.ti,ab. (286)
74. (multimedia or multi-media).ti,ab. (689)
75. new-media.ti,ab. (202)
76. (online* or on-line*).ti,ab. (15,020)
77. podcast*.ti,ab. (34)
78. reddit.ti,ab. (6)
79. social network* site*.ti,ab. (150)
80. sms.ti,ab. (814)
81. snapchat.ti,ab. (4)
82. social-medi*.ti,ab. (1696)
83. software.ti,ab. (23,353)
84. telecomm*.ti,ab. (309)
85. text-messag*.ti,ab. (837)
86. texting.ti,ab. (132)
87. twitter.ti,ab. (277)
88. video-based.ti,ab. (116)
89. virtual*.ti,ab. (11,376)
90. vlog*.ti,ab. (2)

91. web*.ti,ab. (19,092)
92. www.ti,ab. (72)
93. youtube.ti,ab. (119)
94. or/59-93 [SOFTWARE OR MEDIA] (77,865)
95. 43 or 58 or 94 [ALL EHEALTH] (180,720)
96. 30 and 95 [MSM AND EHEALTH] (1962)
97. limit 96 to yr = "1995 -Current" (1894)
98. remove duplicates from 97 (1893).

OvidSP EconLit

Database name	EconLit
Database platform	OvidSP
Dates of database coverage	1886 to 18 October 2018
Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	56
EndNote import order	4
Number of results once duplicates removed	53
Search strategy notes	Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexual*.ti,ab. (137)
2. gay.ti,ab. (374)
3. "men who have sex with men".ti,ab. (13)
4. MSM.ti,ab. (69)
5. bisexual*.ti,ab. (100)
6. gbMSM.ti,ab. (0)
7. (transgender* or trans-gender*).ti,ab. (52)
8. (transsexual* or trans-sexual*).ti,ab. (11)
9. (transm#n or trans-men or trans-man).ti,ab. (1)
10. (transwom#n or trans-wom#n).ti,ab. (1)
11. (transfemale? or trans female?).ti,ab. (0)
12. trans people.ti,ab. (2)
13. trans person.ti,ab. (0)
14. tgm.ti,ab. (3)
15. tgw.ti,ab. (0)
16. gender identity.ti,ab. (84)
17. cross gender.ti,ab. (9)
18. sex reassignment.ti,ab. (1)
19. gender reassignment.ti,ab. (1)
20. gender dysphoria.ti,ab. (0)
21. gender transition.ti,ab. (4)
22. queer.ti,ab. (58)
23. sexual-minorit*.ti,ab. (41)
24. gender-minorit*.ti,ab. (12)

25. LGBT*.ti,ab. (99)
26. or/1-25 [MSM] (776)
27. ccbt.ti,ab. (1)
28. (ehealth or e-health or electronic health*).ti,ab. (80)
29. (etherap* or e-therap* or electronic therap*).ti,ab. (0)
30. (eportal or e-portal or electronic portal).ti,ab. (0)
31. telehealth*.ti,ab. (5)
32. telemed*.ti,ab. (36)
33. telemonitor*.ti,ab. (7)
34. telepsych*.ti,ab. (0)
35. teletherap*.ti,ab. (0)
36. icbt.ti,ab. (2)
37. (mhealth or m-health).ti,ab. (12)
38. cellphone.ti,ab. (15)
39. computer*.ti,ab. (6894)
40. (ipad or i-pad).ti,ab. (9)
41. (iphone or i-phone).ti,ab. (36)
42. (ipod or i-pod).ti,ab. (26)
43. mobile*.ti,ab. (5085)
44. phone*.ti,ab. (1384)
45. smartphone.ti,ab. (120)
46. technolog*.ti,ab. (74,958)
47. telephon*.ti,ab. (2218)
48. wifi.ti,ab. (16)
49. wireless.ti,ab. (591)
50. android.ti,ab. (25)
51. (app or apps).ti,ab. (163)
52. blog*.ti,ab. (197)
53. cyber*.ti,ab. (810)
54. (email* or e-mail*).ti,ab. (470)
55. facebook.ti,ab. (259)
56. instagram.ti,ab. (8)
57. instant messag*.ti,ab. (20)
58. internet*.ti,ab. (7134)
59. media-based.ti,ab. (20)
60. media-deliver*.ti,ab. (2)
61. messag* service?.ti,ab. (26)
62. (multimedia or multi-media).ti,ab. (251)
63. new-media.ti,ab. (196)
64. (online* or on-line*).ti,ab. (6447)
65. podcast*.ti,ab. (16)
66. reddit.ti,ab. (1)
67. social network* site*.ti,ab. (70)
68. sms.ti,ab. (107)
69. snapchat.ti,ab. (0)
70. social-medi*.ti,ab. (673)
71. software.ti,ab. (4961)
72. telecomm*.ti,ab. (5683)
73. text-messag*.ti,ab. (87)
74. texting.ti,ab. (14)
75. twitter.ti,ab. (169)
76. video-based.ti,ab. (4)
77. virtual*.ti,ab. (5044)

78. vlog*.ti,ab. (63)
79. web*.ti,ab. (5465)
80. www.ti,ab. (30)
81. youtube.ti,ab. (48)
82. or/27-81 [ALL EHEALTH] (110,729)
83. 26 and 82 (56)
84. limit 83 to yr = "1995 -Current" (56)
85. remove duplicates from 84 (56).

OvidSP PsycINFO

Database name	PsycINFO
Database platform	OvidSP
Dates of database coverage	1806 to October Week 3 2018
Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	4854
EndNote import order	5
Number of results once duplicates removed	2675
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexuality/ (7362)
2. male homosexuality/ (13,758)
3. same sex marriage/ (548)
4. same sex couples/ (495)
5. bisexuality/ (7295)
6. exp gender identity/ (13,387)
7. same sex intercourse/ (2714)
8. sex change/ (517)
9. exp gender identity disorder/ (3346)
10. homosexual*.ti,ab. (13,293)
11. gay.ti,ab. (18,896)
12. "men who have sex with men".ti,ab. (3975)
13. MSM.ti,ab. (3091)
14. bisexual*.ti,ab. (10,701)
15. gbMSM.ti,ab. (15)
16. (transgender* or trans-gender*).ti,ab. (6114)
17. (transsexual* or trans-sexual*).ti,ab. (2126)
18. (transm#n or trans-men or trans-man).ti,ab. (165)
19. (transwom#n or trans-wom#n).ti,ab. (210)
20. (transfemale? or trans female?).ti,ab. (24)
21. trans people.ti,ab. (173)

22. trans person.ti,ab. (17)
23. tgm.ti,ab. (9)
24. tgw.ti,ab. (24)
25. gender identity.ti,ab. (5000)
26. cross gender.ti,ab. (611)
27. sex reassignment.ti,ab. (463)
28. gender reassignment.ti,ab. (123)
29. gender dysphoria.ti,ab. (637)
30. gender transition.ti,ab. (140)
31. queer.ti,ab. (3667)
32. sexual-minorit*.ti,ab. (3197)
33. gender-minorit*.ti,ab. (428)
34. LGBT*.ti,ab. (3630)
35. or/1-34 [MSM] (49,855)
36. telemedicine/ (4519)
37. computer assisted diagnosis/ (1540)
38. computer assisted therapy/ (964)
39. online therapy/ (2508)
40. ccbt.ti,ab. (156)
41. (ehealth or e-health or electronic health*).ti,ab. (2477)
42. (etherap* or e-therap* or electronic therap*).ti,ab. (171)
43. (eportal or e-portal or electronic portal).ti,ab. (7)
44. telehealth*.ti,ab. (1088)
45. telemed*.ti,ab. (1377)
46. telemonitor*.ti,ab. (148)
47. telepsych*.ti,ab. (523)
48. teletherap*.ti,ab. (55)
49. icbt.ti,ab. (306)
50. (mhealth or m-health).ti,ab. (463)
51. or/36-50 [GENERAL E-HEALTH] (12,131)
52. computers/ (9700)
53. cloud computing/ (174)
54. digital computers/ (1117)
55. microcomputers/ (1243)
56. exp computer peripheral devices/ (1494)
57. exp mobile devices/ (5910)
58. cellphone.ti,ab. (89)
59. computer*.ti,ab. (84,572)
60. (ipad or i-pad).ti,ab. (708)
61. (iphone or i-phone).ti,ab. (246)
62. (ipod or i-pod).ti,ab. (247)
63. mobile*.ti,ab. (13,803)
64. phone*.ti,ab. (24,361)
65. smartphone.ti,ab. (1715)
66. technolog*.ti,ab. (98,179)
67. telephon*.ti,ab. (22,981)
68. wifi.ti,ab. (55)
69. wireless.ti,ab. (1446)
70. or/52-69 [HARDWARE] (221,866)
71. computer applications/ (11,186)
72. exp computer software/ (13,940)
73. exp electronic communication/ (20,152)
74. exp human computer interaction/ (19,643)

75. computer usage/ (599)
76. teleconferencing/ (856)
77. virtual reality/ (7301)
78. android.ti,ab. (348)
79. (app or apps).ti,ab. (5472)
80. blog*.ti,ab. (2910)
81. cyber*.ti,ab. (7311)
82. (email* or e-mail*).ti,ab. (8393)
83. facebook.ti,ab. (4128)
84. instagram.ti,ab. (225)
85. instant messag*.ti,ab. (659)
86. internet*.ti,ab. (34,303)
87. media-based.ti,ab. (414)
88. media-deliver*.ti,ab. (26)
89. messag* service?.ti,ab. (438)
90. (multimedia or multi-media).ti,ab. (4692)
91. new-media.ti,ab. (1936)
92. (online* or on-line*).ti,ab. (72,673)
93. podcast*.ti,ab. (432)
94. reddit.ti,ab. (42)
95. social network* site*.ti,ab. (2540)
96. sms.ti,ab. (1311)
97. snapchat.ti,ab. (51)
98. social-medi*.ti,ab. (8306)
99. software.ti,ab. (22,941)
100. telecomm*.ti,ab. (2165)
101. text-messag*.ti,ab. (1818)
102. texting.ti,ab. (699)
103. twitter.ti,ab. (2047)
104. video-based.ti,ab. (1222)
105. virtual*.ti,ab. (32,030)
106. vlog*.ti,ab. (47)
107. web*.ti,ab. (46,196)
108. www.ti,ab. (414)
109. youtube.ti,ab. (917)
110. or/71-109 [SOFTWARE OR MEDIA] (225,040)
111. 51 or 70 or 110 [ALL EHEALTH] (385,341)
112. 35 and 111 [MSM AND EHEALTH] (4979)
113. limit 112 to yr = "1995 -Current" (4861)
114. remove duplicates from 113 (4854).

OvidSP Social Policy & Practice

Database name	Social Policy & Practice
Database platform	OvidSP
Dates of database coverage	Inception to 24 October 2018
Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	204
EndNote import order	6

Number of results once duplicates removed	100
Search strategy notes	Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexual*.ti,ab. (301)
2. gay.ti,ab. (1832)
3. "men who have sex with men".ti,ab. (94)
4. MSM.ti,ab. (62)
5. bisexual*.ti,ab. (932)
6. gbMSM.ti,ab. (0)
7. (transgender* or trans-gender*).ti,ab. (639)
8. (transsexual* or trans-sexual*).ti,ab. (83)
9. (transm#n or trans-men or trans-man).ti,ab. (4)
10. (transwom#n or trans-wom#n).ti,ab. (3)
11. (transfemale? or trans female?).ti,ab. (0)
12. trans people.ti,ab. (43)
13. trans person.ti,ab. (1)
14. tgm.ti,ab. (0)
15. tgw.ti,ab. (1)
16. gender identity.ti,ab. (211)
17. cross gender.ti,ab. (10)
18. sex reassignment.ti,ab. (8)
19. gender reassignment.ti,ab. (46)
20. gender dysphoria.ti,ab. (35)
21. gender transition.ti,ab. (7)
22. queer.ti,ab. (135)
23. sexual-minorit*.ti,ab. (118)
24. gender-minorit*.ti,ab. (19)
25. LGBT*.ti,ab. (499)
26. or/1-25 [MSM] (2683)
27. ccbt.ti,ab. (26)
28. (ehealth or e-health or electronic health*).ti,ab. (60)
29. (etherap* or e-therap* or electronic therap*).ti,ab. (17)
30. (eportal or e-portal or electronic portal).ti,ab. (0)
31. telehealth*.ti,ab. (178)
32. telemed*.ti,ab. (65)
33. telemonitor*.ti,ab. (4)
34. telepsych*.ti,ab. (9)
35. teletherap*.ti,ab. (0)
36. icbt.ti,ab. (3)
37. (mhealth or m-health).ti,ab. (5)
38. cellphone.ti,ab. (3)
39. computer*.ti,ab. (2129)
40. (ipad or i-pad).ti,ab. (11)
41. (iphone or i-phone).ti,ab. (5)
42. (ipod or i-pod).ti,ab. (10)
43. mobile*.ti,ab. (893)
44. phone*.ti,ab. (640)
45. smartphone.ti,ab. (20)
46. technolog*.ti,ab. (6282)
47. telephon*.ti,ab. (2196)

48. wifi.ti,ab. (3)
49. wireless.ti,ab. (43)
50. android.ti,ab. (6)
51. (app or apps).ti,ab. (86)
52. blog*.ti,ab. (112)
53. cyber*.ti,ab. (424)
54. (email* or e-mail*).ti,ab. (471)
55. facebook.ti,ab. (80)
56. instagram.ti,ab. (8)
57. instant messag*.ti,ab. (11)
58. internet*.ti,ab. (2314)
59. media-based.ti,ab. (16)
60. media-deliver*.ti,ab. (0)
61. messag* service?.ti,ab. (5)
62. (multimedia or multi-media).ti,ab. (168)
63. new-media.ti,ab. (56)
64. (online* or on-line*).ti,ab. (4013)
65. podcast*.ti,ab. (22)
66. reddit.ti,ab. (1)
67. social network* site*.ti,ab. (126)
68. sms.ti,ab. (18)
69. snapchat.ti,ab. (11)
70. social-medi*.ti,ab. (377)
71. software.ti,ab. (510)
72. telecomm*.ti,ab. (271)
73. text-messag*.ti,ab. (62)
74. texting.ti,ab. (23)
75. twitter.ti,ab. (30)
76. video-based.ti,ab. (21)
77. virtual*.ti,ab. (773)
78. vlog*.ti,ab. (0)
79. web*.ti,ab. (3094)
80. www.ti,ab. (18)
81. youtube.ti,ab. (101)
82. or/27-81 [ALL EHEALTH] (18,805)
83. 26 and 82 (209)
84. limit 83 to yr = "1995 -Current" (205)
85. remove duplicates from 84 (204).

OvidSP Health Management Information Consortium

Database name	HMIC
Database platform	OvidSP
Dates of database coverage	1979 to July 2018
Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	90
EndNote import order	7
Number of results once duplicates removed	33

Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard
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1. homosexuality/ (114)
2. homosexual men/ (362)
3. homosexuals/ (239)
4. homosexual relations/ (32)
5. bisexuality/ (28)
6. gender identity/ (5)
7. gender dysphoria/ (3)
8. transgendered people/ (100)
9. transsexualism/ (44)
10. gender reassignment/ (11)
11. homosexual*.ti,ab. (231)
12. gay.ti,ab. (503)
13. "men who have sex with men".ti,ab. (168)
14. MSM.ti,ab. (134)
15. bisexual*.ti,ab. (270)
16. gbMSM.ti,ab. (0)
17. (transgender* or trans-gender*).ti,ab. (101)
18. (transsexual* or trans-sexual*).ti,ab. (12)
19. (transm#n or trans-men or trans-man).ti,ab. (3)
20. (transwom#n or trans-wom#n).ti,ab. (1)
21. (transfemale? or trans female?).ti,ab. (0)
22. trans people.ti,ab. (24)
23. trans person.ti,ab. (1)
24. tgm.ti,ab. (0)
25. tgw.ti,ab. (0)
26. gender identity.ti,ab. (25)
27. cross gender.ti,ab. (5)
28. sex reassignment.ti,ab. (1)
29. gender reassignment.ti,ab. (6)
30. gender dysphoria.ti,ab. (3)
31. gender transition.ti,ab. (0)
32. queer.ti,ab. (8)
33. sexual-minorit*.ti,ab. (23)
34. gender-minorit*.ti,ab. (9)
35. LGBT*.ti,ab. (87)
36. or/1-35 [MSM] (1077)
37. telecare/ (706)
38. telemedicine/ (1289)
39. teletherapy/ (4)
40. computer aided decision making/ (28)
41. computer aided diagnosis/ (14)
42. ccbt.ti,ab. (16)
43. (ehealth or e-health or electronic health*).ti,ab. (693)
44. (etherap* or e-therap* or electronic therap*).ti,ab. (2)
45. (eportal or e-portal or electronic portal).ti,ab. (1)
46. telehealth*.ti,ab. (369)
47. telemed*.ti,ab. (836)
48. telemonitor*.ti,ab. (100)

49. telepsych*.ti,ab. (62)
50. teletherap*.ti,ab. (3)
51. icbt.ti,ab. (10)
52. (mhealth or m-health).ti,ab. (38)
53. or/37-52 [GENERAL E-HEALTH] (2764)
54. exp personal computers/ (368)
55. computers/ (1809)
56. digital computers/ (6)
57. microprocessors/ (20)
58. exp computer hardware/ (126)
59. exp mobile communications systems/ (313)
60. exp wireless technology/ (11)
61. cellphone.ti,ab. (0)
62. computer*.ti,ab. (6270)
63. (ipad or i-pad).ti,ab. (10)
64. (iphone or i-phone).ti,ab. (7)
65. (ipod or i-pod).ti,ab. (5)
66. mobile*.ti,ab. (979)
67. phone*.ti,ab. (600)
68. smartphone.ti,ab. (53)
69. technolog*.ti,ab. (9035)
70. telephon*.ti,ab. (3451)
71. wifi.ti,ab. (3)
72. wireless.ti,ab. (86)
73. or/54-72 [HARDWARE] (19,462)
74. computer applications/ (1098)
75. computer software/ (520)
76. computer programs/ (120)
77. freeware/ (0)
78. malware/ (0)
79. open source software/ (1)
80. shareware/ (0)
81. operating systems/ (5)
82. exp computer networks/ (1678)
83. exp world wide web/ (119)
84. internet/ (1322)
85. internet browsers/ (0)
86. internet websites/ (936)
87. world wide web users/ (3)
88. search engines/ (3)
89. exp email/ (225)
90. broadband/ (2)
91. cyberspace/ (1)
92. exp multi media/ (54)
93. android.ti,ab. (12)
94. (app or apps).ti,ab. (93)
95. blog*.ti,ab. (46)
96. cyber*.ti,ab. (67)
97. (email* or e-mail*).ti,ab. (598)
98. facebook.ti,ab. (42)
99. instagram.ti,ab. (0)
100. instant messag*.ti,ab. (8)
101. internet*.ti,ab. (1914)

102. media-based.ti,ab. (7)
103. media-deliver*.ti,ab. (1)
104. messag* service?.ti,ab. (58)
105. (multimedia or multi-media).ti,ab. (181)
106. new-media.ti,ab. (18)
107. (online* or on-line*).ti,ab. (2049)
108. podcast*.ti,ab. (23)
109. reddit.ti,ab. (1)
110. social network* site*.ti,ab. (23)
111. sms.ti,ab. (102)
112. snapchat.ti,ab. (1)
113. social-medi*.ti,ab. (200)
114. software.ti,ab. (1403)
115. telecomm*.ti,ab. (255)
116. text-messag*.ti,ab. (115)
117. texting.ti,ab. (16)
118. twitter.ti,ab. (44)
119. video-based.ti,ab. (25)
120. virtual*.ti,ab. (856)
121. vlog*.ti,ab. (0)
122. web*.ti,ab. (6325)
123. www.ti,ab. (27)
124. youtube.ti,ab. (14)
125. or/74-124 [SOFTWARE OR MEDIA] (14,072)
126. 53 or 73 or 125 [ALL EHEALTH] (31,171)
127. 36 and 126 [MSM AND EHEALTH] (97)
128. limit 127 to yr = "1995 -Current" (90)
129. remove duplicates from 128 (90).

EBSCO Cumulative Index to Nursing and Allied Health Literature Plus

Database name	CINAHL Plus
Database platform	EBSCO
Dates of database coverage	Inception to 24 October 2018
Date searched	24 October 2018
Searched by	Jane Falconer
Number of results	3061
EndNote import order	8
Number of results once duplicates removed	977
Search strategy notes	Search lines using an MH code are subject heading searches. Subject heading searches ending in a + are exploded. Search lines using a TI code search in the title only. Search lines using an AB code search in the abstract only. * is used for truncation. ? is used for an optional wildcard

S1 MH "Homosexuality" (5124)

S2 MH "Gay Men" (3812)

S3 MH "Gay Persons" (1340)

- S4 MH "Men Who Have Sex With Men" (597)
- S5 MH "Bisexuality" (1176)
- S6 MH "GLBT Persons" (3251)
- S7 MH "Sexual Identity" (224)
- S8 MH "Bisexuals" (898)
- S9 MH "Transgender Persons+" (1899)
- S10 MH "Transsexualism" (885)
- S11 MH "Gender Identity" (4959)
- S12 MH "Gender Dysphoria" (68)
- S13 MH "Sex Reassignment Procedures+" (198)
- S14 (TI homosexual*) OR (AB homosexual*) (1852)
- S15 (TI gay) OR (AB gay) (5928)
- S16 (TI "men who have sex with men") OR (AB "men who have sex with men") (4655)
- S17 (TI MSM) OR (AB MSM) (3078)
- S18 (TI bisexual*) OR (AB bisexual*) (3800)
- S19 (TI gbMSM) OR (AB gbMSM) (19)
- S20 (TI (transgender* OR trans-gender*)) OR (AB (transgender* OR trans-gender*)) (3156)
- S21 (TI (transsexual* OR trans-sexual*)) OR (AB (transsexual* OR trans-sexual*)) (442)
- S22 (TI (transm?n OR trans-men OR trans-man)) OR (AB (transm?n OR trans-men OR trans-man)) (65)
- S23 (TI (transwom?n OR trans-wom?n)) OR (AB (transwom?n OR trans-wom?n)) (117)
- S24 (TI (transfemale? OR trans-female?)) OR (AB (transfemale? OR trans-female?)) (7)
- S25 (TI trans people) OR (AB trans people) (80)
- S26 (TI trans person) OR (AB trans person) (19)
- S27 (TI tgm) OR (AB tgm) (17)
- S28 (TI tgw) OR (AB tgw) (26)
- S29 (TI gender identity) OR (AB gender identity) (1110)
- S30 (TI cross gender) OR (AB cross gender) (65)

APPENDIX 2

- S31 (TI sex reassignment) OR (AB sex reassignment) (116)
- S32 (TI gender reassignment) OR (AB gender reassignment) (67)
- S33 (TI gender dysphoria) OR (AB gender dysphoria) (280)
- S34 (TI gender transition) OR (AB gender transition) (62)
- S35 (TI queer) OR (AB queer) (645)
- S36 (TI sexual-minorit*) OR (AB sexual-minorit*) (1200)
- S37 (TI gender minorit*) OR (AB gender minorit*) (205)
- S38 (TI LGBT*) OR (AB LGBT*) (1464)
- S39 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 (23,994)
- S40 (MH "Telehealth+") (17,151)
- S41 (TI ccbt) OR (AB ccbt) (84)
- S42 (TI (ehealth OR e-health OR electronic health*)) OR (AB (ehealth OR e-health OR electronic health*)) (10,083)
- S43 (TI (etherap* OR e-therap* OR electronic therap*)) OR (AB (etherap* OR e-therap* OR electronic therap*)) (107)
- S44 (TI (eportal OR e-portal OR electronic portal)) OR (AB (eportal OR e-portal OR electronic portal)) (141)
- S45 (TI telehealth*) OR (AB telehealth*) (2650)
- S46 (TI telemed*) OR (AB telemed*) (3907)
- S47 (TI telemonitor*) OR (AB telemonitor*) (622)
- S48 (TI telepsych*) OR (AB telepsych*) (297)
- S49 (TI teletherap*) OR (AB teletherap*) (61)
- S50 (TI icbt) OR (AB icbt) (153)
- S51 (TI (mhealth OR m-health)) OR (AB (mhealth OR m-health)) (1075)
- S52 S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 (28,888)
- S53 MH "Computer Hardware" (1005)

- S54 MH "Computer Peripherals+" (9617)
- S55 MH "Computer Processor+" (84)
- S56 MH "Computer Types+" (7797)
- S57 (MH "Cellular Phone") (1249)
- S58 (MH "Wireless Local Area Networks") (125)
- S59 (TI cellphone) OR (AB cellphone) (139)
- S60 (TI computer*) OR (AB computer*) (49,954)
- S61 (TI (ipad OR i-pad)) OR (AB (ipad OR i-pad)) (740)
- S62 (TI (iphone OR i-phone)) OR (AB (iphone OR i-phone)) (474)
- S63 (TI (ipod OR i-pod)) OR (AB (ipod OR i-pod)) (207)
- S64 (TI mobile*) OR (AB mobile*) (13,962)
- S65 (TI phone*) OR (AB phone*) (12,459)
- S66 (TI smartphone) OR (AB smartphone) (3048)
- S67 (TI technolog*) OR (AB technolog*) (89,946)
- S68 (TI telephon*) OR (AB telephon*) (24,752)
- S69 (TI wifi) OR (AB wifi) (50)
- S70 (TI wireless) OR (AB wireless) (2452)

- S71 S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69 OR S70 (190,715)

- S72 MH "Instant Messaging" (145)
- S73 MH "Internet+" (121,053)
- S74 MH "Text Messaging" (1704)
- S75 MH "Videoconferencing+" (1865)
- S76 MH "Wireless Communications" (9751)
- S77 (MH "Electronic Mail") (0)
- S78 MH "Mobile Applications" (4027)
- S79 MH "Multimedia" (1801)

APPENDIX 2

- S80 MH "Operating Systems" (284)
- S81 MH "Decision Making, Computer Assisted" (1131)
- S82 MH "Diagnosis, Computer Assisted+" (14,848)
- S83 MH "Therapy, Computer Assisted+" (14,289)
- S84 MH "Virtual Reality+" (3396)
- S85 (TI android) OR (AB android) (549)
- S86 (TI (app OR apps)) OR (AB (app or apps)) (5232)
- S87 (TI blog*) OR (AB blog*) (2160)
- S88 (TI cyber*) OR (AB cyber*) (2931)
- S89 (TI (email* OR e-mail*)) OR (AB (email* OR e-mail*)) (7629)
- S90 (TI facebook) OR (AB facebook) (2541)
- S91 (TI instagram) OR (AB instagram) (228)
- S92 (TI instant messag*) OR (AB instant messag*) (173)
- S93 (TI internet*) OR (AB internet*) (23,777)
- S94 (TI media-based) OR (AB media-based) (165)
- S95 (TI media-deliver*) OR (AB media-deliver*) (16)
- S96 (TI messag* service?) OR (AB messag* service?) (63)
- S97 (TI (multimedia or multi-media)) OR (AB (multimedia or multi-media)) (2013)
- S98 (TI new-media) OR (AB new-media) (310)
- S99 (TI (online* OR on-line*)) OR (AB (online* OR on-line*)) (177,965)
- S100 (TI podcast*) OR (AB podcast*) (600)
- S101 (TI reddit) OR (AB reddit) (38)
- S102 (TI social network* site*) OR (AB social network* site*) (741)
- S103 (TI sms) OR (AB sms) (1017)
- S104 (TI snapchat) OR (AB snapchat) (33)
- S105 (TI social-medi*) OR (AB social-medi*) (6142)
- S106 (TI software) OR (AB software) (32,742)

- S107 (TI telecomm*) OR (AB telecomm*) (872)
- S108 (TI text-messag*) OR (AB text-messag*) (1840)
- S109 (TI texting) OR (AB texting) (486)
- S110 (TI twitter) OR (AB twitter) (1716)
- S111 (TI video-based) OR (AB video-based) (709)
- S112 (TI virtual*) OR (AB virtual*) (16,370)
- S113 (TI vlog*) OR (AB vlog*) (22)
- S114 (TI web) OR (AB web) (37,322)
- S115 (TI www) OR (AB www) (257)
- S116 (TI youtube) OR (AB youtube) (597)
- S117 S72 OR S73 OR S74 OR S75 OR S76 OR S78 OR S79 OR S80 OR S81 OR S82 OR S83 OR S84 OR S85 OR S86 OR S87 OR S88 OR S89 OR S90 OR S91 OR S92 OR S93 OR S94 OR S95 OR S96 OR S97 OR S98 OR S99 OR S100 OR S101 OR S102 OR S103 OR S104 OR S105 OR S106 OR S107 OR S108 OR S109 OR S110 OR S111 OR S112 OR S113 OR S114 OR S115 OR S116 (402,899)
- S118 S52 OR S71 OR S117 (557,416)
- S119 S39 AND S118 (3081)
- S120 S119 Limiters - Published Date: 19950101-20181231 (3061)

Web of Science Science Citation Index Expanded

Database name	Science Citation Index Expanded
Database platform	Web of Science
Dates of database coverage	1970–present. Data last updated 24 October 2018
Date searched	25 October 2018
Searched by	Jane Falconer
Number of results	3212
EndNote import order	9
Number of results once duplicates removed	1031
Search strategy notes	* is used for truncation. \$ is used for an optional wildcard

1 TOPIC: (homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale\$ OR “trans-female\$” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) Indexes = SCI-EXPANDED Timespan = 1995-2018 (29,312)

2 TOPIC: (cbt OR ehealth OR “e-health” OR “electronic health*” OR etherap* OR “e-therap*” OR “electronic therap*” OR eportal OR “e-portal” OR “electronic portal” OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR ictb OR mhealth OR “m-health” OR cellphone OR computer* OR ipad OR “i-pad” OR iphone OR “i-phone” OR ipod OR “i-pod” OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR “e-mail” OR facebook OR instagram OR “instant messag*” OR internet* OR “media-based” OR “media-deliver*” OR “messag* service\$” OR multimedia OR “multi-media” OR “new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software or telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube) Indexes = SCI-EXPANDED Timespan = 1995-2018 (2,282,228)

3 #2 AND #1 Indexes = SCI-EXPANDED Timespan = 1995-2018 (3212)

Web of Science Social Sciences Citation Index Expanded

Database name	Social Sciences Citation Index Expanded
Database platform	Web of Science
Dates of database coverage	1970–present. Data last updated 24 October 2018
Date searched	25 October 2018
Searched by	Jane Falconer
Number of results	4365
EndNote import order	10
Number of results once duplicates removed	809
Search strategy notes	* is used for truncation. \$ is used for an optional wildcard

1 TOPIC: (homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale\$ OR “trans-female\$” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) Indexes = SCI-EXPANDED Timespan = 1995-2018 (34,993)

2 TOPIC: (cbt OR ehealth OR “e-health” OR “electronic health*” OR etherap* OR “e-therap*” OR “electronic therap*” OR eportal OR “e-portal” OR “electronic portal” OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR ictb OR mhealth OR “m-health” OR cellphone OR computer* OR ipad OR “i-pad” OR iphone OR “i-phone” OR ipod OR “i-pod” OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR “e-mail” OR facebook OR instagram OR “instant messag*” OR internet* OR “media-based” OR “media-deliver*” OR “messag* service\$” OR multimedia OR “multi-media” OR “new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software or telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube) Indexes = SCI-EXPANDED Timespan = 1995-2018 (482,003)

3 #2 AND #1 Indexes = SCI-EXPANDED Timespan = 1995-2018 (4365)

Scopus

Database name	Scopus
Database platform	Scopus
Dates of database coverage	Inception to 25 October 2018
Date searched	25 October 2018
Searched by	Jane Falconer
Number of results	10,537
EndNote import order	11
Number of results once duplicates removed	3729
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard

TITLE-ABS-KEY (homosexual* OR gay OR "men who have sex with men" OR msm OR bisexual* OR gbmsm OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR lgbt*) AND TITLE-ABS-KEY (cbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) (10,537)

Centre for Reviews and Dissemination databases

Database names	DARE, NHS EED, HTA
Database platform	CRD
Dates of database coverage	DARE and NHS EED: inception to 2015 (no longer updated; stopped in 2015) HTA: inception to 26 October 2018
Date searched	26 October 2018
Searched by	Jane Falconer
Number of results	95
EndNote import order	12
Number of results once duplicates removed	77
Search strategy notes	* is used for truncation

1. MeSH DESCRIPTOR Homosexuality
2. MeSH DESCRIPTOR Homosexuality, Male
3. MeSH DESCRIPTOR "Sexual and Gender Minorities" EXPLODE ALL TREES

4. MeSH DESCRIPTOR Bisexuality
5. MeSH DESCRIPTOR Transsexualism
6. MeSH DESCRIPTOR gender identity
7. MeSH DESCRIPTOR Health Services for Transgender Persons
8. MeSH DESCRIPTOR Sex Reassignment Procedures
9. (homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwoman OR transwomen OR "trans-woman" OR "trans-women" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*)
10. (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9)
11. MeSH DESCRIPTOR telemedicine EXPLODE ALL TREES
12. MeSH DESCRIPTOR cell phone
13. MeSH DESCRIPTOR wireless technology
14. MeSH DESCRIPTOR microcomputers EXPLODE ALL TREES
15. MeSH DESCRIPTOR electronic mail
16. MeSH DESCRIPTOR text messaging
17. MeSH DESCRIPTOR videoconferencing EXPLODE ALL TREES
18. MeSH DESCRIPTOR internet EXPLODE ALL TREES
19. MeSH DESCRIPTOR mobile applications
20. MeSH DESCRIPTOR virtual reality
21. MeSH DESCRIPTOR "cell phone use"
22. (ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service\$" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software or telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)
23. (#11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22
24. (#10 and #23).

The Cochrane Library

Database name	The Cochrane Library
Database platform	Wiley Online Library
Dates of database coverage	Inception to 26 October 2018
Date searched	26 October 2018
Searched by	Jane Falconer
Number of results	378
EndNote import order	13
Number of results once duplicates removed	125
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Searches ending :ti,ab,kw search the title, abstract and keywords

- #1 MeSH descriptor: [Homosexuality] this term only (102)
- #2 MeSH descriptor: [Homosexuality, Male] this term only (293)
- #3 MeSH descriptor: [Sexual and Gender Minorities] explode all trees (39)
- #4 MeSH descriptor: [Bisexuality] this term only (49)
- #5 MeSH descriptor: [Transsexualism] this term only (26)
- #6 MeSH descriptor: [Gender Identity] this term only (228)
- #7 MeSH descriptor: [Health Services for Transgender Persons] this term only (0)
- #8 MeSH descriptor: [Sex Reassignment Procedures] explode all trees (4)
- #9 (homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*):ti,ab,kw (1662)
- #10 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 (1664)
- #11 MeSH descriptor: [Telemedicine] explode all trees (1936)
- #12 MeSH descriptor: [Cell Phone] this term only (586)
- #13 MeSH descriptor: [Wireless Technology] this term only (33)
- #14 MeSH descriptor: [Microcomputers] explode all trees (638)
- #15 MeSH descriptor: [Electronic Mail] this term only (291)
- #16 MeSH descriptor: [Text Messaging] this term only (579)
- #17 MeSH descriptor: [undefined] explode all trees (0)
- #18 MeSH descriptor: [Internet] explode all trees (3360)
- #19 MeSH descriptor: [Mobile Applications] this term only (320)
- #20 MeSH descriptor: [Virtual Reality] this term only (38)
- #21 MeSH descriptor: [Cell Phone Use] this term only (1)
- #22 (cbct OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR

“media-based” OR “media-deliver*” OR “messag* service*” OR multimedia OR “multi-media” OR “new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software or telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube):ti,ab,kw (125,743)

#23 #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 (125,976)

#24 #10 and #23 (378)

ProQuest International Bibliography of the Social Sciences

Database name	IBSS
Database platform	ProQuest
Dates of database coverage	1951–29 October 2018
Date searched	29 October 2018
Searched by	Jane Falconer
Number of results	2503
EndNote import order	14
Number of results once duplicates removed	968
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Searches ending :ti,ab, kw search the title, abstract and keywords

(TI(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale* OR “trans-female*” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) OR AB(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale* OR “trans-female*” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*)) AND (TI(ccbt OR ehealth OR “e-health” OR “electronic health*” OR etherap* OR “e-therap*” OR “electronic therap*” OR eportal OR “e-portal” OR “electronic portal” OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR “m-health” OR cellphone OR computer* OR ipad OR “i-pad” OR iphone OR “i-phone” OR ipod OR “i-pod” OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR “e-mail” OR facebook OR instagram OR “instant messag*” OR internet* OR “media-based” OR “media-deliver*” OR “messag* service*” OR multimedia OR “multi-media” OR “new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software OR telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube) OR AB(ccbt OR ehealth OR “e-health” OR “electronic health*” OR etherap* OR “e-therap*” OR “electronic therap*” OR eportal OR “e-portal” OR “electronic portal” OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR “m-health” OR cellphone OR computer* OR ipad OR “i-pad” OR iphone OR “i-phone” OR ipod OR “i-pod” OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR “e-mail” OR facebook OR instagram OR “instant messag*” OR internet* OR “media-based” OR “media-deliver*” OR “messag* service*” OR multimedia OR “multi-media” OR

“new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software OR telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube)) Limits: date: after 1994 (2503).

Campbell Library

Database name	Campbell Library
Database platform	Campbell Collaboration
Dates of database coverage	Inception to 29 October 2018
Date searched	29 October 2018
Searched by	Jane Falconer
Number of results	0

homosexual OR gay OR men who have sex with men OR MSM OR bisexual OR gbMSM OR transgender OR trans-gender OR transsexual OR trans-sexual OR transman OR transmen OR trans-men OR trans-man OR transwoman OR transwomen OR trans-woman OR trans-women OR transfemale OR trans-female OR trans people OR trans person OR tgm OR tgw OR gender identity OR cross gender OR sex reassignment OR gender reassignment OR gender dysphoria OR gender transition OR queer OR sexual-minorit OR gender-minorit OR LGBT.

ProQuest Dissertations & Theses Global

Database name	Dissertations & Theses Global
Database platform	ProQuest
Dates of database coverage	1951–29 October 2018
Date searched	29 October 2018
Searched by	Jane Falconer
Number of results	2231
EndNote import order	15
Number of results once duplicates removed	1427
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

(TI(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale* OR “trans-female*” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) OR AB(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale* OR “trans-female*” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*)) AND (TI(ccbt OR ehealth

OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) OR AB(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)) Limits: date: after December 31 1994 (2231).

ProQuest Applied Social Sciences Index and Abstracts

Database name	ASSIA
Database platform	ProQuest
Dates of database coverage	1987 to 29 October 2018
Date searched	29 October 2018
Searched by	Jane Falconer
Number of results	1812
EndNote import order	16
Number of results once duplicates removed	142
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

(TI(homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) OR AB(homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*)) AND (TI(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR

iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) OR AB(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) Limits: date: after 1994 (1812).

ProQuest Sociological Abstracts

Database name	Sociological Abstracts
Database platform	ProQuest
Dates of database coverage	1952–29 October 2018
Date searched	29 October 2018
Searched by	Jane Falconer
Number of results	3314
EndNote import order	17
Number of results once duplicates removed	1277
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

(TI(homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) OR AB(homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*)) AND (TI(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR

podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) OR AB(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)) Limits: date: after 1994 (3314).

EPPI-Centre database of health promotion research (Bibliomap)

Database name	Bibliomap
Database platform	EPPI-Centre
Dates of database coverage	Inception to 1 November 2018
Date searched	1 November 2018
Searched by	Jane Falconer
Number of results	7
EndNote import order	18
Number of results once duplicates removed	0
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

1. Characteristics of the study population: homosexual OR bisexual OR transsexual (824)
2. Freetext: homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transman OR transmen OR "trans-men" OR "trans-man" OR transwoman OR transwomen OR "trans-woman" OR "trans-women" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT* (516)
3. 1 OR 2 (881)
4. Freetext: ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube (424)
5. 3 AND 4 (8)

One item not added as published in 1994.

OpenGrey

Database name	OpenGrey
Database platform	OpenGrey
Dates of database coverage	Inception to 1 November 2018
Date searched	1 November 2018
Searched by	Jane Falconer
Number of results	87
EndNote import order	19
Number of results once duplicates removed	50
Search strategy notes	NA
NA, not applicable.	

(homosexual* OR gay OR "men who have sex with men" OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transman OR transmen OR "trans-men" OR "trans-man" OR transwoman OR transwomen OR "trans-woman" OR "trans-women" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) AND (ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)

Only references published after 1994 added.

EPPI-Centre Trials Register of Promoting Health Interventions

Database name	TRoPHI
Database platform	EPPI-Centre
Dates of database coverage	Inception to 1 November 2018
Date searched	1 November 2018
Searched by	Jane Falconer
Number of results	0
EndNote import order	NA
Number of results once duplicates removed	0
Search strategy notes	NA
NA, not applicable.	

The search on this database timed out before the results could be displayed and an error was reported. Therefore no results from this source could be included in the review.

Google

Database name	Google
Database platform	Google
Dates of database coverage	Inception to 21 November 2018
Date searched	21 November 2018
Searched by	Jane Falconer
Number of results	Five results met the inclusion criteria and were manually added to EPPI-Reviewer 4
Search strategy notes	<p>Google searched in incognito mode to remove as much individualisation of results as possible. Google UK filters were switched on. It is not possible to search Google without a geographical filter applied. As Google limits the number of terms that can be used in one search string, the search terms were simplified and multiple searches were run. All search strategies listed below were searched four times, with the following search limits added:</p> <ul style="list-style-type: none"> • Site:.org.* • Site:.org • Site:.gov.* • Site:.gov <p>The first 100 results for each search were examined for their relevance and included if they met the inclusion criteria</p>

- (homosexual OR gay OR “men who have sex with men” OR bisexual OR trans OR LGBT OR LGBTQ) AND (ccbt OR ehealth OR “e-health” OR “electronic health” OR etherapy OR “e-therapy” OR “electronic therapy” OR eportal OR “e-portal” OR “electronic portal” OR telehealth OR telemedicine OR telemonitoring)
- (homosexual OR gay OR “men who have sex with men” OR bisexual OR trans OR LGBT OR LGBTQ) AND (telepsychology OR teletherapy OR icbt OR mhealth OR “m-health” OR cellphone OR computer OR ipad OR “i-pad” OR iphone OR “i-phone” OR ipod OR “i-pod” OR mobile OR smartphone)
- (homosexual OR gay OR “men who have sex with men” OR bisexual OR trans OR LGBT OR LGBTQ) AND (technology OR telephone OR wifi OR wireless OR android OR app OR apps OR blog OR cyber OR email OR “e-mail” OR facebook OR instagram OR “instant message” OR internet OR “media-based”) site:.org.*
- (homosexual OR gay OR “men who have sex with men” OR bisexual OR trans OR LGBT OR LGBTQ) AND (“media-delivery” OR “messaging service” OR multimedia OR “multi-media” OR “new-media” OR online OR “on-line” OR podcast OR reddit OR “social network site” OR sms OR snapchat)
- (homosexual OR gay OR “men who have sex with men” OR bisexual OR trans OR LGBT OR LGBTQ) AND (“social media” OR software OR telecommunication OR “text-message” OR texting OR twitter OR “video-based” OR virtual OR vlog OR web OR www OR youtube).

ClinicalTrials.gov

Database name	ClinicalTrials.gov
Dates of database coverage	Inception to 21 November 2018
Date searched	21 November 2018
Searched by	Jane Falconer
Number of results	685
Search strategy notes	As ClinicalTrials.gov limits the number of terms that can be used in one search string, the search terms were simplified and multiple searches were run. All searches were run in the 'Other terms' search box. As it is not possible to export results to EndNote or EPPI-Reviewer 4, all results were examined for their relevance and manually added to EPPI-Reviewer 4 if they met the inclusion criteria. A total of 58 records were added

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND (ehealth OR "e-health" OR "electronic health" OR etherapy OR "e-therapy" OR "electronic therapy" OR eportal OR "e-portal" OR "electronic portal" OR telehealth) (18)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND (telemedicine OR teletherapy OR "m-health" OR telepsychology OR icbt OR mhealth OR "m-health" OR cellphone OR computer OR ipad OR "i-pad" OR iphone) (84)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("i-phone" OR ipod OR "i-pod" OR mobile OR smartphone OR technology OR telephone OR wifi OR wireless OR android OR app OR apps OR blog OR cyber OR email) (229)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("e-mail" OR facebook OR instagram OR "instant message" OR internet OR "media-based" OR "media-delivery" OR "messaging service" OR multimedia OR "multi-media") (100)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("new-media" OR online OR "on-line" OR podcast OR reddit OR "social network site" OR sms OR snapchat OR "social media" OR software OR telecommunication) (123)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("text-message" OR texting OR twitter OR "video-based" OR virtual OR vlog OR web OR www OR youtube) (131)

World Health Organization International Clinical Trials Registry Platform

Database name	ICTRP
Dates of database coverage	Inception to 26 November 2018
Date searched	26 November 2018
Searched by	Jane Falconer
Number of results	3
Search strategy notes	As ICTRP prioritises AND over OR in search strings, and does not allow parentheses in searches, a number of two-term search strings were used to search this source. As it is not possible to export results to EndNote or EPPI-Reviewer 4, all results were examined for their relevance and manually added to EPPI-Reviewer 4 if they met the inclusion criteria. A total of 58 records were added. The search system automatically includes synonyms in searches, thus only one term was used for concept 1

- homosexual AND ehealth (1) [deduplicated]
- homosexual AND e-health (0)
- homosexual AND electronic health (0)
- homosexual AND etherapy (0)
- homosexual AND e-therapy (7) [none included]
- homosexual AND electronic therapy (0)
- homosexual AND eportal (0)
- homosexual AND e-portal (0)
- homosexual AND electronic portal (0)
- homosexual AND telehealth (1) [deduplicated]
- homosexual AND telemedicine (0)
- homosexual AND teletherapy (0)
- homosexual AND m-health (0)
- homosexual AND telepsychology (0)
- homosexual AND icbt (0)
- homosexual AND mhealth (0)
- homosexual AND cellphone (0)
- homosexual AND computer (0)
- homosexual AND ipad (0)
- homosexual AND i-pad (0)
- homosexual AND iphone (0)
- homosexual AND i-phone (0)
- homosexual AND ipod (0)
- homosexual AND i-pod (0)
- homosexual AND mobile (3) [1 added, 2 deduplicated]
- homosexual AND smartphone (0)
- homosexual AND technology (1) [none included]
- homosexual AND telephone (1) [deduplicated]
- homosexual AND wifi (0)
- homosexual AND wireless (0)
- homosexual AND android (0)
- homosexual AND app (0)
- homosexual AND apps (0)
- homosexual AND blog (0)
- homosexual AND cyber (0)
- homosexual AND email (4) [2 deduplicated, 2 not included]
- homosexual AND facebook (0)
- homosexual AND instagram (0)
- homosexual AND instant message (0)
- homosexual AND internet (2) [1 deduplicated, 1 not included]
- homosexual AND media-based (0)
- homosexual AND media-delivery (0)
- homosexual AND messaging service (0)
- homosexual AND multimedia (0)
- homosexual AND multi-media (0)
- homosexual AND new-media (0)
- homosexual AND online (2) [2 not included]
- homosexual AND on-line (1) [1 not included]
- homosexual AND podcast (0)
- homosexual AND reddit (0)
- homosexual AND social network site (0)
- homosexual AND sms (1) [1 not included]
- homosexual AND snapchat (0)

- homosexual AND social media (0)
- homosexual AND software (1) [1 added]
- homosexual AND telecommunication (0)
- homosexual AND text message (0)
- homosexual AND texting (0)
- homosexual AND twitter (0)
- homosexual AND video-based (0)
- homosexual AND virtual (0)
- homosexual AND vlog (0)
- homosexual AND web (5) [1 added, 3 deduplicated, 1 not included]
- homosexual AND www (2) [1 deduplicated, 1 not included]
- homosexual AND youtube (0)

Appendix 3 Full search terms and strategies: 2020 search update

About this appendix

This appendix provides full details of all search strings used for the 2020 update to searches on bibliographic databases and trials registers. It includes dates and number of references returned and notes explaining any unusual search techniques or syntax. The EndNote X9 import order is provided, as the deduplication technique keeps the first uploaded copy of the reference by default. Papers retrieved by the 2018 searches were removed so only items retrieved in the update were screened.

In all searches, numbers in parentheses at the end of each row show the number of hits retrieved.

OvidSP MEDLINE

Database name	MEDLINE ALL
Database platform	OvidSP
Dates of database coverage	1946 to 21 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	5896
EndNote import order	1
Number of results once duplicates and 2018 results removed	1279
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. Homosexuality/ (12,287)
2. Homosexuality, Male/ (15,383)
3. exp "Sexual and Gender Minorities"/ (5789)
4. Bisexuality/ (4060)
5. Transsexualism/ (3710)
6. gender identity/ (18,259)
7. Health Services for Transgender Persons/ (131)
8. exp Sex Reassignment Procedures/ (792)
9. homosexual*.ti,ab. (13,329)
10. gay.ti,ab. (10,707)
11. "men who have sex with men".ti,ab. (11,064)
12. MSM.ti,ab. (9848)
13. bisexual*.ti,ab. (8994)
14. gbMSM.ti,ab. (88)
15. (transgender* or trans-gender*).ti,ab. (5672)
16. (transsexual* or trans-sexual*).ti,ab. (2407)

17. (transm#n or trans-men or trans-man).ti,ab. (315)
18. (transwom#n or trans-wom#n).ti,ab. (368)
19. (transfemale? or trans female?).ti,ab. (25)
20. trans people.ti,ab. (126)
21. trans person.ti,ab. (3)
22. tgm.ti,ab. (367)
23. tgw.ti,ab. (253)
24. gender identity.ti,ab. (2792)
25. cross gender.ti,ab. (271)
26. sex reassignment.ti,ab. (549)
27. gender reassignment.ti,ab. (296)
28. gender dysphoria.ti,ab. (891)
29. gender transition.ti,ab. (127)
30. queer.ti,ab. (1201)
31. sexual-minorit*.ti,ab. (2361)
32. gender-minorit*.ti,ab. (594)
33. LGBT*.ti,ab. (1898)
34. or/1-33 [MSM] (69,287)
35. exp telemedicine/ (27,624)
36. ccbt.ti,ab. (164)
37. (ehealth or e-health or electronic health*).ti,ab. (20,001)
38. (etherap* or e-therap* or electronic therap*).ti,ab. (456)
39. (eportal or e-portal or electronic portal).ti,ab. (1076)
40. telehealth*.ti,ab. (3862)
41. telemed*.ti,ab. (10,329)
42. telemonitor*.ti,ab. (1451)
43. telepsych*.ti,ab. (600)
44. teletherap*.ti,ab. (1336)
45. icbt.ti,ab. (685)
46. (mhealth or m-health).ti,ab. (3186)
47. or/35-46 [GENERAL E-HEALTH] (55,063)
48. cell phone/ (8375)
49. wireless technology/ (3445)
50. exp microcomputers/ (21,777)
51. cellphone.ti,ab. (245)
52. computer*.ti,ab. (294,506)
53. (ipad or i-pad).ti,ab. (1243)
54. (iphone or i-phone).ti,ab. (794)
55. (ipod or i-pod).ti,ab. (317)
56. mobile*.ti,ab. (95,991)
57. phone*.ti,ab. (35,689)
58. smartphone.ti,ab. (8461)
59. technolog*.ti,ab. (456,495)
60. telephon*.ti,ab. (59,103)
61. wifi.ti,ab. (386)
62. wireless.ti,ab. (13,546)
63. or/48-62 [HARDWARE] (914,078)
64. electronic mail/ (2656)
65. text messaging/ (2755)
66. exp videoconferencing/ (1781)
67. exp internet/ (77,890)
68. mobile applications/ (5545)
69. virtual reality/ (1700)

70. android.ti,ab. (2440)
71. (app or apps).ti,ab. (27,061)
72. blog*.ti,ab. (1775)
73. cyber*.ti,ab. (6705)
74. (email* or e-mail*).ti,ab. (15,947)
75. facebook.ti,ab. (3340)
76. instagram.ti,ab. (444)
77. instant messag*.ti,ab. (302)
78. internet*.ti,ab. (50,067)
79. media-based.ti,ab. (940)
80. media-deliver*.ti,ab. (58)
81. messag* service?.ti,ab. (1325)
82. (multimedia or multi-media).ti,ab. (5230)
83. new-media.ti,ab. (689)
84. (online* or on-line*).ti,ab. (140,538)
85. podcast*.ti,ab. (744)
86. reddit.ti,ab. (118)
87. social network* site*.ti,ab. (1138)
88. sms.ti,ab. (5753)
89. snapchat.ti,ab. (73)
90. social-medi*.ti,ab. (12,713)
91. software.ti,ab. (162,741)
92. telecomm*.ti,ab. (4236)
93. text-messag*.ti,ab. (3928)
94. texting.ti,ab. (832)
95. twitter.ti,ab. (2871)
96. video-based.ti,ab. (2305)
97. virtual*.ti,ab. (125,302)
98. vlog*.ti,ab. (47)
99. web*.ti,ab. (151,677)
100. www.ti,ab. (1497)
101. youtube.ti,ab. (1791)
102. or/64-101 [SOFTWARE OR MEDIA] (662,265)
103. "Cell Phone Use"/ (165)
104. 47 or 63 or 102 or 103 [ALL EHEALTH] (1,492,950)
105. 34 and 104 [MSM AND EHEALTH] (6245)
106. limit 105 to yr = "1995 -Current" (5938)
107. remove duplicates from 106 (5896)

OvidSP EMBASE

Database name	EMBASE
Database platform	OvidSP
Dates of database coverage	1947 to 21 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	7909
EndNote import order	2
Number of results once duplicates removed	805

Search strategy notes	<p>Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard</p> <p>The remove duplicates function is available only for sets smaller than 6000 results. Thus the search is split into two by publication year, deduplicated, then recombined</p>
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1. homosexuality/ (22,454)
2. male homosexuality/ (3200)
3. men who have sex with men/ (10,133)
4. "sexual and gender minority"/ (1990)
5. bisexuality/ (6532)
6. bisexual male/ (1197)
7. "men who have sex with men and women"/ (162)
8. lgbt people/ (807)
9. exp transgender/ (6122)
10. exp gender dysphoria/ (5571)
11. exp gender identity/ (16,992)
12. sex reassignment/ (1074)
13. sex transformation/ (2148)
14. homosexual*.ti,ab. (15,480)
15. gay.ti,ab. (12,013)
16. "men who have sex with men".ti,ab. (14,335)
17. MSM.ti,ab. (14,781)
18. bisexual*.ti,ab. (10,111)
19. gbMSM.ti,ab. (121)
20. (transgender* or trans-gender*).ti,ab. (7355)
21. (transsexual* or trans-sexual*).ti,ab. (3318)
22. (transm#n or trans-men or trans-man).ti,ab. (371)
23. (transwom#n or trans-wom#n).ti,ab. (521)
24. (transfemale? or trans female?).ti,ab. (55)
25. trans people.ti,ab. (173)
26. trans person.ti,ab. (7)
27. tgm.ti,ab. (582)
28. tgw.ti,ab. (330)
29. gender identity.ti,ab. (3805)
30. cross gender.ti,ab. (349)
31. sex reassignment.ti,ab. (842)
32. gender reassignment.ti,ab. (507)
33. gender dysphoria.ti,ab. (1332)
34. gender transition.ti,ab. (171)
35. queer.ti,ab. (1260)
36. sexual-minorit*.ti,ab. (2543)
37. gender-minorit*.ti,ab. (646)
38. LGBT*.ti,ab. (2362)
39. or/1-38 [MSM] (81,922)
40. telemedicine/ (22,972)
41. telehealth/ (6041)
42. teleconsultation/ (9289)
43. tediagnosis/ (261)
44. telemonitoring/ (3021)

45. telepsychiatry/ (629)
46. telerehabilitation/ (741)
47. teletherapy/ (1111)
48. ccbt.ti,ab. (210)
49. (ehealth or e-health or electronic health*).ti,ab. (28,000)
50. (etherap* or e-therap* or electronic therap*).ti,ab. (637)
51. (eportal or e-portal or electronic portal).ti,ab. (1633)
52. telehealth*.ti,ab. (4916)
53. telemed*.ti,ab. (14,267)
54. telemonitor*.ti,ab. (2235)
55. telepsych*.ti,ab. (747)
56. teletherap*.ti,ab. (1907)
57. icbt.ti,ab. (927)
58. (mhealth or m-health).ti,ab. (3228)
59. or/40-58 [GENERAL E-HEALTH] (75,772)
60. wireless communication/ (5186)
61. exp computer/ (151,454)
62. exp mobile phone/ (27,510)
63. cellphone.ti,ab. (405)
64. computer*.ti,ab. (374,346)
65. (ipad or i-pad).ti,ab. (2603)
66. (iphone or i-phone).ti,ab. (1530)
67. (ipod or i-pod).ti,ab. (555)
68. mobile*.ti,ab. (131,822)
69. phone*.ti,ab. (55,523)
70. smartphone.ti,ab. (11,531)
71. technolog*.ti,ab. (612,168)
72. telephon*.ti,ab. (84,215)
73. wifi.ti,ab. (604)
74. wireless.ti,ab. (16,520)
75. or/60-74 [HARDWARE] (1,273,741)
76. e-mail/ (21,705)
77. text messaging/ (4760)
78. videoconferencing/ (3723)
79. blogging/ (328)
80. webcast/ (342)
81. internet/ (107,499)
82. social media/ (18,981)
83. mobile application/ (10,335)
84. virtual reality/ (16,628)
85. multimedia/ (3943)
86. android.ti,ab. (3985)
87. (app or apps).ti,ab. (37,684)
88. blog*.ti,ab. (2778)
89. cyber*.ti,ab. (9502)
90. (email* or e-mail*).ti,ab. (32,902)
91. facebook.ti,ab. (5314)
92. instagram.ti,ab. (687)
93. instant messag*.ti,ab. (395)
94. internet*.ti,ab. (68,128)
95. media-based.ti,ab. (1109)

96. media-deliver*.ti,ab. (79)
97. messag* service?.ti,ab. (1463)
98. (multimedia or multi-media).ti,ab. (7755)
99. new-media.ti,ab. (917)
100. (online* or on-line*).ti,ab. (200,373)
101. podcast*.ti,ab. (1239)
102. reddit.ti,ab. (149)
103. social network* site*.ti,ab. (1418)
104. sms.ti,ab. (7725)
105. snapchat.ti,ab. (117)
106. social-medi*.ti,ab. (17,874)
107. software.ti,ab. (276,357)
108. telecomm*.ti,ab. (4220)
109. text-messag*.ti,ab. (5117)
110. texting.ti,ab. (1155)
111. twitter.ti,ab. (4101)
112. video-based.ti,ab. (3153)
113. virtual*.ti,ab. (159,650)
114. vlog*.ti,ab. (45)
115. web*.ti,ab. (197,291)
116. www.ti,ab. (2819)
117. youtube.ti,ab. (2440)
118. or/76-117 (963,273)
119. "cell phone use"/ (710)
120. 59 or 75 or 118 or 119 (2,103,382)
121. 39 and 120 (8235)
122. limit 121 to yr = "1995 - 2015" (4064)
123. limit 121 to yr = "2015 - Current" (4669)
124. remove duplicates from 122 (3985)
125. remove duplicates from 123 (4640)
126. 124 or 125 (7909)

OvidSP Global Health

Database name	Global Health
Database platform	OvidSP
Dates of database coverage	1910 to 2020 week 15
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	2368
EndNote import order	3
Number of results once duplicates removed	95
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexuality/ (11,416)
2. homosexual men/ (1102)
3. men who have sex with men/ (5146)
4. bisexuality/ (1664)
5. homosexual*.ti,ab. (5198)
6. gay.ti,ab. (3371)
7. "men who have sex with men".ti,ab. (7752)
8. MSM.ti,ab. (6499)
9. bisexual*.ti,ab. (3412)
10. gbMSM.ti,ab. (45)
11. (transgender* or trans-gender*).ti,ab. (1386)
12. (transsexual* or trans-sexual*).ti,ab. (138)
13. (transm#n or trans-men or trans-man).ti,ab. (25)
14. (transwom#n or trans-wom#n).ti,ab. (84)
15. (transfemale? or trans female?).ti,ab. (8)
16. trans people.ti,ab. (26)
17. trans person.ti,ab. (0)
18. tgm.ti,ab. (76)
19. tgw.ti,ab. (59)
20. gender identity.ti,ab. (323)
21. cross gender.ti,ab. (15)
22. sex reassignment.ti,ab. (17)
23. gender reassignment.ti,ab. (15)
24. gender dysphoria.ti,ab. (38)
25. gender transition.ti,ab. (18)
26. queer.ti,ab. (175)
27. sexual-minorit*.ti,ab. (815)
28. gender-minorit*.ti,ab. (147)
29. LGBT*.ti,ab. (345)
30. or/1-29 [MSM] (19,251)
31. telemedicine/(1241)
32. ccbt.ti,ab. (4)
33. (ehealth or e-health or electronic health*).ti,ab. (2187)
34. (etherap* or e-therap* or electronic therap*).ti,ab. (107)
35. (eportal or e-portal or electronic portal).ti,ab. (6)
36. telehealth*.ti,ab. (399)
37. telemed*.ti,ab. (785)
38. telemonitor*.ti,ab. (57)
39. telepsych*.ti,ab. (40)
40. teletherap*.ti,ab. (19)
41. icbt.ti,ab. (12)
42. (mhealth or m-health).ti,ab. (646)
43. or/31-42 [GENERAL E-HEALTH] (4404)
44. exp computer hardware/ (1700)
45. mobile telephones/ (2514)
46. cellphone.ti,ab. (77)
47. computer*.ti,ab. (21,222)
48. (ipad or i-pad).ti,ab. (116)
49. (iphone or i-phone).ti,ab. (44)
50. (ipod or i-pod).ti,ab. (26)

51. mobile*.ti,ab. (19,724)
52. phone*.ti,ab. (5362)
53. smartphone.ti,ab. (955)
54. technolog*.ti,ab. (74,673)
55. telephon*.ti,ab. (11,956)
56. wifi.ti,ab. (31)
57. wireless.ti,ab. (602)
58. or/44-57 [HARDWARE] (126,805)
59. computer software/ (4713)
60. exp internet/ (8784)
61. social media/ (1809)
62. android.ti,ab. (548)
63. (app or apps).ti,ab. (2047)
64. blog*.ti,ab. (253)
65. cyber*.ti,ab. (509)
66. (email* or e-mail*).ti,ab. (2179)
67. facebook.ti,ab. (584)
68. instagram.ti,ab. (68)
69. instant messag*.ti,ab. (47)
70. internet*.ti,ab. (8949)
71. media-based.ti,ab. (208)
72. media-deliver*.ti,ab. (8)
73. messag* service?.ti,ab. (375)
74. (multimedia or multi-media).ti,ab. (771)
75. new-media.ti,ab. (222)
76. (online* or on-line*).ti,ab. (19,194)
77. podcast*.ti,ab. (41)
78. reddit.ti,ab. (15)
79. social network* site*.ti,ab. (189)
80. sms.ti,ab. (1016)
81. snapchat.ti,ab. (9)
82. social-medi*.ti,ab. (2380)
83. software.ti,ab. (28,336)
84. telecomm*.ti,ab. (344)
85. text-messag*.ti,ab. (1104)
86. texting.ti,ab. (176)
87. twitter.ti,ab. (410)
88. video-based.ti,ab. (137)
89. virtual*.ti,ab. (12,257)
90. vlog*.ti,ab. (3)
91. web*.ti,ab. (23,909)
92. www.ti,ab. (80)
93. youtube.ti,ab. (165)
94. or/59-93 [SOFTWARE OR MEDIA] (94,369)
95. 43 or 58 or 94 [ALL EHEALTH] (210,833)
96. 30 and 95 [MSM AND EHEALTH] (2437)
97. limit 96 to yr = "1995 -Current" (2369)
98. remove duplicates from 97 (2368)

OvidSP EconLit

Database name	EconLit
Database platform	OvidSP
Dates of database coverage	1886 to 16 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	69
EndNote import order	4
Number of results once duplicates removed	9
Search strategy notes	Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexual*.ti,ab. (146)
2. gay.ti,ab. (410)
3. "men who have sex with men".ti,ab. (14)
4. MSM.ti,ab. (74)
5. bisexual*.ti,ab. (114)
6. gbMSM.ti,ab. (0)
7. (transgender* or trans-gender*).ti,ab. (65)
8. (transsexual* or trans-sexual*).ti,ab. (11)
9. (transm#n or trans-men or trans-man).ti,ab. (1)
10. (transwom#n or trans-wom#n).ti,ab. (1)
11. (transfemale? or trans female?).ti,ab. (0)
12. trans people.ti,ab. (2)
13. trans person.ti,ab. (0)
14. tgm.ti,ab. (3)
15. tgw.ti,ab. (0)
16. gender identity.ti,ab. (99)
17. cross gender.ti,ab. (9)
18. sex reassignment.ti,ab. (1)
19. gender reassignment.ti,ab. (1)
20. gender dysphoria.ti,ab. (0)
21. gender transition.ti,ab. (4)
22. queer.ti,ab. (73)
23. sexual-minorit*.ti,ab. (51)
24. gender-minorit*.ti,ab. (16)
25. LGBT*.ti,ab. (115)
26. or/1-25 [MSM] (866)
27. ccbt.ti,ab. (1)
28. (ehealth or e-health or electronic health*).ti,ab. (96)
29. (etherap* or e-therap* or electronic therap*).ti,ab. (0)
30. (eportal or e-portal or electronic portal).ti,ab. (0)
31. telehealth*.ti,ab. (7)
32. telemed*.ti,ab. (41)
33. telemonitor*.ti,ab. (8)
34. telepsych*.ti,ab. (0)

35. teletherap*.ti,ab. (0)
36. icbt.ti,ab. (2)
37. (mhealth or m-health).ti,ab. (18)
38. cellphone.ti,ab. (22)
39. computer*.ti,ab. (7258)
40. (ipad or i-pad).ti,ab. (12)
41. (iphone or i-phone).ti,ab. (36)
42. (ipod or i-pod).ti,ab. (26)
43. mobile*.ti,ab. (5598)
44. phone*.ti,ab. (1543)
45. smartphone.ti,ab. (174)
46. technolog*.ti,ab. (80,523)
47. telephon*.ti,ab. (2277)
48. wifi.ti,ab. (17)
49. wireless.ti,ab. (623)
50. android.ti,ab. (33)
51. (app or apps).ti,ab. (264)
52. blog*.ti,ab. (211)
53. cyber*.ti,ab. (985)
54. (email* or e-mail*).ti,ab. (523)
55. facebook.ti,ab. (369)
56. instagram.ti,ab. (18)
57. instant messag*.ti,ab. (21)
58. internet*.ti,ab. (7833)
59. media-based.ti,ab. (26)
60. media-deliver*.ti,ab. (2)
61. messag* service?.ti,ab. (30)
62. (multimedia or multi-media).ti,ab. (258)
63. new-media.ti,ab. (207)
64. (online* or on-line*).ti,ab. (7896)
65. podcast*.ti,ab. (18)
66. reddit.ti,ab. (1)
67. social network* site*.ti,ab. (93)
68. sms.ti,ab. (120)
69. snapchat.ti,ab. (3)
70. social-medi*.ti,ab. (940)
71. software.ti,ab. (5355)
72. telecomm*.ti,ab. (5885)
73. text-messag*.ti,ab. (111)
74. texting.ti,ab. (17)
75. twitter.ti,ab. (246)
76. video-based.ti,ab. (7)
77. virtual*.ti,ab. (5380)
78. vlog*.ti,ab. (67)
79. web*.ti,ab. (5981)
80. www.ti,ab. (31)
81. youtube.ti,ab. (55)
82. or/27-81 [ALL EHEALTH] (120,005)
83. 26 and 82 (69)
84. limit 83 to yr = "1995 -Current" (69)
85. remove duplicates from 84 (69)

OvidSP PsycINFO

Database name	PsycINFO
Database platform	OvidSP
Dates of database coverage	1806 to April week 2 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	5849
EndNote import order	5
Number of results once duplicates removed	472
Search strategy notes	Search lines ending in a '/' are subject heading searches. Search lines beginning 'exp' are exploded subject heading searches. Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexuality/ (7731)
2. male homosexuality/ (14,352)
3. same sex marriage/ (597)
4. same sex couples/ (582)
5. bisexuality/ (7863)
6. exp gender identity/ (37,406)
7. same sex intercourse/ (3251)
8. sex change/ (559)
9. exp gender identity disorder/ (921)
10. homosexual*.ti,ab. (13,638)
11. gay.ti,ab. (20,472)
12. "men who have sex with men".ti,ab. (4522)
13. MSM.ti,ab. (3498)
14. bisexual*.ti,ab. (11,910)
15. gbMSM.ti,ab. (40)
16. (transgender* or trans-gender*).ti,ab. (7329)
17. (transsexual* or trans-sexual*).ti,ab. (2173)
18. (transm#n or trans-men or trans-man).ti,ab. (218)
19. (transwom#n or trans-wom#n).ti,ab. (295)
20. (transfemale? or trans female?).ti,ab. (26)
21. trans people.ti,ab. (235)
22. trans person.ti,ab. (25)
23. tgm.ti,ab. (11)
24. tgw.ti,ab. (36)
25. gender identity.ti,ab. (5542)
26. cross gender.ti,ab. (637)
27. sex reassignment.ti,ab. (475)
28. gender reassignment.ti,ab. (134)
29. gender dysphoria.ti,ab. (767)
30. gender transition.ti,ab. (178)
31. queer.ti,ab. (4280)
32. sexual-minorit*.ti,ab. (3895)
33. gender-minorit*.ti,ab. (662)

34. LGBT*.ti,ab. (4423)
35. or/1-34 [MSM] (56,431)
36. telemedicine/ (5056)
37. computer assisted diagnosis/ (1572)
38. computer assisted therapy/ (1069)
39. online therapy/ (2847)
40. ccbt.ti,ab. (166)
41. (ehealth or e-health or electronic health*).ti,ab. (2988)
42. (etherap* or e-therap* or electronic therap*).ti,ab. (180)
43. (eportal or e-portal or electronic portal).ti,ab. (8)
44. telehealth*.ti,ab. (1261)
45. telemed*.ti,ab. (1483)
46. telemonitor*.ti,ab. (163)
47. telepsych*.ti,ab. (581)
48. teletherap*.ti,ab. (62)
49. icbt.ti,ab. (374)
50. (mhealth or m-health).ti,ab. (646)
51. or/36-50 [GENERAL E-HEALTH] (13,797)
52. computers/ (9906)
53. cloud computing/ (225)
54. digital computers/ (1220)
55. microcomputers/ (1286)
56. exp computer peripheral devices/ (1524)
57. exp mobile devices/ (7742)
58. cellphone.ti,ab. (106)
59. computer*.ti,ab. (88,666)
60. (ipad or i-pad).ti,ab. (851)
61. (iphone or i-phone).ti,ab. (271)
62. (ipod or i-pod).ti,ab. (257)
63. mobile*.ti,ab. (16,004)
64. phone*.ti,ab. (26,208)
65. smartphone.ti,ab. (2569)
66. technolog*.ti,ab. (107,397)
67. telephon*.ti,ab. (24,126)
68. wifi.ti,ab. (62)
69. wireless.ti,ab. (1576)
70. or/52-69 [HARDWARE] (238,828)
71. computer applications/ (11,412)
72. exp computer software/ (14,516)
73. exp electronic communication/ (31,009)
74. exp human computer interaction/ (24,131)
75. computer usage/ (697)
76. teleconferencing/ (887)
77. virtual reality/ (8167)
78. android.ti,ab. (423)
79. (app or apps).ti,ab. (6683)
80. blog*.ti,ab. (3182)
81. cyber*.ti,ab. (8251)
82. (email* or e-mail*).ti,ab. (9122)
83. facebook.ti,ab. (5012)
84. instagram.ti,ab. (447)
85. instant messag*.ti,ab. (702)
86. internet*.ti,ab. (37,471)

87. media-based.ti,ab. (474)
88. media-deliver*.ti,ab. (29)
89. messag* service?.ti,ab. (486)
90. (multimedia or multi-media).ti,ab. (5010)
91. new-media.ti,ab. (2051)
92. (online* or on-line*).ti,ab. (85,263)
93. podcast*.ti,ab. (468)
94. reddit.ti,ab. (81)
95. social network* site*.ti,ab. (2926)
96. sms.ti,ab. (1445)
97. snapchat.ti,ab. (100)
98. social-medi*.ti,ab. (10,929)
99. software.ti,ab. (25,195)
100. telecomm*.ti,ab. (2267)
101. text-messag*.ti,ab. (2172)
102. texting.ti,ab. (837)
103. twitter.ti,ab. (2557)
104. video-based.ti,ab. (1407)
105. virtual*.ti,ab. (34,548)
106. vlog*.ti,ab. (69)
107. web*.ti,ab. (50,575)
108. www.ti,ab. (422)
109. youtube.ti,ab. (1096)
110. or/71-109 [SOFTWARE OR MEDIA] (256,615)
111. 51 or 70 or 110 [ALL EHEALTH] (426,826)
112. 35 and 111 [MSM AND EHEALTH] (5982)
113. limit 112 to yr = "1995 -Current" (5859)
114. remove duplicates from 113 (5849)

OvidSP Social Policy & Practice

Database name	Social Policy & Practice
Database platform	OvidSP
Dates of database coverage	Inception to 22 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	222
EndNote import order	6
Number of results once duplicates removed	15
Search strategy notes	Search lines ending in '.ti,ab.' search in the title and abstract only. 'or/x-y' combines search sets in the range x-y with the Boolean operator OR. * is used for the truncation of words. # is used for a compulsory wildcard. ? is used for an optional wildcard

1. homosexual*.ti,ab. (302)
2. gay.ti,ab. (1906)
3. "men who have sex with men".ti,ab. (102)
4. MSM.ti,ab. (66)
5. bisexual*.ti,ab. (992)

6. gbMSM.ti,ab. (0)
7. (transgender* or trans-gender*).ti,ab. (701)
8. (transsexual* or trans-sexual*).ti,ab. (84)
9. (transm#n or trans-men or trans-man).ti,ab. (4)
10. (transwom#n or trans-wom#n).ti,ab. (4)
11. (transfemale? or trans female?).ti,ab. (0)
12. trans people.ti,ab. (47)
13. trans person.ti,ab. (1)
14. tgm.ti,ab. (0)
15. tgw.ti,ab. (1)
16. gender identity.ti,ab. (227)
17. cross gender.ti,ab. (10)
18. sex reassignment.ti,ab. (8)
19. gender reassignment.ti,ab. (47)
20. gender dysphoria.ti,ab. (37)
21. gender transition.ti,ab. (9)
22. queer.ti,ab. (155)
23. sexual-minorit*.ti,ab. (130)
24. gender-minorit*.ti,ab. (26)
25. LGBT*.ti,ab. (576)
26. or/1-25 [MSM] (2832)
27. ccbt.ti,ab. (29)
28. (ehealth or e-health or electronic health*).ti,ab. (81)
29. (etherap* or e-therap* or electronic therap*).ti,ab. (17)
30. (eportal or e-portal or electronic portal).ti,ab. (0)
31. telehealth*.ti,ab. (197)
32. telemed*.ti,ab. (68)
33. telemonitor*.ti,ab. (7)
34. telepsych*.ti,ab. (9)
35. teletherap*.ti,ab. (0)
36. icbt.ti,ab. (3)
37. (mhealth or m-health).ti,ab. (10)
38. cellphone.ti,ab. (3)
39. computer*.ti,ab. (2188)
40. (ipad or i-pad).ti,ab. (16)
41. (iphone or i-phone).ti,ab. (5)
42. (ipod or i-pod).ti,ab. (11)
43. mobile*.ti,ab. (940)
44. phone*.ti,ab. (685)
45. smartphone.ti,ab. (42)
46. technolog*.ti,ab. (6767)
47. telephon*.ti,ab. (2281)
48. wifi.ti,ab. (3)
49. wireless.ti,ab. (47)
50. android.ti,ab. (6)
51. (app or apps).ti,ab. (124)
52. blog*.ti,ab. (115)
53. cyber*.ti,ab. (476)
54. (email* or e-mail*).ti,ab. (485)
55. facebook.ti,ab. (102)
56. instagram.ti,ab. (13)
57. instant messag*.ti,ab. (11)
58. internet*.ti,ab. (2416)

59. media-based.ti,ab. (18)
60. media-deliver*.ti,ab. (0)
61. messag* service?.ti,ab. (7)
62. (multimedia or multi-media).ti,ab. (171)
63. new-media.ti,ab. (56)
64. (online* or on-line*).ti,ab. (4579)
65. podcast*.ti,ab. (24)
66. reddit.ti,ab. (2)
67. social network* site*.ti,ab. (139)
68. sms.ti,ab. (21)
69. snapchat.ti,ab. (13)
70. social-medi*.ti,ab. (480)
71. software.ti,ab. (551)
72. telecomm*.ti,ab. (275)
73. text-messag*.ti,ab. (65)
74. texting.ti,ab. (26)
75. twitter.ti,ab. (36)
76. video-based.ti,ab. (24)
77. virtual*.ti,ab. (828)
78. vlog*.ti,ab. (0)
79. web*.ti,ab. (3295)
80. www.ti,ab. (18)
81. youtube.ti,ab. (104)
82. or/27-81 [ALL EHEALTH] (20,223)
83. 26 and 82 (227)
84. limit 83 to yr = "1995 -Current" (223)
85. remove duplicates from 84 (222).

EBSCO Cumulative Index to Nursing and Allied Health Literature Plus

Database name	CINAHL Plus
Database platform	EBSCO
Dates of database coverage	Inception to 22 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	4679
EndNote import order	7
Number of results once duplicates removed	406
Search strategy notes	Search lines using an MH code are subject heading searches. Subject heading searches ending in a + are exploded. Search lines using a TI code search in the title only. Search lines using an AB code search in the abstract only. * is used for truncation. ? is used for an optional wildcard

S1 MH "Homosexuality" (6575)

S2 MH "Gay Men" (4995)

S3 MH "Gay Persons" (1774)

APPENDIX 3

- S4 MH "Men Who Have Sex With Men" (1152)
- S5 MH "Bisexuality" (1453)
- S6 MH "GLBT Persons" (0)
- S7 MH "Sexual Identity" (445)
- S8 MH "Bisexuals" (1244)
- S9 MH "Transgender Persons+" (3074)
- S10 MH "Transsexualism" (1093)
- S11 MH "Gender Identity" (6832)
- S12 MH "Gender Dysphoria" (191)
- S13 MH "Sex Reassignment Procedures+" (358)
- S14 (TI homosexual*) OR (AB homosexual*) (2633)
- S15 (TI gay) OR (AB gay) (8554)
- S16 (TI "men who have sex with men") OR (AB "men who have sex with men") (6729)
- S17 (TI MSM) OR (AB MSM) (4792)
- S18 (TI bisexual*) OR (AB bisexual*) (5771)
- S19 (TI gbMSM) OR (AB gbMSM) (55)
- S20 (TI (transgender* OR trans-gender*)) OR (AB (transgender* OR trans-gender*)) (5238)
- S21 (TI (transsexual* OR trans-sexual*)) OR (AB (transsexual* OR trans-sexual*)) (614)
- S22 (TI (transm?n OR trans-men OR trans-man)) OR (AB (transm?n OR trans-men OR trans-man)) (113)
- S23 (TI (transwom?n OR trans-wom?n)) OR (AB (transwom?n OR trans-wom?n)) (205)
- S24 (TI (transfemale? OR trans-female?)) OR (AB (transfemale? OR trans-female?)) (18)
- S25 (TI trans people) OR (AB trans people) (144)
- S26 (TI trans person) OR (AB trans person) (28)
- S27 (TI tgm) OR (AB tgm) (25)
- S28 (TI tgw) OR (AB tgw) (55)
- S29 (TI gender identity) OR (AB gender identity) (1889)
- S30 (TI cross gender) OR (AB cross gender) (98)

- S31 (TI sex reassignment) OR (AB sex reassignment) (157)
- S32 (TI gender reassignment) OR (AB gender reassignment) (107)
- S33 (TI gender dysphoria) OR (AB gender dysphoria) (472)
- S34 (TI gender transition) OR (AB gender transition) (105)
- S35 (TI queer) OR (AB queer) (1120)
- S36 (TI sexual-minorit*) OR (AB sexual-minorit*) (1982)
- S37 (TI gender minorit*) OR (AB gender minorit*) (433)
- S38 (TI LGBT*) OR (AB LGBT*) (2512)
- S39 S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36 OR S37 OR S38 (32,972)
- S40 (MH "Telehealth+") (23,712)
- S41 (TI ccbt) OR (AB ccbt) (120)
- S42 (TI (ehealth OR e-health OR electronic health*)) OR (AB (ehealth OR e-health OR electronic health*)) (15,743)
- S43 (TI (etherap* OR e-therap* OR electronic therap*)) OR (AB (etherap* OR e-therap* OR electronic therap*)) (140)
- S44 (TI (eportal OR e-portal OR electronic portal)) OR (AB (eportal OR e-portal OR electronic portal)) (199)
- S45 (TI telehealth*) OR (AB telehealth*) (3783)
- S46 (TI telemed*) OR (AB telemed*) (5216)
- S47 (TI telemonitor*) OR (AB telemonitor*) (820)
- S48 (TI telepsych*) OR (AB telepsych*) (402)
- S49 (TI teletherap*) OR (AB teletherap*) (83)
- S50 (TI icbt) OR (AB icbt) (240)
- S51 (TI (mhealth OR m-health)) OR (AB (mhealth OR m-health)) (1756)
- S52 S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51 (41,558)
- S53 MH "Computer Hardware" (1115)

APPENDIX 3

- S54 MH "Computer Peripherals+" (11,498)
- S55 MH "Computer Processor+" (105)
- S56 MH "Computer Types+" (10,537)
- S57 (MH "Cellular Phone") (1890)
- S58 (MH "Wireless Local Area Networks") (185)
- S59 (TI cellphone) OR (AB cellphone) (229)
- S60 (TI computer*) OR (AB computer*) (66,111)
- S61 (TI (ipad OR i-pad)) OR (AB (ipad OR i-pad)) (1333)
- S62 (TI (iphone OR i-phone)) OR (AB (iphone OR i-phone)) (861)
- S63 (TI (ipod OR i-pod)) OR (AB (ipod OR i-pod)) (363)
- S64 (TI mobile*) OR (AB mobile*) (21,681)
- S65 (TI phone*) OR (AB phone*) (17,978)
- S66 (TI smartphone) OR (AB smartphone) (5425)
- S67 (TI technolog*) OR (AB technolog*) (128,344)
- S68 (TI telephon*) OR (AB telephon*) (32,607)
- S69 (TI wifi) OR (AB wifi) (91)
- S70 (TI wireless) OR (AB wireless) (3406)

- S71 S53 OR S54 OR S55 OR S56 OR S57 OR S58 OR S59 OR S60 OR S61 OR S62 OR S63 OR S64 OR S65 OR S66 OR S67 OR S68 OR S69 OR S70 (263,685)

- S72 MH "Instant Messaging" (305)
- S73 MH "Internet+" (159,187)
- S74 MH "Text Messaging" (2968)
- S75 MH "Videoconferencing+" (3056)
- S76 MH "Wireless Communications" (13,118)
- S77 (MH "Electronic Mail") (0)
- S78 MH "Mobile Applications" (7158)
- S79 MH "Multimedia" (2236)

- S80 MH "Operating Systems" (353)
- S81 MH "Decision Making, Computer Assisted" (1380)
- S82 MH "Diagnosis, Computer Assisted+" (17,363)
- S83 MH "Therapy, Computer Assisted+" (18,484)
- S84 MH "Virtual Reality+" (5215)
- S85 (TI android) OR (AB android) (955)
- S86 (TI (app OR apps)) OR (AB (app or apps)) (9066)
- S87 (TI blog*) OR (AB blog*) (3414)
- S88 (TI cyber*) OR (AB cyber*) (4357)
- S89 (TI (email* OR e-mail*)) OR (AB (email* OR e-mail*)) (10,973)
- S90 (TI facebook) OR (AB facebook) (4819)
- S91 (TI instagram) OR (AB instagram) (520)
- S92 (TI instant messag*) OR (AB instant messag*) (288)
- S93 (TI internet*) OR (AB internet*) (32,289)
- S94 (TI media-based) OR (AB media-based) (245)
- S95 (TI media-deliver*) OR (AB media-deliver*) (19)
- S96 (TI messag* service?) OR (AB messag* service?) (794)
- S97 (TI (multimedia or multi-media)) OR (AB (multimedia or multi-media)) (2665)
- S98 (TI new-media) OR (AB new-media) (476)
- S99 (TI (online* OR on-line*)) OR (AB (online* OR on-line*)) (263,105)
- S100 (TI podcast*) OR (AB podcast*) (998)
- S101 (TI reddit) OR (AB reddit) (87)
- S102 (TI social network* site*) OR (AB social network* site*) (1673)
- S103 (TI sms) OR (AB sms) (1584)
- S104 (TI snapchat) OR (AB snapchat) (89)
- S105 (TI social-medi*) OR (AB social-medi*) (11,106)
- S106 (TI software) OR (AB software) (46,779)

APPENDIX 3

- S107 (TI telecomm*) OR (AB telecomm*) (1187)
- S108 (TI text-messag*) OR (AB text-messag*) (2857)
- S109 (TI texting) OR (AB texting) (829)
- S110 (TI twitter) OR (AB twitter) (3027)
- S111 (TI video-based) OR (AB video-based) (1041)
- S112 (TI virtual*) OR (AB virtual*) (23,489)
- S113 (TI vlog*) OR (AB vlog*) (70)
- S114 (TI web) OR (AB web) (53,663)
- S115 (TI www) OR (AB www) (307)
- S116 (TI youtube) OR (AB youtube) (1074)
- S117 S72 OR S73 OR S74 OR S75 OR S76 OR S78 OR S79 OR S80 OR S81 OR S82 OR S83 OR S84 OR S85 OR S86 OR S87 OR S88 OR S89 OR S90 OR S91 OR S92 OR S93 OR S94 OR S95 OR S96 OR S97 OR S98 OR S99 OR S100 OR S101 OR S102 OR S103 OR S104 OR S105 OR S106 OR S107 OR S108 OR S109 OR S110 OR S111 OR S112 OR S113 OR S114 OR S115 OR S116 (565,977)
- S118 S52 OR S71 OR S117 (777,524)
- S119 S39 AND S118 (4704)
- S120 s119 Limiters - Published Date: 19950101-20201231 (4679)

Web of Science Science Citation Index Expanded

Database name	Science Citation Index Expanded
Database platform	Web of Science
Dates of database coverage	1970–present. Data last updated 21 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	4111
EndNote import order	8
Number of results once duplicates removed	185
Search strategy notes	* is used for truncation. \$ is used for an optional wildcard

1 TOPIC: (homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale\$ OR “trans-female\$” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) Indexes = SCI-EXPANDED Timespan = 1995-2018 (40,267)

2 TOPIC: (ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service\$" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software or telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) Indexes = SCI-EXPANDED Timespan = 1995-2018 (2,873,202)

3 #2 AND #1 Indexes = SCI-EXPANDED Timespan = 1995-2018 (4111)

Web of Science Social Sciences Citation Index Expanded

Database name	Social Sciences Citation Index Expanded
Database platform	Web of Science
Dates of database coverage	1970–present. Data last updated 21 April 2020
Date searched	22 April 2020
Searched by	Jane Falconer
Number of results	5712
EndNote import order	9
Number of results once duplicates removed	339
Search strategy notes	* is used for truncation. \$ is used for an optional wildcard

1 TOPIC: (homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale\$ OR "trans-female\$" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) Indexes = SCI-EXPANDED Timespan = 1995-2018 (47,924)

2 TOPIC: (ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service\$" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software or telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) Indexes = SCI-EXPANDED Timespan = 1995-2018 (644,393)

3 #2 AND #1 Indexes = SCI-EXPANDED Timespan = 1995-2018 (5712)

Scopus

Database name	Scopus
Database platform	Scopus
Dates of database coverage	Full database as of 22 April 2020
Date searched	22 April 2020
Searched by	JF
Number of results	13,379
EndNote import order	10
Number of results once duplicates removed	981
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard.

TITLE-ABS-KEY (homosexual* OR gay OR "men who have sex with men" OR msm OR bisexual* OR gbmsm OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR lgbt*) AND TITLE-ABS-KEY (ccbt OR ehealth OR "e-health" OR "electronic health" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR ictb OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) (13,379)

The Cochrane Library

Database name	The Cochrane Library
Database platform	Wiley Online Library
Dates of database coverage	Library as of 22 April 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	531
EndNote import order	12
Number of results once duplicates removed	83
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Searches ending :ti,ab,kw search the title, abstract and keywords

- #1 MeSH descriptor: [Homosexuality] this term only (103)
- #2 MeSH descriptor: [Homosexuality, Male] this term only (356)
- #3 MeSH descriptor: [Sexual and Gender Minorities] explode all trees (84)
- #4 MeSH descriptor: [Bisexuality] this term only (51)
- #5 MeSH descriptor: [Transsexualism] this term only (27)
- #6 MeSH descriptor: [Gender Identity] this term only (227)
- #7 MeSH descriptor: [Health Services for Transgender Persons] this term only (0)
- #8 MeSH descriptor: [Sex Reassignment Procedures] explode all trees (4)
- #9 (homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*):ti,ab,kw (2160)
- #10 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 (2165)
- #11 MeSH descriptor: [Telemedicine] explode all trees (2343)
- #12 MeSH descriptor: [Cell Phone] this term only (640)
- #13 MeSH descriptor: [Wireless Technology] this term only (34)
- #14 MeSH descriptor: [Microcomputers] explode all trees (804)
- #15 MeSH descriptor: [Electronic Mail] this term only (313)
- #16 MeSH descriptor: [Text Messaging] this term only (765)
- #17 MeSH descriptor: [undefined] explode all trees (0)
- #18 MeSH descriptor: [Internet] explode all trees (3776)
- #19 MeSH descriptor: [Mobile Applications] this term only (537)
- #20 MeSH descriptor: [Virtual Reality] this term only (143)
- #21 MeSH descriptor: [Cell Phone Use] this term only (5)
- #22 (cbct OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR

“media-based” OR “media-deliver*” OR “messag* service*” OR multimedia OR “multi-media” OR “new-media” OR online* OR “on-line*” OR podcast* OR reddit OR “social network* site*” OR sms OR snapchat OR “social medi*” OR software or telecomm* OR “text-messag*” OR texting OR twitter OR “video-based” OR virtual* OR vlog* OR web* OR www OR youtube):ti,ab,kw (133,378)

#23 #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 (133,660)

#24 #10 and #23 (531)

Campbell Library

Database name	Campbell Library
Database platform	Campbell Collaboration
Dates of database coverage	Inception to 27 April 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	0

homosexual OR gay OR men who have sex with men OR MSM OR bisexual OR gbMSM OR transgender OR trans-gender OR transsexual OR trans-sexual OR transman OR transmen OR trans-men OR trans-man OR transwoman OR transwomen OR trans-woman OR trans-women OR transfemale OR trans-female OR trans people OR trans person OR tgm OR tgw OR gender identity OR cross gender OR sex reassignment OR gender reassignment OR gender dysphoria OR gender transition OR queer OR sexual-minorit OR gender-minorit OR LGBT

ProQuest Dissertations & Theses Global

Database name	Dissertations & Theses Global
Database platform	ProQuest
Dates of database coverage	1951–27 April 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	2563
EndNote import order	11
Number of results once duplicates removed	243
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

(TI(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual*” OR transm?n OR “trans-men” OR “trans-man” OR transwom?n OR “trans-wom?n” OR transfemale* OR “trans-female*” OR “trans people” OR “trans person” OR tgm OR tgw OR “gender identity” OR “cross gender” OR “sex reassignment” OR “gender reassignment” OR “gender dysphoria” OR “gender transition” OR queer OR “sexual-minorit*” OR “gender-minorit*” OR LGBT*) OR AB(homosexual* OR gay OR “men who have sex with men” OR MSM OR bisexual* OR gbMSM OR transgender OR “trans-gender” OR transsexual* OR “trans-sexual”

OR transm?n OR "trans-men" OR "trans-man" OR transwom?n OR "trans-wom?n" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) AND (TI(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube) OR AB(ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR telemed* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)) Limits: date: after December 31 1994 (2563)

EPPI-Centre database of health promotion research (Bibliomap)

Database name	Bibliomap
Database platform	EPPI-Centre
Dates of database coverage	Inception to 27 April 4 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	7
Number of results once duplicates removed	0
Search strategy notes	* is used for truncation. ? is used for a mandatory wildcard. Search strings starting with TI search the title only. Search strings starting with AB search the abstract only

1 Characteristics of the study population: homosexual OR bisexual OR transsexual (824)

2 Freetext: homosexual* OR gay OR "men who have sex with men" OR MSM OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transman OR transmen OR "trans-men" OR "trans-man" OR transwoman OR transwomen OR "trans-woman" OR "trans-women" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT* (516)

3 1 OR 2 (881)

4 Freetext: ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube (424)

5 3 AND 4 (8)

One item not added as published in 1994.

OpenGrey

Database name	OpenGrey
Database platform	OpenGrey
Dates of database coverage	Inception to 27 April 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	93
Number of results once duplicates removed	0
Search strategy notes	NA
NA, not applicable.	

(homosexual* OR gay OR "men who have sex with men" OR bisexual* OR gbMSM OR transgender OR "trans-gender" OR transsexual* OR "trans-sexual*" OR transman OR transmen OR "trans-men" OR "trans-man" OR transwoman OR transwomen OR "trans-woman" OR "trans-women" OR transfemale* OR "trans-female*" OR "trans people" OR "trans person" OR tgm OR tgw OR "gender identity" OR "cross gender" OR "sex reassignment" OR "gender reassignment" OR "gender dysphoria" OR "gender transition" OR queer OR "sexual-minorit*" OR "gender-minorit*" OR LGBT*) AND (ccbt OR ehealth OR "e-health" OR "electronic health*" OR etherap* OR "e-therap*" OR "electronic therap*" OR eportal OR "e-portal" OR "electronic portal" OR telehealth* OR teled* OR telemonitor* OR telepsych* OR teletherap* OR icbt OR mhealth OR "m-health" OR cellphone OR computer* OR ipad OR "i-pad" OR iphone OR "i-phone" OR ipod OR "i-pod" OR mobile* OR smartphone OR technolog* OR telephon* OR wifi OR wireless OR android OR app OR apps OR blog* OR cyber* OR email OR "e-mail" OR facebook OR instagram OR "instant messag*" OR internet* OR "media-based" OR "media-deliver*" OR "messag* service*" OR multimedia OR "multi-media" OR "new-media" OR online* OR "on-line*" OR podcast* OR reddit OR "social network* site*" OR sms OR snapchat OR "social medi*" OR software OR telecomm* OR "text-messag*" OR texting OR twitter OR "video-based" OR virtual* OR vlog* OR web* OR www OR youtube)

Only references published after 1994 added.

ClinicalTrials.gov

Database name	ClinicalTrials.gov
Dates of database coverage	Inception to 27 April 2020
Date searched	27 April 2020
Searched by	Jane Falconer
Number of results	786
EndNote import order	13
Number of results once duplicates removed	405
Search strategy notes	As ClinicalTrials.gov limits the number of terms that can be used in one search string, the search terms were simplified and multiple searches were run. All searches were run in the 'Other terms' search box

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND (ehealth OR "e-health" OR "electronic health" OR etherapy OR "e-therapy" OR "electronic therapy" OR eportal OR "e-portal" OR "electronic portal" OR telehealth) (23)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND (telemedicine OR teletherapy OR "m-health" OR telepsychology OR icbt OR mhealth OR "m-health" OR cellphone OR computer OR ipad OR "i-pad" OR iphone) (103)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("i-phone" OR ipod OR "i-pod" OR mobile OR smartphone OR technology OR telephone OR wifi OR wireless OR android OR app OR apps OR blog OR cyber OR email) (224)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("e-mail" OR facebook OR instagram OR "instant message" OR internet OR "media-based" OR "media-delivery" OR "messaging service" OR multimedia OR "multi-media") (114)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("new-media" OR online OR "on-line" OR podcast OR reddit OR "social network site" OR sms OR snapchat OR "social media" OR software OR telecommunication) (163)

(homosexual OR gay OR "sex with men" OR bisexual OR trans OR LGBT OR LGBTQ OR MSM) AND ("text-message" OR texting OR twitter OR "video-based" OR virtual OR vlog OR web OR www OR youtube) (159)

Appendix 4 Protocol deviations and clarifications

TABLE 12 Protocol deviations

Date deviation implemented	Change	Rationale
23 October 2018	Additional databases searched: the complete Cochrane Library, not just the Cochrane Central Register of Controlled Trials database; Global Health; Web of Science Science Citation Index Expanded; Scopus	Complete Cochrane Library includes systematic reviews and protocols that may be relevant; Global Health is a specialist public health database that may yield non-peer reviewed journal articles; Web of Science Science Citation Index Expanded may find information in technology literature; Scopus may find information across medicine and social sciences
23 October 2018	Did not search the following databases: CISDOC; Dissertation Abstracts/Index to Theses	CISDOC is focused on occupational safety and unlikely to yield relevant studies. The website hosting Dissertation Abstracts/Index to Theses was shut down on 15 January 2015. Content is now available on ProQuest Dissertations & Theses: Global, which we searched as per the study protocol
1 November 2018	Search results uploaded to EndNote and duplicates removed before being downloaded into EPPI-Reviewer 4	Differences in data formatting between databases meant that the EPPI-Reviewer 4 duplicates tool was not able to find all duplicates. To save time, without affecting accuracy, a quicker EndNote technique was used
30 April 2020	Conducted an updated search	Updated searches were required by the funder when original searches are > 1 year old at the point of report submission
30 January 2019	Used a diagrammatic approach rather than line-by-line coding of descriptive text to synthesise intervention theories	Line-by-line coding of descriptive text did not readily capture the inter-relationships between theoretical constructs, a critical component of this synthesis
30 January 2019	Rather than including tables showing how first-, second- and third-order constructs relate to one another for the theory synthesis, we appended individual and overarching theory of change diagrams for one inductive group of interventions	Because we used a diagrammatic approach rather than line-by-line coding to synthesise intervention theories, producing coding tables was not appropriate for this synthesis
1 April 2020	Stakeholder consultations were held as individual interviews rather than as group discussions	Individual interviews allowed for more detailed discussion with each individual and better accommodated stakeholders' busy schedules
1 July 2020	Ordered narrative synthesis of outcome data by outcome, follow-up time and intervention type rather than by outcome, intervention type and follow-up time	To improve readability of the narrative synthesis
1 July 2020	In addition to pooling outcomes by follow-up time in the meta-analysis, when appropriate we also pooled outcomes across follow-up times	We considered that this would provide an average effect over all follow-ups, given that many outcomes drew on incidence-based measures

Appendix 5 Expert searches

Experts contacted

Initial search: 25 September 2018

1. Jo Abbott (Swinburne University of Technology).
2. Barry Adam (University of Windsor).
3. Christopher Bourne (Sydney Hospital).
4. Anne Markey Bowen (University of Arizona).
5. Sheana Bull (University of Colorado).
6. MN Burns (Northwestern University).
7. M Isabel Fernandez (Nova Southeastern University).
8. Lisa Hightow-Weidman (University of North Carolina).
9. Sabina Hirshfield (Public Health Solutions).
10. Keith J Horvath (University of Minnesota).
11. Archana Krishnan (University at Albany).
12. Ann Kurth (Yale University).
13. Kelly L'Engle (FHI 360).
14. Corina Lelutiu-Weinberger (Hunter College, City University of New York).
15. Yen-Jui Lin (University of California, Santa Barbara).
16. Joel E Milam (University of Southern California).
17. Tanya Millard (Monash University).
18. Joyal Miranda (Ryerson University).
19. Jason W Mitchelle (University of Hawai'i).
20. Brian Mustanski (Northwestern University).
21. Cathy J Reback (Friends Research Institute).
22. Tomas Rozbroj (Monash University).
23. Lena Nilsson Schönnesson (Karolinska Institutet).
24. Traci Schwinn (Columbia University).
25. Dallas Swendeman (University of California, Los Angeles).
26. JM Wilkerson (University of Minnesota).
27. Ciu Yang (Johns Hopkins University).
28. Michele Ybarra (Center for Innovative Public Health Research).
29. Sean Young (University of California, Los Angeles).

Updated search: 30 April 2020

1. Todd Raymond Avellar (Point Park University).
2. José A Bauermeister (University of Pennsylvania).
3. Anne Markey Bowen (University of Arizona).
4. Kelly Carpenter (Optimum).
5. Mary Ann Chiasson (Columbia University).
6. John Christensen (University of Connecticut).
7. Udi Davidovich (Public Health Service of Amsterdam/GGD Amsterdam).
8. Deborah Estrin (Cornell Tech).
9. Christopher MA Frampton (University of Otago).
10. George Jesus Greene (Northwestern University).
11. Gary Harper (University of Michigan).
12. Richard Haubrich (University of California, San Diego).
13. Sabina Hirshfield (State University of New York Downstate Health Sciences University).

14. G.J. Kok (Maastricht University).
15. Mathijs Lucassen (Open University).
16. Joel E Milam (University of Southern California).
17. Sheldon Morris (University of California, San Diego).
18. Brian Mustanski (Northwestern University).
19. Cathy J Reback (Friends Research Institute).
20. Stephen Read (University of Southern California).
21. BR Simon Rosser (University of Minnesota).
22. Lena Nilsson Schönnesson (Karolinska Institutet).
23. Rob Stephenson (University of Michigan).
24. Patrick Sullivan (Emory University).
25. Gregory Swann (Northwestern University).
26. Dallas Swendeman (University of California, Los Angeles).
27. Sarah Whitton (University of Cincinnati).
28. JM Wilkerson (University of Texas).
29. Mark Williams (Florida International University).

E-mails sent to experts

Initial search

Original e-mail (sent 25 September 2018)

Hello

I am a researcher from the London School of Hygiene and Tropical Medicine. We are currently undertaking a systematic review of e-health interventions addressing sexual health, alcohol and drug use and mental health among gay and other men who have sex with men, and we would like your advice finding relevant papers.

Please find the protocol here: www.crd.york.ac.uk/PROSPERO/display_record.php?RecordID=110317.

I would be very grateful if could tell us any research of which you are aware that may be relevant to this review. At the end of this email is a list of relevant studies of which we are already aware.

The table below summarises the types of study in which we are interested.

Participation	Gay, bisexual and other men (including trans men) who have sex with men including those who have been diagnosed as HIV positive, those whose last HIV test was negative or those who have never tested for HIV
Intervention	Interactive or non-interactive e-health interventions delivered via mobile phone apps, internet or other electronic media to prevent HIV, STIs, sexual risk behaviour, alcohol and drug use, or common mental illnesses. These could include interventions that also aim to promote HIV treatment adherence or that address HIV testing or pre-exposure prophylaxis as long as these are part of ongoing not one-off support. It will exclude e-health interventions merely facilitating one-off support regarding HIV self-testing, clinic attendance or STI partner notification. The review will exclude interventions delivered by human providers via electronic media, for example chat rooms
Outcome	Prevention of HIV, STIs, sexual risk behaviour, alcohol and drug use, or common mental illnesses
Study design	Process or outcome evaluations (including economic evaluations) or papers describing intervention theory of change. Included process evaluations can employ any quantitative and/or qualitative design but must report empirically how delivery or receipt varied by characteristics of intervention, provider, user or context using quantitative and/or qualitative data. These studies may report exclusively on process evaluations or report process alongside outcome data. Included outcome and economic evaluations must employ prospective experimental or quasi-experimental control groups

Ideally I would be very grateful if you could let me know of additional relevant studies by email by 1 November 2018. However, if this is not possible, please could you indicate if and by when you would be able to respond?

If there are other experts you would recommend we contact, please do let me know.

If you have any questions, please do not hesitate to get in touch.

Thank you in advance for your assistance on this matter.

Yours sincerely

Chris Bonell

.....
Chris Bonell Professor of Public Health Sociology Head of Department of Public Health, Environments and Society

London School of Hygiene & Tropical Medicine

15–17 Tavistock Place

London WC1H 9SH Tel. + 44 (0)20 7612 7918

Already known studies

Abbott JAM, Klein B, McLaren S, Austin DW, Molloy M, Meyer D, McLeod B. Out & Online; effectiveness of a tailored online multi-symptom mental health and wellbeing program for same-sex attracted young adults: study protocol for a randomised controlled trial. *Trials* 2014;**15**:504.

Adam BD, Murray J, Ross S, Oliver J, Lincoln SG, Rynard V. hivstigma.com, an innovative web-supported stigma reduction intervention for gay and bisexual men. *Health Educ Res* 2011;**26**:795–807.

Bowen AM, Horvath K, Williams ML. A randomized control trial of internet-delivered HIV prevention targeting rural MSM. *Health Educ Res* 2007;**22**:120–7.

Bourne C, Knight V, Guy R, Wand H, Lu H, McNulty A. Short message service reminder intervention doubles sexually transmitted infection/HIV re-testing rates among men who have sex with men. *Sex Transm Infect* 2011;**87**:229–31.

Burns MN, Montague E, Mohr DC. Initial design of culturally informed behavioural intervention technologies: developing an mHealth intervention for young sexual minority men with generalized anxiety disorder and major depression. *J Med Internet Res* 2013;**15**:e271.

Bull SS, Vallejos D, Levine D, Ortiz C. Improving recruitment and retention for an online randomized controlled trial: experience from the Youthnet study. *AIDS Care* 2008;**20**:887–93.

Du Bois SN, Johnson SE, Mustanski B. Examining racial and ethnic minority differences among YMSM during recruitment for an online HIV prevention intervention study. *AIDS Behav* 2012;**16**:1430–5.

Fernandez MI, Hosek SG, Hotton AL, Gaylord SE, Hernandez N, Alfonso SV, Joseph H. A randomized controlled trial of POWER: an internet-based HIV prevention intervention for black bisexual men. *AIDS Behav* 2016;**20**:1951–60.

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Reminder e-mail (sent 2 October 2018)

Hello

I just wanted to follow up to see if there were any publications by yourself or others that you would recommend we consider for inclusion in the systematic review detailed below.

All the best

Chris Bonell

Updated search

E-mail sent on 30 April 2020

Dear All,

I hope this message finds you well. I am a Research Fellow at the London School of Hygiene & Tropical Medicine in the UK, where I am part of a team that is conducting a systematic review and meta-analysis of interventions addressing sexual health, mental health and substance use among MSM.

I'm writing to ask whether you have, or are aware of, any ongoing or completed work that has not yet been captured in our search and should be included in the review. Please find below a list of studies that are already included. Eligible studies must:

- Population: focus on men who have sex with men, transgender women and/or transgender men.
- Intervention: report on an intervention that is delivered via the internet, mobile phones, or other electronic means, targeting sexual behaviour, substance use and/or mental health among MSM.
- Exclusions: interventions that include a significant element of human delivery (e.g. receiving personal treatment from a provider via electronic means) are excluded, as are those offering 'one-off' (as opposed to ongoing) support.
- Types of reports: reports on outcome evaluations, process evaluations and/or theories of change are eligible, including those such as study protocols that describe any underlying programme theory of how the intervention is expected to work.
- Types of literature: published and unpublished/grey literature are both included.

Many thanks in advance,

Rebecca Meiksin

Rebecca Meiksin, MPH

Research Fellow

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Identified studies

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List of study suggestions generated from expert search

Initial search

None.

Updated search

Suggestions from Mathjis Lucassen

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Van Der Pol-Harney E, McAloon J. Psychosocial interventions for mental illness among LGBTQIA youth: a PRISMA-based systematic review. *Adolesc Res Rev* 2019;**4**:149–68.

Suggestion from Sheldon Morris

Moore DJ, Jain S, Dubé MP, Daar ES, Sun X, Young J, *et al.* Randomized controlled trial of daily text messages to support adherence to PrEP in at-risk for HIV individuals: the TAPIR study. *Clin Infect Dis* 2018;**66**:1566–72.

Suggestion from Cathy Reback

Reback C. *Text Messaging to Improve Linkage, Retention and Health Outcomes Among HIV-positive Young Transgender Women: Text Me, Girl!* Los Angeles, CA: Friends Research Institute, Inc.; 2020.

Suggestion from BR Simon Rosser

Rosser BRS, Oakes MJ, Konstan J, Hooper S, Horvath KJ, Danilenko GP, *et al.* Reducing HIV risk behavior of men who have sex with men through persuasive computing: results of the Men's INternet Study-II. *AIDS* 2010;**24**:2099–107.

Suggestion from Rob Stephenson

Stephenson R, Todd K, Kahle E, Sullivan SP, Miller-Perusse M, Sharma A, Horvath KJ. Project Moxie: results of a feasibility study of a telehealth intervention to increase HIV testing among binary and nonbinary transgender youth. *AIDS Behav* 2020;**24**:1517–30.

Suggestion from Patrick Sullivan

Jones J, Dominguez K, Stephenson R, Stekler JD, Castel AD, Mena LA, *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**:e16231.

Appendix 6 Economic report data extraction and quality assessment tools

Data extraction: economic evaluations

Item
Research question
Intervention
Comparator(s) and whether or not this represents standard practice in the UK
Base-case population characteristics and analysed subgroups
Form of economic evaluation
If cost–utility analysis, were QALYs reported?
Primary outcome measure(s) for the economic evaluation
Methods used to value health states and other benefits
Methods and sources of information used to estimate resource use
Did the study include start-up provider costs?
Did the study include ongoing provider costs?
Did the study include provider costs per contact?
Did the study include costs to patients?
Currency and price year
Details of model used and key structural issues and assumptions
Justification for model used
Base-case time horizon
Base-case discount rates for costs and benefits
Statistical test(s) and CI(s) for stochastic data
Sensitivity analyses

Base-case ICER

ICERs for specified subgroups

Author conclusions

QALY, quality-adjusted life-year.

Quality assessment: economic evaluations

Quality assessment items		Assessor				
		[Name]		[Name]		
Item	Sub-item	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment	Overall item assessment
Well-defined question in answerable form?	Did study examine both costs and effects of programme(s)?					
	Did study involve comparison of alternatives?					
	Was viewpoint for the analysis stated and was study placed in a decision-making context?					
Comprehensive description of competing alternatives?	Were any important alternatives omitted?					
	Was routine practice considered?					
Effectiveness of programme assessed?	Was effectiveness assessed through a randomised, controlled clinical trial? If so, did the trial protocol reflect what would happen in regular practice?					
	Were observational data or assumptions used to assess effectiveness? If so, are there any potential biases in results?					
All important and relevant costs and consequences for each alternative identified?	Was the range of outcomes broad enough for the research question?					
	Did the consequences cover all relevant viewpoints? (Possible viewpoints include community or social viewpoint, and those of patients and third-party payers. Other viewpoints may also be relevant depending on particular analysis)					
	Were capital costs, as well as operating costs, included?					

Quality assessment items		Assessor				
		[Name]		[Name]		Overall item assessment
Item	Sub-item	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment	
Costs and consequences measured accurately in appropriate physical units?	Were any of the identified items omitted from measurement? If so, does this indicate that they carried no weight in the subsequent analysis?					
	Were there any special circumstances (e.g. joint use of resources) making measurement difficult?					
	Were such circumstances handled appropriately?					
	Were unit and total costs reported transparently?					
	Were methods and sources of resource use credible?					
Costs and consequences valued credibly?	Were sources of all values clearly identified?					
	Were market values used for changes involving resources gained or depleted?					
	When market values were absent or did not reflect actual values, were adjustments made to approximate market values?					
	Was the valuation of consequences appropriate for the question?					
Costs and consequences adjusted for differential timing?	Were costs and consequences occurring in the future 'discounted' to present values? If so, were they discounted at 3.5% per annum?					
	Was there any justification provided for the discount rate used?					
Incremental analysis of costs and consequences of alternatives performed?	Were the additional (incremental) costs generated by one alternative vs. another compared with the additional effects, benefits, or utilities that were generated?					
Allowance made for uncertainty in estimates of costs and consequences?	If data on costs and consequences were stochastic, were relevant statistical analyses performed?					

Quality assessment items		Assessor				
		[Name]		[Name]		
Item	Sub-item	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment	Overall item assessment
Discussion of results includes all issues of concern to users?	If sensitivity analysis was employed, was there justification for choice of variables and the range of values?					
	Were study results sensitive to changes in the values?					
	Were conclusions of analysis based on an overall index or ratio of costs to consequences? If so, was the index interpreted in a mechanistic fashion or intelligently?					
	Did conclusions follow from the data reported?					
	Were results compared with those of others who have investigated same question? If so, were allowances made for potential differences in study methods?					
	Did the study discuss generalisability of results to other settings and patient/client groups?					
	Did the study allude to, or take account of, other important factors in the choice or decision under consideration?					
	Did the study discuss issues of implementation, such as feasibility of adopting 'preferred' programme given existing financial or other constraints, and whether or not any freed resources could be redeployed to other worthwhile programmes?					

Appendix 7 Protocol amendments

TABLE 13 Protocol amendments

Version	Amendment	Rationale	Date	Submitted to the National Institute for Health Research	Submitted to the international prospective register of systematic reviews (PROSPERO)
1 (proposal)	NA	NA	29 March 2018	29 March 2018	19 August 2018
2	Added 'For non-random evaluations, we will assess quality using the ROBINS-I tool'	We included random and non-random controlled outcome evaluations, but previously specified the risk-of-bias tool only for random designs	3 October 2018	4 October 2018	3 October 2018
3	Amended to indicate on p. 8 that the quality of economic evaluations was to be assessed using an adapted version of Drummond <i>et al.</i> , ⁸³ rather than the CHEERS checklist	Discussion with Alec Miners, the study economist, concluded that this was a more appropriate tool	16 April 2019	16 April 2019	16 April 2019
4	Corrected description of domains of assessment in Cochrane risk-of-bias tool	We noticed that these were slightly incorrect	8 May 2019	8 May 2019	No need to, as PROSPERO registration does not describe domains of assessment

NA, not applicable.

Appendix 8 Individual and synthesised theory of change diagrams for the ‘self-monitoring’ theory of change grouping

Figure 16 shows the theory of change diagram developed from Reback *et al.*'s¹¹⁵ reporting on the theory of change underpinning the TXT-Auto intervention. Through a combination of content tailored to a participant's risk profile (determined based on responses to a baseline survey), general content and weekly risk assessments, the intervention aimed to lead to self-monitoring and an increase in knowledge. Based on the description of its theory of change, the intervention also appeared to aim to increase self-efficacy. Although the report did not detail pathways from these mediators to targeted outcomes, the intervention ultimately aimed to reduce methamphetamine use, sex while using methamphetamines and CAI with male partners.

Figure 17 shows the diagram developed from Swendeman *et al.*'s¹¹⁹ reporting on the theory of change underpinning the smartphone self-monitoring intervention. Through self-monitoring of behaviours, and through what we inferred from the authors' description were activities to define criteria for one's behaviours, the intervention was theorised to lead to reflection on one's behaviours. This reflection was theorised to lead to self-reward or critique, resulting in self-regulation and self-management. Although the report did not detail pathways from these mediators to targeted outcomes, the intervention ultimately aimed to improve outcomes in the areas of medication adherence, mental health, substance use and sexual risk behaviours.

Figure 18 shows the ‘self-monitoring’ theory of change diagram, which was developed by synthesising the theories of change underpinning two interventions: TXT-Auto and the smartphone self-monitoring intervention.^{2,3} Based on the theory reports' descriptions of each intervention's activities, the synthesised theory posits that responding to questions about one's behaviour leads to behavioural self-monitoring. Informed primarily by the theory of change for the smartphone self-monitoring intervention, which offered a more detailed theorised pathway than the TXT-Auto intervention theory of change, self-monitoring is theorised to lead to reflection on one's behaviours in comparison with particular criteria. This is theorised to lead to self-reward or self-critique, which is posited to prompt self-regulation. This process is theorised to influence behavioural outcomes.

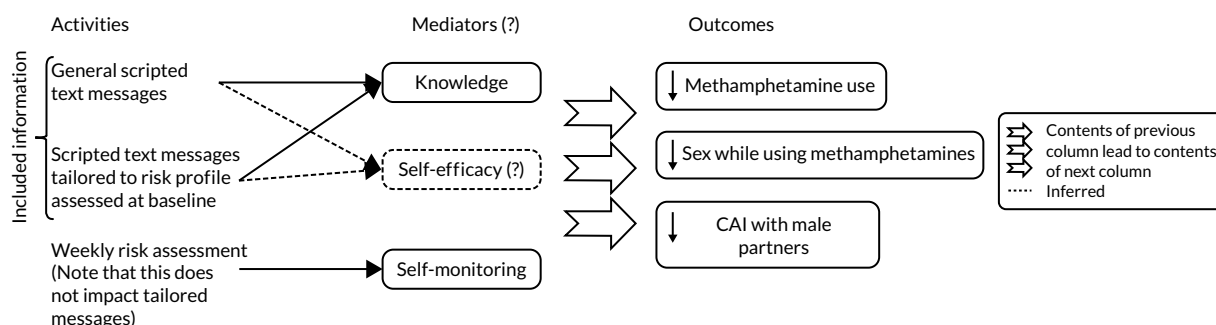


FIGURE 16 Theory of change diagram for the TXT-Auto intervention. Reproduced with permission from Meiksin *et al.*¹ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>. The figures include minor changes from the original figure.

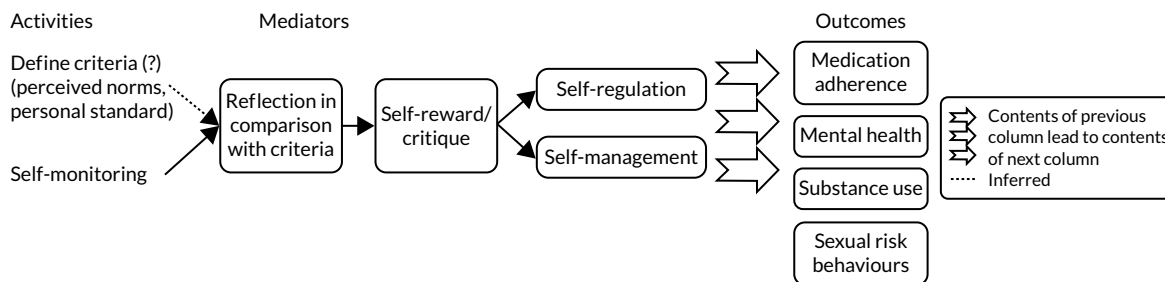


FIGURE 17 Theory of change diagram for the smartphone self-monitoring intervention. Reproduced with permission from Meiksin *et al.*¹ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>. The figures include minor changes from the original figure.

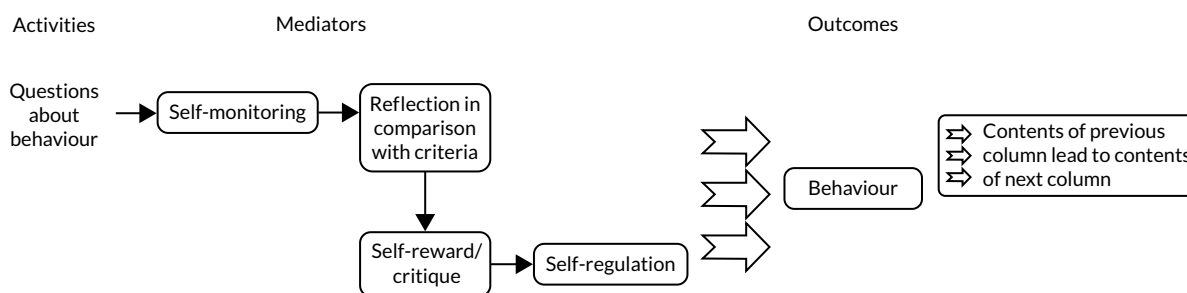


FIGURE 18 ‘Self-monitoring’ synthesised theory of change diagram. Reproduced with permission from Meiksin *et al.*¹ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: <https://creativecommons.org/licenses/by/4.0/>. The figures include minor changes from the original figure.

Appendix 9 Characteristics and quality appraisal of process evaluations

TABLE 14 Summary of process evaluation characteristics and quality appraisal

Study details	Characteristics of process evaluations	
<i>Programme: HealthMindr (Sullivan et al.¹¹⁸)</i>		
Methods	Overall study design	Cross-sectional
	Research questions/hypotheses:	Purpose was to describe and report on the initial evaluation of the app for usability and acceptability; hypothesised that, compared with those in Atlanta, GA, participants in Seattle, WA, would be less interested in using the app to access services
	Timing and duration	Recruitment May–August 2015. Participants completed the evaluation survey after having the app on their mobile phone for 4 months
	Aspects of process evaluated	Reach, acceptability, mechanism, context
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied with context and with characteristics of intervention and participants
	Data collection	Usage data on participants' actions within the app (button clicks, page views and assessment and quiz responses), and web-based survey after 4-month intervention period. Survey asked about motivation to use the app; use of at-home test kit and of condoms for those placing in-app orders; HIV testing, PrEP and nPEP use during the study period; and questions on the app's features, usability, design, content and functionality (using Likert scales and optional open-text fields). In-depth interviews with subsample of participants recommended to receive PrEP (about their decision of whether or not to start PrEP and how the app influenced their decision-making)
	Data analysis	Used usage log data to calculate descriptive statistics for the number of days using the app, number of pages accessed and time spent in the app and engaged with the app, and counts and percentages of features used and app pages accessed. Calculated percentage of participants completing the follow-up survey; calculated system usability score (aggregate score ranges 1–100 based on a series of survey questions)
		continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Details of participants	Location: country (region)	USA (Atlanta, GA, and Seattle, WA)
	Target population	MSM living in Atlanta, GA, and Seattle, WA, metro areas
	Sampling	Web-based recruitment via Facebook advertisements targeting adult males living in Atlanta or Seattle who indicate an interest in men; and advertisements on a MSM social or sexual networking mobile app using geolocation to target users in the Atlanta or Seattle metropolitan areas
		Eligible participants were Android phone users aged ≥ 18 years living in the targeted areas, spoke English, were assigned male sex at birth and identified as male at screening, had had sex with a man in the previous year and had never tested positive for HIV
		Invited selected participants recommended to receive PrEP for in-depth interviews, including all participants who started PrEP
	Actual sample	<ul style="list-style-type: none"> Participants: 121 MSM (72 in Atlanta, GA, and 49 in Seattle, WA) Follow-up: app usage data available for 90% of sample; 81% completed 4-month evaluation survey
	Sexuality	<ul style="list-style-type: none"> Total: 86% gay/homosexual, 11.6% bisexual Atlanta: 88.9% gay/homosexual, 11.1% bisexual Seattle: 81.6% gay/homosexual, 12.2% bisexual
	Gender identity	100% male
	Ethnicity	<ul style="list-style-type: none"> Total: 51.2% white/Caucasian, 20.7% black or African American, 8.3% Hispanic Atlanta: 47.2% white or Caucasian, 33.3% black or African American, 4.2% Hispanic or Latino, 6.9% Asian or Pacific Islander, 8.3% multiracial or other Seattle: 57.1% white or Caucasian, 2% black or African American, 14.3% Hispanic or Latino, 14.3% Asian or Pacific Islander, 12.2% multiracial or other
	SES	Not stated
Median age in years (interquartile range)	<ul style="list-style-type: none"> Total: 28 (24–34) Atlanta: 28 (24–35) Seattle: 28 (23–33) 	

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Quality assessment</i>		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Large, purposively selected sample; used multiple methods of recruitment
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Used multiple forms of data including open-text fields and validated usability scale
Were steps taken to minimise bias and error/increase rigour in data analysis?	No	Did not describe analysis methods for qualitative data
Were the findings of the study grounded in/supported by data?	Yes	All findings were supported by evidence
Was there good breadth and depth achieved in the findings?	Yes	Although the study used primarily quantitative methods, these data provided both a breadth and depth of findings about different aspects of the app
Were the perspectives of MSM privileged?	No	Data were from MSM, but appeared to be reported from closed-ended questions; briefly referenced qualitative findings, but these were not clearly identified
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	Medium	High rates of survey response and usage data, but qualitative analysis methods not presented and results from qualitative data collection not clearly presented
Usefulness of findings	High	Data provided useful findings that shed light on how design affected use, and on differences in receipt by setting
Programme: Keep it Up! (Mustanski et al.¹²²)		
Methods	Overall study design	RCT
	Research questions/hypotheses	This pilot study aimed to determine the feasibility of the study methods (enrolment and retention) and measure the acceptability of the intervention
	Timing and duration	Evaluation took place August 2009–September 2010
	Aspects of process evaluated	Feasibility, reach, acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention
Data collection	Assessed acceptability using a self-administered eight-item Likert scale measure as well as open-ended questions administered immediately post intervention. Assessed feasibility using enrolment and retention data, and assessed reach by calculating the proportion of participants completing all intervention modules	

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Data analysis	Descriptive statistics of quantitative acceptability measure, and counts and percentages to assess enrolment and retention. Responses to qualitative questions on acceptability were coded based on the main categories of format, content and take-away. Responses were double-coded and reliability assessed using Cohen's kappa
Details of participants	Location: country (region)	USA (Chicago, IL)
	Target population	Ethnically and racially diverse young MSM who have received a HIV-negative test result at a clinic
	Sampling	Young MSM aged 18–24 years with a HIV-negative test result from participating clinics were eligible to participate if their birth sex and gender identity were male and they had had sex with a male in the previous 3 months, had at least one act of unprotected anal sex in the previous 3 months, were not currently in a monogamous/exclusive relationship lasting longer than 1 year, were able to read at an eighth-grade level and had accessed the internet at least several times in the previous month
	Actual sample	102 participants completed the baseline assessment and were randomised, of which 50 were randomised to the intervention arm. Of those in the intervention arm, 48 (96.1%) completed post-intervention follow-up when process evaluation questions were asked
	Sexuality	Baseline characteristics among intervention sample: 78.0% gay/homosexual, 22.0% bisexual/other
	Gender identity	Not stated; eligible participants were male at birth and had a male gender identity
	Ethnicity	Baseline characteristics among intervention sample: 46.0% white Latino, 24.0% white non-Latino, 14.0% African American, 16.0% other
	SES	Baseline characteristics among intervention sample: <ul style="list-style-type: none"> • Employment: 56.0% employed • Education: 24.0% some high school or graduated high school, 76.0% some college or graduated college
	Age (years)	Baseline characteristics among intervention sample: Mean 21.62 (SD 1.97)

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Quality assessment</i>		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Sample was all those involved in RCT, which had clear inclusion criteria and used multiple methods of recruitment
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Assessed acceptability using items from existing scale; open-ended question also used
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Qualitative data were double-coded and reliability was assessed
Were the findings of the study grounded in/supported by data?	No	Did not provide supporting quotations for all themes
Was there good breadth and depth achieved in the findings?	No	Quantitative findings were reported as one combined rating; qualitative findings reported thinly on aspects of the intervention that participants did and did not like
Were the perspectives of MSM privileged?	Yes	Data came from MSM and were analysed and reported in detail; data collection included open-ended questions
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	High	High response rate among intervention participants and well-described methods; findings were likely to be valid
Usefulness of findings	Medium	Findings were relatively thin, but addressed how acceptability varied by characteristics of the intervention
Programme: Keep it Up! (Greene et al.¹⁰³)		
Methods	Overall study design	Uncontrolled before/after
	Research questions/hypotheses	Aimed to describe the adaptation and implementation procedures for intervention delivery in a non-profit, community-based organisation and to assess intervention acceptability among participants
	Timing and duration	Intervention was delivered from 2012 to 2013
	Aspects of process evaluated	Reach, acceptability, context
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention and of participants
Data collection	Online evaluation surveys at baseline, post intervention and at the 6- and 12-week follow-ups. Data for process evaluation synthesis come from responses to three open-ended questions administered at the 6- and 12-week follow-ups	

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Data analysis	Content analysis. Following coding by two independent raters, reliability was assessed using Cohen's kappa. Excerpts were organised by theme and coders identified examples of typical responses
Details of participants	Location: country	USA
	Target population	Racially and ethnically diverse young MSM
	Sampling	Participants were recruited by counsellors in a HIV testing clinic, at the organisation's in-house events, via print and online advertisements, and via friend referrals. Eligible participants were aged 18–24 years, assigned male sex at birth, had a valid e-mail address and either received a HIV-negative test result from clinic staff or self-reported having a HIV-negative test result in the previous 3 months. All were invited to take part in evaluation surveys containing the questions used in this review's process evaluation synthesis
	Actual sample	343 participants enrolled in and completed the intervention (this is 45.4% of those eligible; no information is provided on the number completing the baseline survey but not the intervention, if any). Of these, 219 (63.8%) completed the 6-week follow-up survey and 200 (58.31%) completed the 12-week follow-up survey
	Sexuality	<ul style="list-style-type: none"> • Baseline: 73.4% gay/homosexual, 26.3% bisexual/other • 12-month follow-up: 84.5% gay/homosexual, 15.5% bisexual/other
	Gender identity	<ul style="list-style-type: none"> • Baseline: 92.8% male, 1.8% female, 5.0% transgender • 12-month follow-up: 93.0% male, 1.5% female, 5.5% transgender
	Ethnicity	<ul style="list-style-type: none"> • Baseline: 31.6% African American, 21.6% Latino, 33.9% white, 12.9% other • 12-month follow-up: 21.0% African American, 19.0% Latino, 48.5% white, 11.5% other
	SES	<p>Baseline:</p> <ul style="list-style-type: none"> • Employment: 50.6% employed • Education: 33.6% some high school or graduated high school, 66.4% some college or graduated college <p>12-month follow-up:</p> <ul style="list-style-type: none"> • Employment: 60.0% employed • Education: 20.5% some high school or graduated high school, 79.5% some college or graduated college
	Age (years), mean (SD)	<ul style="list-style-type: none"> • Baseline: 21.52 (1.94) • 12-month follow-up: 21.73 (1.91)

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Quality assessment</i>		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Questions directed at all intervention recipients, with good response rate
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Used existing survey measures of acceptability augmented by open-ended questions
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Qualitative data double-coded with high reliability
Were the findings of the study grounded in/supported by data?	Yes	Themes were defined and supporting questions provided
Was there good breadth and depth achieved in the findings?	No	Qualitative findings thinly described likes and dislikes and quantitative findings reported as one combined rating
Were the perspectives of MSM privileged?	Yes	Sampled MSM and survey included a few open-ended response questions
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	High	Data were not in-depth but were likely to be valid
Usefulness of findings	High	Findings addressed how acceptability varied by aspects of the intervention
Programme: Keep it Up! (Madkins et al.¹³⁰)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Examined acceptability of and engagement with Keep it Up! intervention and aimed to explore differences in acceptability and engagement by age, race/ethnicity and education
	Timing and duration	Recruitment took place May–December 2013. Following baseline assessment, participants were enrolled and randomised. Post-test survey immediately followed intervention modules
	Aspects of process evaluated	Acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention and participants
	Data collection	Baseline and post-test survey data from intervention arm participants, data captured from intervention use on time spent in the intervention and participants' ratings of each module, provided before proceeding to the next module. Intervention acceptability and tolerability assessed using adapted version of existing scale

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Data analysis	Conducted confirmatory factor analysis followed by ANOVA to compare differences in intervention acceptability and tolerability scale, and ANOVA to compare differences in time to complete intervention. Logistic regression was used to assess star ratings, adjusting for demographic factors and intervention site; also assessed race by education interactions and included these when significant. Two independent raters conducted content analysis using qualitative data to identify themes related to acceptability, assessing reliability via Cohen's kappa. Subtracted number of 'dislike' codes from number of 'like' codes to create score for overall favourability, comparing mean scores by race and education
Details of participants	Location: country	USA
	Target population	Ethnically and racially diverse young MSM
	Sampling	Participants were recruited from HIV testing sites, local health department clinics, street outreach, local and national advertising and research participant registries. Eligible participants were cisgender MSM reporting sexual risk, aged 18–20 years, receiving a HIV-negative test from a study site or via remote HIV self-testing
	Actual sample	445 intervention participants at baseline (84% response rate) and 375 (84% of baseline sample) at follow-up
	Sexuality	89.0% gay/homosexual, 7.1% bisexual and 3.9% queer
	Gender identity	Not stated, but eligible participants were cisgender MSM
	Ethnicity	37% white, 24% black, 30% Latino, 9% other race
	Education level	2.8% some high school, 10.6% high school diploma/GED equivalent, 7.8% technical/associate degree, 40% some college education, 29.4% graduated college, 9.5% graduate school
	Age (years), mean (SD)	24.33 (3.00)
Details of intervention	Description	See the Mustanski <i>et al.</i> ¹²² section previously in this table
	Technology	Internet
	Timing and duration	Seven modules had to be done at least 24 hours apart and took 2 hours to complete. These were followed by booster sessions at 3 and 6 months
	Target population	Ethnically and racially diverse young MSM
	Theoretical framework	See the Mustanski <i>et al.</i> ¹²² section previously in this table
	Development	See the Mustanski <i>et al.</i> ¹²² section previously in this table

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details		Characteristics of process evaluations	
	Provider organisation		See the Mustanski <i>et al.</i> ¹²² section previously in this table
	Content and activities		Online modules were based on situations and settings relevant to young MSM and used a variety of media and methods such as video, animation and games. Modules addressed, among other topics, condom use; triggers for unprotected sex; obtaining support; communication; the effects of mood, drug and alcohol abuse and sexual arousal; power dynamics in relationships; and the limits of serosorting. Users developed a HIV/STI prevention plan, and goals were suggested tailored to users' baseline risks. Two booster sessions reinforced learning, introduced new skills and provided an opportunity to review earlier goals
	Control		Online content similar to available didactic HIV prevention materials. Control was matched to the intervention in the number of modules and the requirement to participate in them over three sessions. At 3- and 6-month follow-up sessions (i.e. the same timing as intervention booster sessions), materials were reviewed again and information was provided on biomedical strategies
Quality assessment			
Questions used to judge rigour and relevance	Reviewer judgement	Description	
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Recruited nationwide using a range of avenues with defined recruitment criteria	
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Scale based on existing measure and conducted confirmatory factor analysis in this sample	
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Two coders analysed qualitative data; controlled for potential confounders and explored interaction in quantitative analysis	
Were the findings of the study grounded in/supported by data?	Yes	Quantitative findings in table match article narrative	
Was there good breadth and depth achieved in the findings?	Yes	Used both closed- and open-ended questions and explored a range of aspects of intervention feedback	
Were the perspectives of MSM privileged?	Yes	Collected both quantitative and qualitative data from MSM participants	
Overall reliability and usefulness of findings			
Reliability of findings	High	Used rigour in sampling, analysis and reporting	
Usefulness of findings	High	Conducted an extensive analysis of differences in acceptability by race, education level and age	
			continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Programme: myDEx (Bauermeister et al.¹²³)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Aimed to assess proposed intervention mechanisms of change associated with risk of HIV
	Timing and duration	Baseline questionnaire was followed by randomisation. Follow-up assessments took place at 30, 60 and 90 days post randomisation
	Aspects of process evaluated	Feasibility, acceptability and mechanism
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention
	Data collection	Assessed acceptability, usability and utility quantitatively at the 30-day follow-up assessment. Questions assessed overall satisfaction, willingness to recommend the intervention, likelihood to continue using the intervention, usability, ease of navigation and technical responsiveness
	Data analysis	Compared scores between intervention and control arms
Details of participants	Location: country	USA
	Target population	Single and young gay, bisexual and other MSM who are presumed to be HIV negative and who report CAI with partners met online
	Sampling	Recruited from across the USA via online advertisements on social and sexual networking sites. Eligible participants were single, cisgender males aged 18–24 years who reported online dating app use, sexual risk and HIV-negative or HIV-unknown status
	Actual sample	180 participants enrolled and were randomised; 91.1% completed at least one follow-up assessment, with 79.4% completing the 30-day follow-up. Owing to a programming error, 25 control participants were exposed to the intervention and excluded, leaving 155 participants included in the final analysis overall
	Sexuality	<ul style="list-style-type: none"> • Full sample: 88.3% gay, 7.8% bisexual, 3.9% queer • <i>n</i> = 155 included in analysis: 89.0% gay, 7.1% bisexual, 3.9% queer
	Gender identity	Not stated; eligible participants were cisgender MSM

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Ethnicity	<p>Full sample</p> <ul style="list-style-type: none"> Race: 67.2% white, 16.1% multiracial, 10.0% black, 5.6% Asian, 0.6% Middle Eastern, 0.6% Native American Ethnicity: 30% Hispanic/Latino <p><i>n</i> = 155 included in analysis</p> <ul style="list-style-type: none"> Race: 67.1% white, 16.1% multiracial, 10.0% black, 5.2% Asian, 0.6% Middle Eastern, 0.6% Native American Ethnicity: 30% Hispanic/Latino
	Education level	<p>Full sample:</p> <p>2.8% some high school, 10.6% high school diploma or GED equivalent, 7.8% technical or associate degree, 40.0% some college, 29.4% graduated college, 9.5% reported attending graduate school</p>
	Age (years), mean (SD)	<ul style="list-style-type: none"> Full sample: 21.67 (1.81) <i>n</i> = 155 included in analysis: 21.5 (1.82)
Details of intervention	Description	<p>Online, module-based comprehensive sex education intervention to improve psychological well-being and HIV risk</p>
	Technology	<p>Internet</p>
	Timing and duration	<p>6 sessions, each lasting 10 minutes</p>
	Target population	<p>Young adult MSM</p>
	Theoretical framework	<p>This intervention aimed to improve psychological well-being and reduce HIV risk via behaviour change, increasing PrEP use and decreasing alcohol and drug use before sex by targeting cognitive and affective motivations. It was informed by the notion that decision-making is shaped by both cognitive and affective motivations and that, when these are less aligned, there is less of a correspondence between intentions and behaviour</p> <p>Content targeting cognitive motivations focused on attitudes, norms and perceived behavioural control to engage in risk reduction behaviours. Attitudes and norms were theorised to each influence each other, and all three constructs were theorised to influence behavioural intentions. Content targeting affective motivations addressed relationship ideation, anticipated regret, limerence and decisional balance to forgo condoms. Affective motivations were theorised to influence behavioural intentions, which were theorised to directly influence HIV risk reduction behaviours</p>

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
		Psychological risk correlates, psychological distress and substance use and abuse were theorised to influence regulation of affective motivations, and therefore behavioural control, affecting risk behaviours. Type of sexual partner was theorised to affect perceived behavioural control and the relationship between behavioural intentions and actual behaviours
	Development	Sociodemographically diverse youth advisory board of three young MSM provided input on content and delivery and trained developers on same-sex attraction and young MSM dating behaviours
	Provider organisation	Not stated
	Content and activities	This module-based comprehensive sex education intervention aimed to improve psychological well-being and reduce HIV risk by targeting condom use, HIV/STI testing, unprotected anal sex, PrEP and alcohol/drug use before sex. Each session included activities and videos, and content within each session was organised into three levels: a core message, deeper discussion of relevant topics and an activity. Content used storytelling, case scenarios, motivational interviewing, graphics and videos, and it was tailored via personalisation, content matching and feedback to maximise persuasiveness and relevance. Interactive activities included role-play scenarios, a diary, quizzes and opportunities to develop dating strategies
	Control	Information-only attention control: six sessions, matching the intervention's design, with content mirroring that from the US Centers for Disease Control and Prevention's HIV Risk Reduction Tool ¹⁶⁰
<i>Quality assessment</i>		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Participants recruited from across the country using defined recruitment criteria and multiple online sites
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Provided incentives to support retention throughout follow-up period
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Assessed and found no sociodemographic differences between arms
Were the findings of the study grounded in/supported by data?	Yes	Quantitative results are presented clearly in a table
Was there good breadth and depth achieved in the findings?	No	All findings based on closed-ended Likert scale items
Were the perspectives of MSM privileged?	No	Although participants were MSM, all findings were based on closed-ended Likert scale items

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	High	Participants recruited from across the country
Usefulness of findings	Low	Provided some information on usability, but did not explore which aspects were most useful or could be improved
Programme: online mindfulness-based cognitive therapy (no name) (Avellar⁹⁶)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Aimed to assess feasibility, acceptability and factors leading to high attrition in efficacy study. Research questions: <ul style="list-style-type: none"> • What would be needed to recruit and retain an adequate sample of participants to conduct an efficacy study of multisession online mindfulness training? • How likely are same-sex attracted men on Amazon Mechanical Turk (MTurk) (Amazon.com, Inc., Bellevue, WA, USA) to participate in multi-session online mindfulness training? • What number of participant characteristics, recruitment processes and characteristics of the intervention would yield enough participants to have sufficient statistical power? • How valuable do same-sex attracted men find multisession online mindfulness training? • To what extent did they perceive mindfulness as something that would benefit their mental health? • To what extent do they perceive mindfulness training as worth the effort to commit to the mindfulness practices?
	Timing and duration	Not specified. Pre test preceded allocation to intervention or wait-list control group, sessions were weekly and, following the intervention, participants were invited to participate in the feasibility and acceptability study
	Aspects of process evaluated	Feasibility, reach and acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention and of participants
	Data collection	Online baseline and post-intervention surveys, with the latter including quantitative and qualitative items assessing acceptability and feasibility. Quantitative measures assessed ease of use, overall utility, appropriateness for target group, and acquisition of new knowledge. Qualitative questions asked participants about aspects of the efficacy study they liked most and least
continued		

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Data analysis	<ul style="list-style-type: none"> Quantitative data: analysed by item-by-item descriptive statistics, multinomial logistic regression and chi-squared tests of independence Qualitative data: content analysis, generating descriptive codes to describe each unit of data, then category codes to describe groups of descriptive codes. Codes were audited at two stages by another researcher
Details of participants	Location: country	USA
	Target population	Same-sex attracted men with a range of bullying experiences during grade and high schools
	Sampling	Eligible participants for the overall efficacy study were aged ≥ 18 years, identified gay- or same-sex attracted males, were fluent in English and were not currently engaged in psychotherapy. They were recruited through MTurk using MTurk's keyword function. Intervention group participants were eligible to take part in the process evaluation component if they completed at least the pre test
	Actual sample	80 intervention group participants completed at least the pre test; of these, 41 (51.3%) completed the post-intervention feasibility and acceptability survey
	Sexuality	Not stated
	Gender identity	Not stated
	Ethnicity	<ul style="list-style-type: none"> Baseline: 67.5% European American/white, 12.5% Latino/a or Hispanic, 2.5% African American or black, 1.25% American Indian, 5% Asian American, 1.25% Middle Eastern, 3.75% multiethnic Follow-up: 68.3% European American/white, 9.7% Latino/a or Hispanic, 2.5% African American or black, 2.5% American Indian, 7.3% Asian American, 2.5% Middle Eastern, 7.3% multiethnic
	SES	Baseline: <ul style="list-style-type: none"> SES – level out of 7, with 1 as worst off and 7 as best off: 1 (worst off), 2.5%; 2, 23.75%; 3, 23.75%; 4, 23.75%; 5, 23.75%; 6, 5%; 7 (best off), 0% Education: 1.25% less than high school, 8.75% high school or GED, 1.25% trade or vocational, 27.5% some college – no degree, 16.2% associate degree, 31.2% bachelor degree, 15% graduate or professional degree

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Age (years)	<p>Follow-up:</p> <ul style="list-style-type: none"> • SES – level out of 7, with 1 as worst off and 7 as best off: 1 (worst off), 2.5%; 2, 7.3%; 3, 17.1%; 4, 19.5%; 5, 21.9%; 6, 7.3%; 7 (best off), 0% • Education: 2.5% less than high school, 7.3% high school or GED, 0% trade or vocational, 19.5% some college – no degree, 24.4% associate degree, 29.3% bachelor degree, 17.1% graduate or professional degree <p>Baseline among those ...</p> <ul style="list-style-type: none"> • Completing pre test only: mean 28.14 (SD 8.63), median 25.5 • Completing between one and three sessions: mean 28.14 (SD 8.05), median 25.5 • Completing between four and eight sessions: mean 28.87 (SD 4.03), median 27 <p>Follow-up among those ...</p> <ul style="list-style-type: none"> • Completing pre test only: mean 30.15 (SD 6.41), median 28 • Completing between one and three sessions: mean 30.08 (SD 10.4), median 25 • Completing between four and eight sessions: mean 26.93 (SD 4.06), median 27
Quality assessment		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	No	Low response rate, resulting in small sample likely to differ from trial
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Used quantitative and qualitative survey questions; items based on existing, reliable measures
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Iterative checking of emerging analysis by second researcher
Were the findings of the study grounded in/supported by data?	Yes	Detailed results presented, including clear summaries of participant accounts
Was there good breadth and depth achieved in the findings?	Yes	Results included specific aspects of intervention that participants liked/disliked, and why
Were the perspectives of MSM privileged?	Yes	Qualitative and quantitative data from MSM were reported in detail
Overall reliability and usefulness of findings		
Reliability of findings	Medium	Used multiple methods of data collection, but response rates were low
Usefulness of findings	High	Reported data on aspects of intervention affecting receipt
continued		

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Programme: Queer Sex Ed (Mustanski et al.¹¹¹)</i>		
Methods	Overall study design	Uncontrolled before/after study
	Research questions/hypotheses	The study aimed to: <ol style="list-style-type: none"> 1. determine the feasibility of recruiting and enrolling LGBT youth in same-sex relationships into an online sexual health intervention 2. use mixed methods to evaluate the acceptability of and engagement with the intervention
	Timing and duration	Enrolment from November 2012 to April 2013. Participants completed a pre-test survey, then accessed the intervention. Post-test surveys were completed at least 2 weeks after intervention completion, but it was not clear whether these included the process evaluation questions or only impact-related measures. Content ratings seemed to have been asked throughout the intervention, and qualitative feedback was requested after the intervention (timing was not specified)
	Aspects of process evaluated	Reach and acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention
	Data collection	Participants rated each page on whether or not content was helpful, informational and interesting on a scale of 1–5 stars. Questions seemed to be embedded in the intervention pages rather than asked post intervention, but this is not clear. After intervention completion, participants were asked open-ended questions about what they liked and disliked about the intervention; timing and method of this data collection were unclear
	Data analysis	Overall content ratings calculated by taking the means of all scale ratings for individual pages. Qualitative responses on intervention acceptability were coded by two independent coders according to the categories of format, content and take-away messages; reliability was assessed using Cohen's kappa. List of excerpts for each theme was generated and coders selected examples of typical responses
Details of participants	Location: country	USA <ul style="list-style-type: none"> • Male-born participants (n = 107): 79.4% urban, 20.6% rural • Female-born participants (n = 95): 85.3% urban, 12.6% rural, 2.1% missing
	Target population	LGBT youth

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details		Characteristics of process evaluations
	Sampling	Eligible participants identified as LGBT or queer, or reported same-sex attraction or behaviours; were aged 16–20 years; lived in the USA; and were currently engaged in a romantic relationship with a partner of the same biological sex. Targeted recruitment proceeded via social media
	Actual sample	276 participants consented and completed the pre-test survey, of whom 210 (76.1%) completed the intervention. Of these 210, 202 (73.2%) completed the post-test survey and constitute the sample for the process evaluation
	Sexuality	<ul style="list-style-type: none"> • Male-born participants (n = 107): 84.1% gay/lesbian, 9.3% bisexual, 5.6% queer, 0.9% unsure/questioning • Female-born participants (n = 95): 54.7% gay/lesbian, 22.1% bisexual, 22.1% queer, 1.1% unsure/questioning
	Gender identity	<ul style="list-style-type: none"> • Male-born participants (n = 107): 96.3% male, 3.7% transgender • Female-born participants (n = 95): 88.4% female, 10.5% transgender
	Ethnicity	<ul style="list-style-type: none"> • Male-born participants (n = 107): 76.6% white, 15% Latino/a, 0.9% black, 7.5% other • Female-born participants (n = 95): 82.1% white, 5.3% Latino/a, 5.3% black, 7.4% other
	Education level	<ul style="list-style-type: none"> • Male-born participants (n = 107): 41.4% less than high school, 22.4% high school graduate, 35.5% higher than high school • Female-born participants (n = 95): 40% less than high school, 20.4% high school graduate, 37.9% higher than high school
	Age (years)	<ul style="list-style-type: none"> • Male-born participants (n = 107): 18.7% were aged 16 years, 25.2% were 17, 20.6% were 18, 16.8% were 19 and 18.7% were 20 • Female-born participants (n = 95): 22.1% were aged 16 years, 22.1% were 17, 17.9% were 18, 20% were 19 and 17.9% were 20 • Participants completing pre-test survey only: mean age 18.3 • Participants completing post-test survey: mean age 18.9
Quality assessment		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Sample was all those receiving intervention, which was guided by clear inclusion criteria and used multiple recruitment methods
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Collected both quantitative and qualitative data, including content ratings for each page of the intervention

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Qualitative data were coded by two independent coders who achieved a high rate of reliability
Were the findings of the study grounded in/supported by data?	Yes	Findings were presented in text that gave areas of likes and dislikes and in a table, which provided supporting quotations
Was there good breadth and depth achieved in the findings?	No	Findings were presented as list of likes and dislikes with no in-depth analysis; quotations were very short and not interpreted
Were the perspectives of MSM privileged?	Yes	Open-ended questions allowed some space for MSM participants to set out their own views
Overall reliability and usefulness of findings		
Reliability of findings	Medium	High response rate and well-described analysis methods, but data collected were thin and presented with little interpretation
Usefulness of findings	Low	Presented a list of likes and dislikes with little analysis of how aspects of the intervention affected its receipt
Programme: Rainbow SPARX (Lucassen et al.¹⁰⁸)		
Methods	Overall study design	Uncontrolled before/after study
	Research questions/hypotheses	Objectives of the process evaluation were to: <ul style="list-style-type: none"> ascertain the acceptability of the intervention assess feasibility (based on recruitment and uptake rates)
	Timing and duration	The overall (including effectiveness) study included assessments at pre intervention, post intervention and 3-month follow-up. Acceptability was assessed at post intervention
	Aspects of process evaluated	Feasibility, reach and acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention and of participants
	Data collection	Post-intervention questionnaire assessed acceptability via Likert-format questions on intervention appeal, usefulness and likability. It also asked about time required to complete each module, whether or not participants would recommend the intervention to their friends, whether or not they thought it would appeal to other young people, and how many modules they completed
	Data analysis	Feasibility was determined by the number of participants expressing interest in participating in the study and the number who enrolled. Surveys were analysed quantitatively to assess acceptability

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Details of participants	Location: country (region)	New Zealand (Auckland)
	Target population	Sexual minority youth with depressive symptoms
	Sampling	Eligible participants were sexual minority youth (adolescents who are sexually attracted to the same sex or both sexes, or who were questioning their sexuality) aged 13–19 years with depressive symptoms (Child Depression Rating Scale-Revised raw score > 30), living in Auckland, New Zealand. A youth-led organisation for sexual minority youth promoted the study and four secondary schools supportive of the initiative encouraged participation. Sexual minority media (type not specified) advertised and endorsed the study
	Actual sample	21 participants enrolled in the study. Of these, 19 (91%) completed the intervention and post-intervention assessment
	Sexuality	All were sexual minority participants, defined by the authors as those sexually attracted to the same or both sexes or who were questioning their sexuality
	Gender identity	Participants enrolled in the study: 52.4% identified as male
	Ethnicity	Participants enrolled in the study: 71.4% New Zealand European, 9.5% Māori, 4.8% of a Pacific ethnicity, 14.3% Asian
	SES	Not stated
	Age	Participants enrolled in the study: aged 13–19 years with a mean age of 16.5 (SD 1.6) years
Quality assessment		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Sampled all those involved in pilot study, which had clear inclusion criteria and multimethod recruitment
Were steps taken to minimise bias and error/increase rigour in data collection?	No	Used all fixed-response questions; did not discuss piloting or describe which aspects and components of the intervention were asked about
Were steps taken to minimise bias and error/increase rigour in data analysis?	No	Did not describe analysis methods
Were the findings of the study grounded in/supported by data?	Yes	Findings on acceptability were presented transparently
Was there good breadth and depth achieved in the findings?	No	Findings limited to reporting on intervention reach and limited findings on acceptability based on quantitative data
Were the perspectives of MSM privileged?	No	Sampled MSM, but only findings on fixed-response questions were presented

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	High	Sample was representative of those in the trial; data collected were thin but likely to be valid
Usefulness of findings	Medium	Reported data on aspects of intervention affecting receipt, but findings were thin
Programme: Rainbow SPARX (Lucassen et al.¹⁰⁷)		
Methods	Overall study design	Uncontrolled before/after study
	Research questions/hypotheses	The study sought to determine participants' views on: <ul style="list-style-type: none"> • what they liked and did not like about the intervention • how the intervention might benefit others • what they thought of the sexuality- (or 'Rainbow'-) specific content • what they thought about completing the homework tasks • whether or not the programme helped them feel better or less depressed
	Timing and duration	Data for this component of the study were collected immediately after the post-intervention assessment point
	Aspects of process evaluated	Acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of the intervention and of participants
Data collection	Semistructured interviews, which were audio-recorded and professionally transcribed	
Data analysis	Used the 'general inductive approach', which focused on gathering participants' views on pre-existing questions or topics. Analysis aimed to investigate common themes and points of agreement/disagreement. Transcripts were read and reread, with lower order units of meaning clustered with similar units. Researchers searched for contradictory views and subtopics, and reviewed clusters to identify the meaning of each category. An accuracy check identified only minor discrepancies, resolved through discussion, and data were coded using the identified themes	
Details of participants	Location: country (region):	New Zealand (Auckland)
	Target population	Sexual minority youth
	Sampling	Participants for the overall study of which this process evaluation was a part were recruited from four secondary schools, from a youth-led organisation for sexual minority youth and via sexual minority media advertisements about the study

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details		Characteristics of process evaluations	
	Actual sample		25 participants took part in an interview (this was everyone who was invited to take part in one)
	Sexuality		All were sexual minority participants, defined by the authors as those sexually attracted to the same or both sexes or who are questioning their sexuality
	Gender identity		12 (48%) identified as male, 13 (52%) identified as female (including two transgender girls). In total, 14 (56%) identified as male or as transgender girls
	Ethnicity		15 (60%) New Zealand European, 3 (12%) Māori, 2 (8%) Asian, 1 (4%) Pacific, 4 (16%) 'other' ethnicity
	SES		Not stated
	Age (years)		13–19, mean 16.36
Quality assessment			
Questions used to judge rigour and relevance	Reviewer judgement	Description	
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Sampled all those who were involved in the pilot study, which had clear inclusion criteria and used multiple recruitment methods	
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Provided detail on procedures and on topics explored	
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Used inductive systematic approach, with 10% dual-coded; participants reviewed preliminary summary of findings	
Were the findings of the study grounded in/supported by data?	Yes	Themes described and supporting quotations provided	
Was there good breadth and depth achieved in the findings?	No	Descriptions of themes were brief and not explored in depth; quotations were short and not interpreted	
Were the perspectives of MSM privileged?	Yes	Data came from open-ended questions asked of sexual minority youth	
Overall reliability and usefulness of findings			
Reliability of findings	High	Sample was representative of those in the trial; reported contrasting views	
Usefulness of findings	Medium	Reported findings on how aspects of the intervention and of participants affected intervention receipt, but these findings were thin	
Programme: smartphone self-monitoring (no name) (Swendeman et al.¹¹⁹)			
Methods	Overall study design	RCT	
	Research questions/hypotheses	Process evaluation aimed to explore barriers and challenges encountered with the intervention to inform future work on self-monitoring	

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Timing and duration	Recruitment took place over a 9-month period and process evaluation data were collected at the end of weeks 2, 4 and 6
	Aspects of process evaluated	Acceptability/satisfaction and mechanisms of action
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of participants and of the intervention
	Data collection	Qualitative semistructured interviews conducted by telephone at weeks 2 and 4 post baseline and conducted in person at 6 weeks post baseline. Web-based surveys also used yes/no and open-ended questions to assess goals and supports in each of the four targeted outcome domains (medication adherence, mental health, alcohol/tobacco/other drug use and sexual risk behaviours)
	Data analysis	Coding of interview responses used an iterative, 'grounded' (by which the authors seemed to suggest inductive) approach, identifying key themes and subthemes. The lead researcher and one other researcher generated primary codes and two other researchers then coded the data independently. The lead author reviewed and clarified results and created coding trees for subsequent coding. Emerging themes were compared with constructs drawn from social cognitive theory, the health belief model, the theory of planned behaviour and reasoned action, the transtheoretical model, the precaution adoption process model and the IMB model, and coding also captured emerging pathways. Differences in perceived benefits between intervention and control arms were explored by comparing the proportion of participants reporting benefits to awareness and change in general and in the four targeted domains. The relationship between qualitative findings and survey data on goals and supports were explored using cross-tabulations
Details of participants	Location: country (region)	USA (Los Angeles, CA)
	Target population	People living with HIV
	Sampling	Participants were recruited via study flyers targeting clients at two AIDS service organisations. Eligible participants spoke English and reported taking medication daily; using alcohol, tobacco and/or drugs at least weekly; sexual activity at least weekly; and daily mobile phone and internet use
	Actual sample	50 participants consented and enrolled: <ul style="list-style-type: none"> ● Intervention group A ('Assessment'): $n = 14$ ● Intervention group B ('Behaviour Change'): $n = 20$ ● Control group C (biweekly web survey only): $n = 16$

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
		<p>Participation in qualitative interviews for process evaluation:</p> <ul style="list-style-type: none"> • Week 2 <ul style="list-style-type: none"> ○ 92.9% of intervention group A ○ 85% of intervention group B ○ 68.8% of control group C ○ 82% overall • Week 4 <ul style="list-style-type: none"> ○ 85.7% of intervention group A ○ 60% of intervention group B ○ 56.3% of control group C ○ 66% overall • Week 6 <ul style="list-style-type: none"> ○ 42.9% of intervention group A ○ 30% of intervention group B ○ 25% of control group C ○ 32% overall <p>Sexuality</p> <ul style="list-style-type: none"> • Intervention group A: 23.1% bisexual, 61.5% gay, 15.4% heterosexual • Intervention group B: 15% bisexual, 65% gay, 20% heterosexual • Control group C: 81.3% gay, 18.8% heterosexual <p>Gender identity</p> <ul style="list-style-type: none"> • Intervention group A: 7.1% female, 78.6% male, 14.3% transgender • Intervention group B: 20% female, 75% male, 5% transgender • Control group C: 6.7% female, 93.3% male <p>Ethnicity</p> <ul style="list-style-type: none"> • Intervention group A: 50% black, 7.1% Latino, 28.6% white, 14.3% mixed race • Intervention group B: 40% black, 15% Latino, 5% Native American, 30% white, 10% mixed race • Control group C: 56.3% black, 25% Latino, 18.8% white <p>SES</p> <p>Not stated</p> <p>Age</p> <p>Not stated</p>
<i>Quality assessment</i>		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Large sample recruited from two agencies
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Conducted qualitative interviews at three time points complemented with web survey data
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Detailed description of analysis methods, which included coding by two independent researchers and checking by lead researcher
Were the findings of the study grounded in/supported by data?	Yes	Key findings clearly supported by quotations
continued		

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Was there good breadth and depth achieved in the findings?	Yes	Range of topics explored with in-depth interpretation
Were the perspectives of MSM privileged?	Yes	Conducted three waves of qualitative interviews; participants primarily male and gay or bisexual
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	Medium	Rigorous data collection and analysis; however, interview response rates were low
Usefulness of findings	High	Provides useful findings on how receipt varied by participant characteristics
Programme: WRAPP (Bowen et al.⁹⁸)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Not stated
	Timing and duration	Recruitment took place during April–May 2004. Following the pre-test baseline and the intervention, participants completed the first post-test assessment at 7–14 days post intervention and those in the intervention (not the wait-list control) group then completed a follow-up assessment 7–14 days after the post-test assessment. Process evaluation questions appear to have been asked at post-test assessment
	Aspects of process evaluated	Acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by characteristics of context
	Data collection	Four questions on intervention acceptability – asking about interest, usefulness, whether or not user would do the intervention again and whether or not they would recommend it to a friend – were answered using 6-point Likert-type scales. A fifth question asked whether the time it took for pictures to load was just right, too short or too long
	Data analysis	Analysis for process evaluation questions was not specified. Mann–Whitney <i>U</i> -test was used to compare responses from users with dial-up internet connections with those from users with high-speed internet connections on item assessing acceptability of the length of time to load pictures
Details of participants	Location: country (region)	USA (rural areas)
	Target population	Internet-using MSM living in rural areas
	Sampling	Participants were recruited face to face and via internet banners on a popular website. Eligible participants were at least 18 years of age, had had sex with another man in the preceding 12 months and lived in a rural area

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
	Actual sample	90 men completed the pre test and were randomised to intervention or wait-list control. A total of 20% of intervention and 21% of wait-list control participants dropped out before completing all activities. Overall study completion was 78.9%; however, it appears that acceptability questions were asked prior to the last survey point. A total of 74 participants (82%) responded to process evaluation questions
	Sexuality	<ul style="list-style-type: none"> • Intervention arm: 92% gay, 8% bisexual/heterosexual • Wait-list arm: 91% gay, 9% bisexual/heterosexual
	Gender identity	Not stated
	Ethnicity	<ul style="list-style-type: none"> • Intervention arm: 23% non-white, 77% white • Wait-list arm: 16% non-white, 84% white
	SES	<p>Intervention arm</p> <ul style="list-style-type: none"> • Employment: 68% full time, 13% part time/occasional, 18% not working • Income: 36%, < US\$15,000; 23%, US\$15,000–24,999; 31%, US\$25,000–49,999; 10%, > US\$50,000 <p>Wait-list arm</p> <ul style="list-style-type: none"> • Employment: 64% full time, 20% part time/occasional, 16% not working • Income: 37%, < US\$15,000; 31%, US\$15,000–24,999; 20%, US\$25,000–49,999; 12%, > US\$50,000
Quality assessment		
Questions used to judge rigour and relevance	Reviewer judgement	Description
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Process evaluation was conducted with full trial sample and response rate was good
Were steps taken to minimise bias and error/increase rigour in data collection?	No	Acceptability assessed using a few, fixed-response questions with no information provided on piloting or previous testing
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Straightforward reporting of percentage and mean calculations; statistical tests are named where significance is presented
Were the findings of the study grounded in/supported by data?	Yes	Sufficient data are presented to support findings and conclusions
Was there good breadth and depth achieved in the findings?	No	Explores acceptability using narrow range of questions that do not explore experiences with or views on specific aspects of the intervention
Were the perspectives of MSM privileged?	No	The data are from MSM, but are based solely on a few, fixed-response items

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
<i>Overall reliability and usefulness of findings</i>		
Reliability of findings	High	Data collected are narrow but likely to be valid; high response rate
Usefulness of findings	Low	Very little information provided on how delivery/receipt varied
Programme: WRAPP (Williams et al.¹²¹)		
Methods	Overall study design	Participants were randomised to one of three intervention module orders
	Research questions/hypotheses	The study aimed to 'assess how participants in an Internet HIV/AIDS health promotion intervention perceived the experience'. ¹²¹ Specific objectives were to evaluate: <ul style="list-style-type: none"> • if intervention completion varied by computer issues or satisfaction with intervention delivery • if satisfaction changed from completion of the first module to completion of all three modules • if satisfaction was associated with the order in which modules were encountered
	Timing and duration	Baseline data were collected before randomisation. Post-module assessments were completed after module completion. Each module and its assessment had to be completed within a 14-day period
	Aspects of process evaluated	Reach, acceptability
	Evaluates how processes vary by intervention characteristics, providers, participants and/or contexts?	Explored how receipt varied by context and by characteristics of participants and of the intervention
	Data collection	Baseline survey collected sociodemographic and computer-related data. Computer variables were measured by modem speed, computer location (home or public location) and time of day initially visiting the intervention. Satisfaction was assessed by intervention completion. Survey items after each module assessed technical aspects and acceptability, including time to load screens (binary response), ease of navigating (five-point Likert scale), acceptability of pictures and stories and of time to complete module activities (binary), interest in module activities and usefulness (low, moderate, high), and whether or not user would participate in intervention again and whether or not they would recommend it to a friend (yes/no)
	Data analysis	<ul style="list-style-type: none"> • Compared groups using chi-squared tests, <i>t</i>-tests and Mann-Whitney <i>U</i>-test of proportions; significance set at $p < 0.05$. Where differences were significant, calculated ORs and 95% CIs • Explored differences in completion by sociodemographic variables, computer access and intervention satisfaction.

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details	Characteristics of process evaluations	
Details of participants	Location: country (region):	Dropping out/failing to complete intervention was defined as completing only one module <ul style="list-style-type: none"> • Among those completing all modules, examined significant changes after completing first and all three modules • Explored differences in interest in and reported usefulness of modules by module order, comparing those encountering a module first with those encountering it last
	Target population	USA (rural) Sexually active MSM in rural areas
	Sampling	Recruitment via banner advertisement on a popular MSM dating website. Eligible participants were male, aged ≥ 18 years, reported sex with another man in the preceding year and lived in a rural area at least 1 hour's drive from a major urban area
	Actual sample	300 participants, of which 84% ($n = 252$) completed the first and second modules and 73% ($n = 219$) completed all three modules
	Sexuality	<ul style="list-style-type: none"> • Baseline: 15% heterosexual/bisexual, 85% homosexual • Completed: 15% heterosexual/bisexual, 85% homosexual • Dropped out: 13% heterosexual/bisexual, 86% homosexual
	Gender identity	Not stated
	Ethnicity	<ul style="list-style-type: none"> • Baseline: 77% white, 3% African American, 10% Hispanic, 3% Asian, 5% Native American • Completed: 77% white, 2% African American, 10% Hispanic, 8% Asian, 4% Native American • Dropped out: 84% white, 3% African American, 10% Hispanic, 3% Asian, 1% Native American
	SES	Baseline <ul style="list-style-type: none"> • Education: 31% less than high school, 12% high school, 57% college • Income: 39%, < US\$15,000; 25%, US\$15,000–24,999; 27%, US\$25,000–49,999; 9% \geq US\$50,000 Completed <ul style="list-style-type: none"> • Education: 4% less than high school, 15% high school, 82% college • Income: 34%, < US\$15,000; 28%, US\$15,000–24,999; 27%, US\$25,000–49,999; 11%, \geq US\$50,000

continued

TABLE 14 Summary of process evaluation characteristics and quality appraisal (continued)

Study details		Characteristics of process evaluations	
			Dropped out
			<ul style="list-style-type: none"> • Education: 3% less than high school, 17% high school, 80% college • Income: 49%, < US\$15,000; 14%, US\$15,000–24,999; 26%, US\$25,000–49,999; 11% ≥ US\$50,000
	Age (years)		<ul style="list-style-type: none"> • Baseline: 18–29 (67%), 30–39 (18%), > 40 (15%) • Completed: 18–29 (66%), 30–39 (21%), > 40 (14%) • Dropped out: 18–29 (66%), 30–39 (18%), > 40 (15%)
Quality assessment			
Questions used to judge rigour and relevance	Reviewer judgement	Description	
Were steps taken to minimise bias and error/increase rigour in sampling?	Yes	Large sample, purposively focused on sexually active, rural MSM	
Were steps taken to minimise bias and error/increase rigour in data collection?	Yes	Data collected via multiple questions and user completion data to assess engagement and acceptability	
Were steps taken to minimise bias and error/increase rigour in data analysis?	Yes	Data analysis methods are well described	
Were the findings of the study grounded in/supported by data?	Yes	Findings are supported by quantitative data	
Was there good breadth and depth achieved in the findings?	No	General findings presented on completion and satisfaction, but does not provide in-depth examination of reasons	
Were the perspectives of MSM privileged?	No	Data came from MSM, but were based on quantitative measures that do not allow participants to set out their own views	
Overall reliability and usefulness of findings			
Reliability of findings	High	Large sample, and research methods appear rigorous	
Usefulness of findings	Low	Findings on completion and acceptability are general and lack depth	
AIDS, acquired immunodeficiency syndrome; ANOVA, analysis of variance; GED, General Educational Development Test; SD, standard deviation.			
Note			
Reproduced with permission from Meiksin <i>et al.</i> ⁵⁷ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/ . The table includes additions and minor changes to the original table.			

Appendix 10 Characteristics and risk-of-bias assessment of outcome evaluations

TABLE 15 Summary of outcome evaluation characteristics and risk of bias

Study details	Characteristics of outcome evaluations	
<i>Programme: China-Gate HIV Prevention Program Online Intervention (Cheng et al.¹²⁴)</i>		
Methods	Overall study design	RCT
	Research questions/hypotheses	Aimed to examine intervention efficacy in promoting safe sex behaviours; hypothesised that the intervention would be more effective than the standard referral service
	Timing and duration	Study conducted September 2010–June 2011. Baseline survey conducted before intervention delivery, followed by 6-month post-intervention survey
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Computer algorithm used to randomise participants
	Concealment of allocation (RCTs)	Allocation appeared to have been conducted automatically online
	Baseline equivalence	Arms were balanced on demographic and behavioural characteristics
	Details of participants	Location: country
Target population		MSM
Sampling		Recruited via advertisements on a popular website for gay men. Eligible participants were male internet users aged ≥ 18 years reporting sex with men in prior 6 months; excluded those who participated in a HIV intervention before
Sample size (overall response rate), baseline		Overall: $N = 1100$ completed baseline survey and were randomised <ul style="list-style-type: none"> Intervention: $n = 550$ Control: $n = 550$
Sexuality		<ul style="list-style-type: none"> Overall: 78% homosexual Control: 78% homosexual, 22% bisexual/heterosexual/other Intervention: 78% homosexual, 22% bisexual/heterosexual/other
Gender identity		Not stated; eligible participants were MSM
Ethnicity		<ul style="list-style-type: none"> Control: 98% Han, 2% minority Intervention: 96.5% Han, 3.5% minority

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	<p>SES</p> <p>Age (years)</p> <p>Sample size (overall response rate), follow-up</p>	<p>Education</p> <ul style="list-style-type: none"> • Overall: 80% college or above • Control: 3.6% junior high school or below, 18.5% senior high school, 77.8% college or above • Intervention: 3% junior high school or below, 15% senior high school, 82% college or above <p>Annual income</p> <ul style="list-style-type: none"> • Control: 9% no income, 37% < \$5351; 36% \$5351–12,485; 18% ≥ \$12,485 • Intervention: 7% no income, 29% < \$5351; 44% \$5351–12,485; 20% ≥ \$12,485 <ul style="list-style-type: none"> • Overall: 62% aged 21–30 • Control: 6% aged ≤ 20, 61% aged 21–30, 27% aged 31–40, 6% aged ≥ 41 • Intervention: 4% aged ≤ 20, 64% aged 21–30, 25% aged 31–40, 7% aged ≥ 41 <p>N = 986 (90%) completed post-intervention survey</p> <ul style="list-style-type: none"> • Intervention: n = 501 (91%) completed post-intervention survey • Control: n = 485 (88%) completed post-intervention survey
Outcomes	Outcome measures	<p>Overall</p> <ul style="list-style-type: none"> • CAI in prior 3 months <ul style="list-style-type: none"> ○ Completed records (n = 986): estimated risk difference (difference in proportions) = 9.3% (95% CI 1.1% to 17.5%) ○ Multiple imputation ITT (n = 1100): estimated risk difference (difference in proportions) = 8.9% (95% CI 1.2% to 16.6%) • CAI with regular partner(s) in prior 3 months <ul style="list-style-type: none"> ○ Estimated risk difference (difference in proportions) = 6.5% (95% CI -4.4% to 17.3%) • CAI with casual partner(s) in prior 3 months <ul style="list-style-type: none"> ○ Estimated risk difference (difference in proportions) = 9.2% (95% CI -1.3% to 19.6%) <p>By SES</p> <ul style="list-style-type: none"> • Educational attainment <ul style="list-style-type: none"> ○ Middle school or lower: difference in proportions = 11.7% (95% CI -32.4% to 55.7%); p = -0.12 ○ High school: difference in proportions = 9.7% (95% CI -10.0% to 29.4%) ○ College or higher: difference in proportions = 9.1% (95% CI -0.1% to 18.4%)

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Details of intervention	Description	<ul style="list-style-type: none"> • Annual income <ul style="list-style-type: none"> ○ No income: difference in proportions = -9.6% (95% CI -36.7% to 17.6%) ○ < \$5351: difference in proportions = 15.5% (95% CI 1.8% to 29.3%) ○ \$5351-12,485: difference in proportions = 11.8% (95% CI -1.5% to 25.2%) ○ ≥ \$12,485: difference in proportions = 4.2% (95% CI -16.0% to 24.4%)
	Technology	Online
	Timing and duration	Part I delivered immediately after completing baseline survey. Following completion of part I, part II was delivered in three parts, each delivered weekly
	Target population	MSM
	Theoretical framework	Informed by the theory of planned behaviour, the intervention targeted attitudes, subjective norms, perceived control and behavioural intention, which are posited as key determinants of health behaviours. It aimed to increase knowledge and reduce misconceptions. Part I aimed to engage participants and increase HIV risk perceptions by presenting realistic scenarios and to increase awareness of community norms by presenting peer attitudes towards behavioural decisions. Part II addressed basic HIV/AIDS knowledge and transmission; presented information about the HIV epidemic among MSM, aiming to increase HIV risk perception and reduce sexual risk behaviours; and addressed misconceptions about sexual behaviours
	Development	Intervention was based on formative research and reviewed by professional and community experts. The gay community provided the scenarios presented in part I, which were reviewed by the research team and target population
	Provider organisation	Not stated
	Content	Two-part interactive HIV prevention intervention delivered via popular website for gay men in China. Part I comprised realistic interactive scenarios addressing sexual behaviour (CAI, condom breakage,

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Control	<p>encountering sex partner in a pub and commercial sexual encounter) and HIV testing, and it presented peers' attitudes towards behavioural decisions. Part II presented visually appealing HIV information tailored for MSM, addressing HIV/AIDS basic knowledge and transmission, local epidemic data among MSM and sexual behaviours</p> <p>Standard HIV referral service, also provided to intervention participants: recommendation for HIV test at local clinic</p>
Risk of bias		
Item	Reviewer judgement	Description
Sequence generation: was the allocation sequence adequately generated?	Yes	Computer algorithm used to randomise participants
Allocation concealment: was the allocation adequately concealed?	Yes	Allocation appeared to have been conducted automatically online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Participants were not blinded
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	No	Outcomes were self-reported and participants were not blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Appeared to have recruited participants from throughout China

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations		
Programme: Cognitive Vaccine Approach (Davidovich et al.¹⁰²)			
Methods	Overall study design	RCT	
	Research questions/hypotheses	Examined whether or not an online intervention based on the IMB model and individually tailored helped single gay men practise negotiated safety with future steady partners. Hypothesised that the tailored intervention would be most effective and that promoting negotiated safety might indirectly promote condom use	
	Timing and duration	Recruited over a 2-month period, followed by online baseline and 6-month follow-up surveys	
	Allocation	Individual	
	Generation of allocation sequence (RCTs)	Not stated	
	Concealment of allocation (RCTs)	Randomisation appeared to have taken place automatically online	
	Baseline equivalence	Not stated	
	Details of participants	Location: country	The Netherlands
		Target population	Single males open to a steady relationship with a man in the future
		Sampling	Eligible participants were male, HIV negative or of unknown serostatus, single and open to a steady relationship with a man in the future. They were recruited via websites popular among gay men in the Netherlands
Sample size (overall response rate), baseline		<ul style="list-style-type: none"> • Overall: N = 1013 randomised following baseline questions <ul style="list-style-type: none"> ○ Intervention group <ul style="list-style-type: none"> - Non-tailored: n = 340 - Tailored: n = 340 ○ Control group: n = 333 	
Sexuality		63% exclusively attracted to men, 18% primarily attracted to men, 17% equally attracted to men and women and 2% primarily attracted to women	
Gender identity		All-male sample	
Ethnicity		21% non-Dutch	
Education level	53% had education of university level or equivalent		
Age (years), mean (SD)	33 (SD 11.1)		
Sample size (overall response rate), follow-up	Overall: N = 375 (37.0%) <ul style="list-style-type: none"> • Represented 56% of the sample that provided their e-mail address and could therefore be contacted at follow-up 		

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Outcomes	Outcome measures	<ul style="list-style-type: none"> Of these, 130 (35%) had a new steady partner by follow-up and could be included in the follow-up analysis. Note that the numbers of participants in the intervention and control groups for this subgroup were not specified <p>Intervention group</p> <ul style="list-style-type: none"> Non-tailored: $n = 107$ (31%) Tailored: $n = 128$ (38%) <p>Control group: $n = 140$ (42%)</p> <p>Risky CAI: 52% among control, 63% among non-tailored arm, 33% among tailored arm</p> <p>Negotiated safety: 2% among control, 5% among non-tailored arm, 17% among tailored arm</p> <p>Condom use: 46% among control, 32% among non-tailored arm, 50% among tailored arm</p> <p>Multinomial logistic regression. Outcome variable combines three categories: negotiated safety, condom use, or risky unprotected anal intercourse:</p> <ul style="list-style-type: none"> Overall model: $\chi^2 = 9.12$; $p < 0.05$ Negotiated safety vs. risky CAI, OR (95% CI) <ul style="list-style-type: none"> Tailored: 10.50 (1.19 to 92.72) Non-tailored: 1.62 (0.14 to 19.07) Condom vs. risky CAI, OR (95% CI) <ul style="list-style-type: none"> Tailored arm: 1.66 (0.68 to 4.02) Non-tailored arm: 0.55 (0.22 to 1.37)
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p>	<p>HIV prevention intervention promoting negotiated safety (i.e. unprotected anal intercourse between steady partners who are both HIV-negative)</p> <p>Internet</p> <p>Users spent an estimated mean of 30 minutes in the non-tailored version and 10–30 minutes in the tailored version</p> <p>Single gay men</p> <p>Informed by the IMB model, modules addressed information, motivation and behavioural skills; the motivation component was further informed by the theory of planned behaviour and the health belief model. Information modules aimed to increase response efficacy for practising negotiated safety (comprising knowledge and beliefs). Motivation modules aimed to correct faulty beliefs in order to shape attitudes and aimed to increase perceptions of HIV testing benefits and sense of vulnerability. Attitudes were theorised to increase condom use intentions. Attitudes, sense of vulnerability and perceived benefits of HIV testing were theorised to increase intentions to practise negotiated safety</p>

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Development	Content was based on past research on determinants of sexual risk behaviour in steady relationships and on the intervention's theory of change. To address concern that the impact would be limited by messaging that was too lengthy, the tailored version was designed to address user-specific needs
	Provider organisation	Not stated
	Content	There were two versions of the intervention: a non-tailored version delivered all modules, and a tailored version delivered general content considered relevant for all users in addition to selected modules considered relevant based on a baseline questionnaire. Information modules addressed how to practise negotiated safety; motivation modules addressed HIV transmission risk via steady partners, HIV testing and sexual agreements and stressed the consequences of HIV infection; and skills modules taught skills for negotiated safety
	Control	Seemed to be a wait-list control
<i>Risk of bias</i>		
<i>Item</i>	<i>Reviewer judgement</i>	<i>Description</i>
Sequence generation: was the allocation sequence adequately generated?	Not stated	Only stated that participants were randomly assigned to one of three conditions
Allocation concealment: was the allocation adequately concealed?	Yes	Randomisation appeared to have taken place automatically online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Participants were blinded but study personnel were not
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	All outcomes were self-reported and participants were blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	No	High levels of attrition across all conditions; did not appear balanced by arm
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	All stated outcomes were reported
		continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Used multiple methods of recruitment to obtain a diverse sample
Programme: Hot and Safe M4M (Carpenter et al.¹⁰⁰)		
Methods	Overall study design	RCT
	Research questions/hypotheses	<ul style="list-style-type: none"> • Purpose: to assess the impact of the intervention on self-reported sexual behaviour at the 3-month follow-up • Hypothesis: intervention participants would report a greater reduction in unprotected sex, with greater reductions for the most risky sexual behaviours and with the most risky partners
	Timing and duration	Recruitment from 20 June to 16 November 2006, and online baseline and 3-month follow-up surveys
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Computerised algorithm used random number tables to balance groups by race and ethnicity
	Concealment of allocation (RCTs)	Yes, all study procedures took place online
	Baseline equivalence	Among those completing the follow-up survey, intervention participants were more likely than control participants to be Asian American and, with regard to partners with unknown or positive serostatus, to report unprotected anal intercourse in general, unprotected insertive anal intercourse and unprotected insertive oral intercourse
Details of participants	Location: country	USA
	Target population	Young MSM who were having unsafe sex, including minority MSM
	Sampling	Recruited via banner advertisements on same-sex community websites and profiles of the study on three other websites. Eligible participants were men in the USA aged 18–39 years with internet access and a negative or unknown HIV status who had engaged in unprotected oral or anal intercourse with a man in the previous 3 months
	Sample size (overall response rate), baseline	Overall: $N = 199$ completed baseline measures and were randomised <ul style="list-style-type: none"> • Intervention: $n = 99$ • Control: $n = 100$
	Sexuality	Not stated; only MSM eligible
	Gender identity:	Not stated; only MSM eligible

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations		
Ethnicity	80.4% white, 15.2% Hispanic/Latino, 7.1% Native American, 6.3% African American, 5.4% Asian American, 0.9% Hawaiian/Pacific Islander, 2.7% other		
SES	Annual income		
	16%, < US\$10,000; 20%, US\$10,000–20,000; 36%, US\$21,000–40,000; 21%, US\$41,000–60,000; 8%, ≥ US\$61,000		
	Highest grade (school year) completed		
	3% less than 12th grade or GED, 13% 12th grade or GED, 12% 1 year of college/tech school, 13% 2 years of college/tech school, 59% > 2 years of college/tech school		
Age	Not stated		
Sample size (overall response rate), follow-up	Overall: N = 112 completed follow-up measures (56% of those randomised; 78% of those who completed the intervention and were sent a link to the follow-up survey)		
	<ul style="list-style-type: none"> • Intervention: n = 59 (60% of those randomised to intervention, 80% of those receiving survey link) • Control: n = 53 (53% of those randomised to control, 77% of those receiving survey link) 		
Outcomes	Outcome measures (unprotected sex acts, by partner type)	<p>With any partner regardless of serostatus</p> <ul style="list-style-type: none"> • Time effect: F3,10; df = 5101; $p = 0.012$; $n_2 = 0.133$ • Group × time: F1,42; df = 5101; $p = 0.224$; $n_2 = 0.066$ • Unprotected anal intercourse, time effect: F12,64; df = 1105; $p = 0.001$; $n_2 = 0.107$ • Unprotected insertive anal intercourse, time effect: F6,43; df = 1105; $p = 0.013$; $n_2 = 0.058$ • Unprotected receptive anal intercourse, time effect: F12,47; df = 1105; $p = 0.001$; $n_2 = 0.106$ • Unprotected insertive oral intercourse, time effect: F6,69; df = 1105; $p = 0.011$; $n_2 = 0.60$ • Unprotected receptive oral intercourse, time effect: F11,76; df = 1105; $p = 0.001$; $n_2 = 0.101$ <p>With partner of positive/unknown serostatus</p> <ul style="list-style-type: none"> • Time effect: F3,25; df = 597; $p = 0.009$; $n_2 = 0.144$ • Group × time: F4,13; df = 597; $p = 0.002$; $n_2 = 0.175$ • Unprotected anal intercourse <ul style="list-style-type: none"> ○ Time effect: F7,59; df = 1101; $p = 0.007$; $n_2 = 0.070$ ○ Group × time: F7,59; df = 1101; $p = 0.007$; $n_2 = 0.070$ 	

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		<ul style="list-style-type: none"> ● Unprotected insertive anal intercourse <ul style="list-style-type: none"> ○ Time effect: $F_{3,37}$; $df = 1101$; $p = 0.069$; $n_2 = 0.032$ ○ Group \times time: $F_{7,24}$; $df = 1101$; $p = 0.008$; $n_2 = 0.067$ ● Unprotected receptive anal intercourse <ul style="list-style-type: none"> ○ Time effect: $F_{4,79}$; $df = 1101$; $p = 0.031$; $n_2 = 0.045$ ○ Group \times time: $F_{1,35}$; $df = 1101$; $p = 0.248$; $n_2 = 0.013$ ● Unprotected insertive oral intercourse <ul style="list-style-type: none"> ○ Time effect: $F_{13,88}$; $df = 1101$; $p < 0.001$; $n_2 = 0.121$ ○ Group \times time: $F_{7,45}$; $df = 1101$; $p = 0.007$; $n_2 = 0.069$ ● Unprotected receptive oral intercourse <ul style="list-style-type: none"> ○ Time effect: $F_{13,24}$; $df = 1101$; $p < 0.001$; $n_2 = 0.116$ ○ Group \times time: $F_{8,45}$; $df = 1101$; $p = 0.004$; $n_2 = 0.077$
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p> <p>Development</p> <p>Provider organisation</p>	<p>Multimedia, modular HIV/STI intervention</p> <p>Internet</p> <p>Seven brief sequential modules completed within 1 week. Authors' description suggested that intervention took approximately 1.5 hours. Participants could return to view intervention content during the follow-up period</p> <p>Young MSM, including minority MSM</p> <p>Based on the IMB model, the intervention aimed to reduce risk of HIV and other STIs by addressing information, motivation and behavioural skills. The information component aimed to increase knowledge of risk factors. Intervention activities assessed readiness to change and incorporated 'stage-based' and (informed by motivational interviewing approaches) decisional balance exercises to increase motivation. Informed by motivational interviewing, the intervention also assessed HIV risk factors to inform targeted feedback, and identified perceived barriers to change to increase self-efficacy</p> <p>Pilot tested with a sample of 21 MSM in New York, NY, using a desktop computer at a community organisation specialising in HIV research and intervention development. Minor content revisions were made based on findings</p> <p>Not stated</p>

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details		Characteristics of outcome evaluations	
	Content	This website-based intervention aimed to reduce HIV/STIs via modules addressing information about risk factors, skills (e.g. partner communication) and motivation. Multimedia content included didactic materials, quizzes, interactive exercises and audio from simulated peers. The approach was non-judgemental and emphasised both responsibility and freedom of choice. User assessments informed motivational exercises tailored to a user's readiness to change, as well as tailored feedback	
	Control	Stress reduction training programme originally developed for the general population and customised for young MSM by substituting representative photographs	
Risk of bias			
Item	Reviewer judgement	Description	
Sequence generation: was the allocation sequence adequately generated?	Yes	Computerised algorithm used random number tables to balance groups by race and ethnicity	
Allocation concealment: was the allocation adequately concealed?	Yes	All study procedures took place online	
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Participants were blinded but study personnel were not	
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	All outcomes were self-reported and participants were blinded	
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	No	High rate of attrition across all arms, > 40%	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	Use of MANOVA precludes presentation of all relevant group by time effects for individual outcomes; use of log transformation and MANOVA precludes complete presentation of results	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering	
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Sample recruited from a variety of cities in the USA	
continued			

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
<i>Programme: internet-based safer sex intervention (no name) (Milam et al.^{109,110})</i>		
Methods	Overall study design	RCT
	Research questions/hypotheses	Study assessed the efficacy of an internet-based intervention to reduce STI incidence and high-risk sexual behaviour among HIV-positive MSM
	Timing and duration	Monthly self-report behavioural risk survey, and STIs assessed every 3 months for the 12-month study period. Study ran from November 2010 to July 2012
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Not stated
	Concealment of allocation (RCTs)	Yes
	Baseline equivalence	Arms were not balanced on: <ol style="list-style-type: none"> disclosure of HIV status to partners (significantly higher in intervention than in control arm) duration of treatment among those on ART (significantly longer in intervention arm)
Details of participants	Location: country (region)	USA (southern California)
	Target population	HIV-positive MSM reporting unprotected sex or STIs
	Sampling	Eligible participants were HIV-positive MSM aged ≥ 18 years with risk of HIV transmission. Participants were recruited from three HIV clinics
	Sample size (overall response rate), baseline	Overall: $N = 181$ were randomised. mITT sample was 179 (2 who were randomised did not complete baseline visit) <ul style="list-style-type: none"> Intervention: $n = 90$ Control: $n = 89$
	Sexuality	Not stated, but eligible participants were MSM
	Gender identity	Not stated, but eligible participants were MSM
	Ethnicity	Baseline <ul style="list-style-type: none"> Intervention: 36% white, 31% black, 31% Hispanic, 3% other Control: 30% white, 30% black, 32% Hispanic, 8% other
	SES	Baseline <ul style="list-style-type: none"> Income <ul style="list-style-type: none"> Intervention: 22% have income of \geq US\$2000 per month Control: 24% have income of \geq US\$2000 per month

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		<ul style="list-style-type: none"> • Education <ul style="list-style-type: none"> ◦ Intervention: 77%, more than high school ◦ Control: 75%, more than high school
	Age (years), mean	Baseline <ul style="list-style-type: none"> • Intervention: 44.6 • Control: 42.7
	Sample size (overall response rate), follow-up	mITT sample (randomised and completed baseline visit) <p>N = 179 (99% of those randomised)</p> <ul style="list-style-type: none"> • Intervention: n = 90 • Control: n = 89 Study completers (attended 12-month study visit) <p>N = 140 (77% of those randomised)</p> <ul style="list-style-type: none"> • Intervention: n = 73 • Control: n = 67 As-treated (completed 75%+ of monthly internet visits) <p>N = 107 (60% of those completing baseline visit)</p> <ul style="list-style-type: none"> • Intervention: n = 49 • Control: n = 58
Outcomes	Outcome measures	Incident STI event over 12-month period <ul style="list-style-type: none"> • Primary analysis, mITT sample: OR 1.35 (95% CI 0.68 to 2.70); $p = 0.38$ • Subset analysis, study completers: incident STI 33% vs. 28%; $p = 0.59$ • Subset analysis, as treated: incident STI 24% vs. 24%
Details of intervention	Description	Web-based safer sex intervention tailored to user's risk level, behaviour and intentions
	Technology	Internet
	Timing and duration	Brief intervention provided monthly for 1 year
	Target population	HIV-positive MSM
	Theoretical framework	This intervention aimed to reduce HIV/STI transmission by targeting condom use, disclosure to sex partners, ART initiation and reduced use of drugs and alcohol. Informed by social cognitive theory and the transtheoretical model, users were directed to web pages tailored to their risk level, behaviour and intent related to the targeted behaviour change

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details		Characteristics of outcome evaluations	
	Development	Messages were adapted from an existing intervention effective in reducing unsafe sex. Subsequent pre testing in focus groups with HIV-positive MSM informed changes to content and approach	
	Provider organisation	Three clinic sites that were part of a HIV clinical research network	
	Content	This intervention aimed to reduce HIV/STI transmission by HIV-positive MSM by targeting condom use, disclosure to sex partners, ART initiation and reduced use of drugs and alcohol. Based on their responses to monthly sexual behaviour surveys, users were directed to static web pages tailored to their risk of transmission. Tailored messaging took into account a user's current behaviour and intent related to the targeted behaviour change	
	Control	Brief monthly sexual behaviour survey accessed via computer for 1 year	
Risk of bias			
Item	Reviewer judgement	Description	
Sequence generation: was the allocation sequence adequately generated?	Not stated		
Allocation concealment: was the allocation adequately concealed?	Yes		
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Participants and study co-ordinator were not blinded	
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	Clinicians and the adjudication committee verifying newly diagnosed STIs were both blinded	
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	> 70% retention in both arms; proportions roughly balanced	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	Estimates for secondary end points not presented in sufficient detail to evaluate magnitude of change	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering	
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	No	Presentation of as-treated and completer analyses do not yield unbiased estimates of treatment effect	

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
<i>Programme: Keep it Up! (Mustanski et al.¹²²)</i>		
Methods	Overall study design	RCT
	Research questions/hypotheses	To obtain a preliminary estimate of intervention efficacy, compared with an information-only arm
	Timing and duration	Study took place between August 2009 and September 2010. Assessments at baseline, immediately post test, prior to 6-week booster and at 12 weeks post intervention. Baseline and 12-week follow-up surveys were used to assess outcomes included in this review
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Participants randomised by computerised algorithm
	Concealment of allocation (RCTs)	Randomisation was done using a computer algorithm and eligibility was assessed online
	Baseline equivalence	No significant demographic or risk behaviour differences between arms
Details of participants	Location: country (region)	USA (Chicago, IL)
	Target population	Ethnically/racially diverse young MSM receiving a HIV-negative test result at a clinic
	Sampling	Recruited face to face by clinic staff on receipt of negative HIV test result. Eligible participants were sexually active MSM aged 18–24 years, were not in an exclusive relationship lasting > 12 months and reported internet use
	Sample size (overall response rate), baseline	102 participants consented, completed baseline assessment and were randomised (84% of those eligible) <ul style="list-style-type: none"> • Intervention: <i>n</i> = 50 • Control: <i>n</i> = 52
	Sexuality	Baseline <ul style="list-style-type: none"> • Intervention: 78% gay/homosexual, 22% bisexual/other • Control: 86.5% gay/homosexual, 13.5% bisexual/other
	Gender identity	Not stated; eligible participants had male birth sex and gender identity
	Ethnicity	Baseline <ul style="list-style-type: none"> • Intervention: 46% white Latino, 24% white non-Latino, 14% African American, 16% other • Control: 46% white Latino, 27% white non-Latino, 12% African American, 15% other

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	SES	Baseline <ul style="list-style-type: none"> • Employment <ul style="list-style-type: none"> ○ Intervention: 56% employed ○ Control: 73% employed • Education <ul style="list-style-type: none"> ○ Intervention: 24%, some high school or graduated high school; 76%, some college or graduated college ○ Control: 21%, some high school or graduated high school; 79%, some college or graduated college
	Age (years), mean (SD)	Baseline <ul style="list-style-type: none"> • Intervention: 21.62 (SD 1.97) • Control: 21.04 (1.69)
	Sample size (overall response rate), follow-up	Overall: $N = 90$ (88% of those completing baseline) <ul style="list-style-type: none"> • Intervention: $n = 41$ (80%) • Control: $n = 49$ (94%)
		Note that n varied by outcome as a result of branching and attrition (see Outcome measures below)
Outcomes	Outcome measures	CAI acts ($n = 63$) Rate ratio 0.56; $p = 0.04$ <ul style="list-style-type: none"> • Intervention <ul style="list-style-type: none"> ○ Baseline: mean 3.85 (SD 5.73) ○ 12-week follow-up: mean 3.70 (SD 5.76) • Control <ul style="list-style-type: none"> ○ Baseline: mean 3.77 (SD 3.88) ○ 12-week follow-up: mean 6.20 (SD 12.22) Number of sex partners ($n = 90$) Rate ratio 1.35; $p = 0.32$ <ul style="list-style-type: none"> • Intervention <ul style="list-style-type: none"> ○ Baseline: mean 1.98 (SD 2.73) ○ 12-week follow-up: mean 1.15 (SD 0.88) • Control <ul style="list-style-type: none"> ○ Baseline: mean 1.61 (SD 1.02) ○ 12-week follow-up: mean 0.84 (SD 0.75)

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		<p>Condom-related problems (n = 36)</p> <ul style="list-style-type: none"> • Condom use errors (d = 0.19; p = 0.56) <ul style="list-style-type: none"> ○ Intervention <ul style="list-style-type: none"> - Baseline: mean 1.88 (SD 0.47) - 12-week follow-up: mean 1.56 (SD 0.58) ○ Control <ul style="list-style-type: none"> - Baseline: mean 2.11 (SD 0.62) - 12-week follow-up: mean 1.80 (SD 0.59) • Erection loss when using condoms (d = 0.14; p = 0.60) <ul style="list-style-type: none"> ○ Intervention <ul style="list-style-type: none"> - Baseline: mean 1.86 (SD 0.90) - 12-week follow-up: mean 1.47 (SD 0.70) ○ Control <ul style="list-style-type: none"> - Baseline: mean 2.08 (SD 1.05) - 12-week follow-up: mean 1.61 (SD 0.78) • Condom failures (d = 0.22; p = 0.30) <ul style="list-style-type: none"> ○ Intervention <ul style="list-style-type: none"> - Baseline: mean 1.50 (SD 0.95) - 12-week follow-up: mean 1.14 (SD 0.48) ○ Control <ul style="list-style-type: none"> - Baseline: mean 1.14 (SD 0.29) - 12-week follow-up: mean 1.25 (SD 0.31)
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p> <p>Development</p>	<p>Multimodule, interactive HIV prevention intervention for young MSM from all racial and ethnic groups</p> <p>Internet</p> <p>Seven modules totalling approximately 2 hours, completed across three sessions done at least 24 hours apart. A booster module took place at 6 weeks</p> <p>Ethnically and racially diverse young MSM</p> <p>Informed by the IMB model, intervention activities were theorised to engender knowledge, motivation and behavioural skills, as well as self-efficacy. Reflection was theorised to affect behavioural intentions, and lead to an examination of safer sex practices, perceived social norms and a sense of vulnerability, which, along with the identification of sources of support, were theorised to contribute to motivation. Participants were recruited following a negative HIV test, a time when they were believed to be particularly receptive to HIV prevention efforts</p> <p>Developed in partnership with community-based organisations providing HIV testing to the LGBT community and with the engagement of diverse young MSM, and informed by formative mixed-methods research</p>

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Provider organisation	Not specified. Participants were recruited from community-based organisations providing HIV testing and counselling
	Content	Online modules were based on situations and settings relevant to young MSM and used a variety of media and methods such as video, animation and games. The modules addressed, among other topics, condom use; triggers for unprotected sex; obtaining support; communication; the effects of mood, drug and alcohol abuse and sexual arousal; power dynamics in relationships; and the limits of serosorting. In the last module, users developed a HIV/STI prevention plan. Goals were suggested tailored to users' baseline risks. In the booster, users revisited goals; received tailored feedback to troubleshoot obstacles; and set new, or reaffirmed existing, goals
	Control	Online didactic (information only), non-interactive, non-tailored HIV knowledge information. Control was matched to the intervention in the number of modules and the requirement to participate in them over three sessions. Total time to complete the sessions was not matched to the intervention
Risk of bias		
Item	Reviewer judgement	Description
Sequence generation: was the allocation sequence adequately generated?	Yes	Participants randomised by computerised algorithm; groups stratified by race
Allocation concealment: was the allocation adequately concealed?	Yes	Randomisation was done using a computer algorithm and eligibility was assessed online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	Yes	Both participants and staff with direct participant contact were blinded to participant allocation
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	Outcomes were self-reported by participants, who were blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	Attrition was around 70% for both arms
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	All estimates presented

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	
Programme: Keep it Up! (Mustanski et al.¹¹³)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Hypothesis: incident STIs and CAI will be lower among intervention group than among HIV knowledge-only control
	Timing and duration	Study took place from May 2013 to December 2015. Follow-up and data analysis completed in 2017
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Randomised using six permuted blocks of size four; groups stratified by race and by HIV testing site
	Concealment of allocation (RCTs)	Randomisation conducted via an e-health platform and appears to have taken place online
	Baseline equivalence	Demographics and history of HIV-preventative behaviour were comparable by study arm. Baseline rectal STIs were significantly higher in the intervention arm
Details of participants	Location: country	USA
	Target population	Young MSM
	Sampling	Recruitment was via community-based HIV testing organisations, local health departments, street outreach and local and national advertising. Eligible participants were sexually active MSM aged 18–29 years who were not in a monogamous relationship of > 6 months and tested HIV negative at screening
	Sample size (overall response rate), baseline	901 participants completed baseline assessment and STI testing and were randomised (59% of those eligible) <ul style="list-style-type: none"> • Intervention: <i>n</i> = 445 • Control: <i>n</i> = 456
	Sexuality	Baseline <ul style="list-style-type: none"> • Intervention: 86.5% gay, 11.9% bisexual, 1.6% straight/other • Control: 86.0% gay, 11.2% bisexual, 2.9% straight/other
	Gender identity	Not stated; eligible participants were assigned male at birth and identified as male

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Ethnicity	Baseline <ul style="list-style-type: none"> • Intervention: 37% white, 24% black, 30% Hispanic/Latino, 9% other • Control: 36% white, 25% black, 27% Hispanic/Latino, 12% other
	Education level	Baseline <ul style="list-style-type: none"> • Intervention: 16% high school or less, 26% some college, 46% college, 13% graduate degree • Control: 9% high school or less, 30% some college, 47% college, 14% graduate degree
	Age	Baseline <ul style="list-style-type: none"> • Intervention: 53% were aged 18–24 years, 48% were aged 25–29 years • Control: 54% were aged 18–24 years, 47% were aged 24–29 years
	Sample size (overall response rate), follow-up	<ul style="list-style-type: none"> • 762 contributed data at 12 months (85% of those randomised) • 741 contributed STI data at 12 months (82% of those randomised) Intervention <ul style="list-style-type: none"> • 370 contributed data at 12 months (83%) • 363 contributed STI data at 12 months (82%) Control <ul style="list-style-type: none"> • 392 contributed data at 12 months (86%) • 378 contributed STI data at 12 months (83%)
Outcomes	Outcome measures	Paired analysis considered within-person changes in STIs while adjusting for baseline between-arm infection differences. Other analyses did not adjust for between-arm baseline differences in STIs <p>Incident STI ($n = 733$, 81% of those randomised):</p> <ul style="list-style-type: none"> • Intervention vs. control, risk ratio (95% CI) <ul style="list-style-type: none"> ○ Urethral chlamydia: 0.60 (0.12 to 2.34) ○ Urethral gonorrhoea: 0.35 (0.01 to 4.33) ○ Rectal chlamydia: 0.61 (0.34 to 1.06) ○ Rectal gonorrhoea: 0.91 (0.40 to 2.05) ○ Any STI: 0.60 (0.38 to 0.95) • Any STI at month 12: 40% (95% CI 5% to 30%) lower in intervention arm; $p = 0.01$

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		<p>Paired analysis considered within-person changes in STIs while adjusting for between-arm differences in infection at baseline ($n = 729$, 81% of those randomised):</p> <ul style="list-style-type: none"> Risk ratio 0.32 (95% CI 0.17 to 0.60); $p = 0.0004$ <p>Rates of self-reported incident HIV diagnoses:</p> <ul style="list-style-type: none"> 2%, with no differences between control (diagnosis rate = 2.0%, 95% CI 0.84% to 3.85%) and intervention (2.3%, 95% CI 1.07% to 4.45%) <p>CAI with casual partners in previous 3 months ($n = 757$, 84% of those randomised)</p> <ul style="list-style-type: none"> Prevalence ratio at month 12: 0.83 (95% CI 0.70 to 0.99); $p = 0.04$ Estimated average effect over follow-up: prevalence ratio 0.89; $p = 0.07$ Percentage at month 12: reported by 44% of control, 37% of intervention Estimated average effect over follow-up: 11% (prevalence ratio 0.89; $p = 0.07$)
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p> <p>Development</p> <p>Provider organisation</p> <p>Content</p>	<p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>Seven modules had to be done at least 24 hours apart and took 2 hours to complete. These were followed by booster sessions at 3 and 6 months</p> <p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>See the Mustanski <i>et al.</i>¹²² section previously in this table</p> <p>Online modules were based on situations and settings relevant to young MSM and used a variety of media and methods such as video, animation and games. Modules addressed, among other topics, condom use; triggers for unprotected sex; obtaining support; communication; the effects of mood, drug and alcohol abuse and sexual arousal; power dynamics in relationships; and the limits of serosorting. Users developed a HIV/STI prevention plan, and goals were suggested, tailored to users' baseline risks. Two booster sessions reinforced learning, introduced new skills and provided an opportunity to review earlier goals</p>

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Control	Online content similar to available didactic HIV prevention materials. Control was matched to the intervention in the number of modules and the requirement to participate in them over three sessions. At the 3- and 6-month follow-up sessions (i.e. the same timing as intervention booster sessions), materials were reviewed again and information was provided on biomedical strategies
<i>Risk of bias</i>		
<i>Item</i>	<i>Reviewer judgement</i>	<i>Description</i>
Sequence generation: was the allocation sequence adequately generated?	Yes	Randomised using six permuted blocks of size four; groups stratified by race and by HIV testing site
Allocation concealment: was the allocation adequately concealed?	Yes	Randomisation conducted via an e-health platform and appeared to have taken place online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	Yes	Participants and the study staff who had contact with participants were both blinded to allocation
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	Primary outcome was laboratory based
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	Low and balanced attrition between arms
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	The protocol listed six secondary outcomes (HIV knowledge, HIV motivation and behavioural skills, condom errors, health protective communication, PrEP intentions and use, and intervention acceptability) that were not reported
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Recruitment used multiple methods and targeted different US regions, in addition to local and national advertising. Participants who withdrew or moved out of the country were not excluded from analysis

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
<i>Programme: myDEX (Bauermeister et al.¹²³)</i>		
Methods	Overall study design	RCT
	Research questions/hypotheses	Pilot trial to test acceptability and preliminary efficacy of myDEX, to inform power calculations for large-scale RCT
	Timing and duration	30-minute baseline questionnaire followed by randomisation. Follow-up assessments conducted at 30, 60 and 90 days post randomisation
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Used pseudo-random number generator with permuted blocks
	Concealment of allocation (RCTs)	Yes, allocation conducted automatically online
	Baseline equivalence	No significant sociodemographic differences between arms
	Details of participants	Location: country
Target population		Single, young, HIV-negative MSM reporting CAI with partners met online
Sampling		Recruitment conducted via advertisements on online social and sexual networking sites. Eligible participants were single, cisgender males aged 18–24 years of negative or unknown HIV status reporting unprotected anal intercourse with male partners met online
Sample size (overall response rate), baseline		180 participants enrolled and randomised
Sexuality		<ul style="list-style-type: none"> Overall: 88.3% gay, 7.8% bisexual, 3.9% queer Included in analysis: 89% gay, 7% bisexual, 4% queer
Gender identity		Not stated; eligible participants were MSM
Ethnicity		<ul style="list-style-type: none"> Overall: 67.2% white, 16.1% multiracial, 10.0% black, 5.6% Asian, 0.6% Middle Eastern, 0.6% Native American Included in analysis: 67% white, 16% multiracial, 10% black, 5% Asian, 1% Middle Eastern, 1% Native American
Education level		<ul style="list-style-type: none"> Overall: 2.8% some high school, 10.6% high school diploma or GED equivalent, 7.8% technical or associate degree, 40.0% some college, 29.4% graduated college, 9.5% reported attending graduate school Included in analysis: not stated
Age (years), mean (SD)		<ul style="list-style-type: none"> Overall: 21.67 (1.81) Included in analysis: 21.5 (1.82)
		continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Sample size (overall response rate), follow-up	<ul style="list-style-type: none"> ● 91% completed at least one follow-up assessment ● 30-day assessment: $n = 143$ (79%) ● 60-day assessment: $n = 150$ (83%) ● 90-day assessment: $n = 147$ (82%) ● Included in analysis: $n = 155$ ● Included in sexual behaviour outcome analyses: $N = 123$ <ul style="list-style-type: none"> ○ Intervention: $n = 95$ ○ Control: $n = 28$
Outcomes	Outcome measures	<p>Analyses controlled for baseline levels of relevant outcomes</p> <p>Condomless receptive anal intercourse during 3-month trial period:</p> <p style="padding-left: 40px;">$X_{(1)}^2 = 4.40$; $p = 0.04$; OR 0.43, 95% CI 0.20 to 0.94</p> <p>Condomless receptive anal intercourse with serodiscordant or serounknown partners not known to be on PrEP or virally suppressed:</p> <p style="padding-left: 40px;">$X_{(1)}^2 = 2.18$; $p = 0.14$, OR 0.44, 95% CI 0.15 to 1.31</p> <p>Insertive CAI:</p> <p style="padding-left: 40px;">$X_{(1)}^2 = 1.19$; $p = 0.27$, OR 0.64, 95% CI 0.28 to 1.44</p> <p>Insertive CAI with serodiscordant or serounknown partners not known to be on PrEP or virally suppressed:</p> <p style="padding-left: 40px;">$X_{(1)}^2 = 1.86$; $p = 0.16$, OR 0.49, 95% CI 0.17 to 1.33</p>
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p> <p>Development</p>	<p>Modular HIV prevention intervention</p> <p>Internet</p> <p>Six sessions, which could be accessed for 90 days</p> <p>Young adult MSM</p> <p>Guided by a dual-processing cognitive-emotional decision-making framework, myDEx targeted both cognitive factors (e.g. knowledge, skills and self-reflection) and emotional factors, including limerence. Each session included activities and videos to build HIV risk reduction skills and promote self-reflection</p> <p>Sociodemographically diverse youth advisory board of three young MSM provided input on content and delivery and trained developers on same-sex attraction and young MSM dating behaviours</p>

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Provider organisation	Not stated
	Content	This module-based comprehensive sex education intervention aimed to improve psychological well-being and reduce HIV risk by targeting condom use, HIV/STI testing, unprotected anal intercourse, PrEP, and alcohol/drug use before sex. Content within each session was organised into three levels: a core message, deeper discussion of relevant topics and an activity. Content used storytelling, case scenarios, motivational interviewing strategies, graphics and videos, and it was tailored to the user via personalisation, content matching and feedback to maximise persuasiveness and relevance. Interactive activities included role-play scenarios, a diary, quizzes and opportunities to develop dating strategies
	Control	Information-only attention-control contained six sessions matching the myDEx design. Content mirrored the US Centers for Disease Control and Prevention's HIV Risk Reduction Tool ¹⁶⁰
Risk of bias		
Item	Reviewer judgement	Description
Sequence generation: was the allocation sequence adequately generated?	Yes	Used pseudo-random number generator with permuted blocks
Allocation concealment: was the allocation adequately concealed?	Yes	Allocation conducted automatically online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Study participants were blinded, but analysts were not
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	Outcomes were self-reported and participants were blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	Complete for primary outcomes but not for relevant secondary outcomes specified in protocol (psychological well-being, substance use)

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to adjust for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Recruited nationally
Programme: Safe Behaviour and Screening (Chiou et al.¹²⁵)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Assess how the intervention affects knowledge, motivation and skills for HIV prevention and risky behaviour
	Timing and duration	Study conducted August 2015–May 2017; pre test was followed by post test at 6 months
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Rolled dice and corresponded to random number table
	Concealment of allocation (RCTs)	Yes
	Baseline equivalence	No significant demographic differences between arms at baseline
Details of participants	Location: country	Taiwan (Province of China)
	Target population	HIV-negative MSM
	Sampling	Recruitment was conducted via social media platforms and respondent-driven sampling. Eligible participants were HIV-negative MSM aged ≥ 20 years who had not used a HIV prevention/treatment app in the previous year
	Sample size (overall response rate), baseline	Overall: $N = 300$ <ul style="list-style-type: none"> Intervention: $n = 150$ Control: $n = 150$
	Sexuality	Not stated; eligible participants were MSM
	Gender identity	Not stated; eligible participants were MSM
	Ethnicity	Not stated
	SES	Education <ul style="list-style-type: none"> Overall: 65% college or university Intervention: 64% college or university, 21% above university, 15% high school or less Control: 66% college or university, 20% above university, 14% high school or less
		Employment <ul style="list-style-type: none"> Overall: 78% employed Intervention: 77% employed, 21% student, 2% unemployed Control: 79% employed, 19% student, 3% unemployed

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Age (years), mean (SD)	<ul style="list-style-type: none"> • Overall: 27 (5.6) • Intervention: 27.4 (6.3) • Control: 27 (4.7)
	Sample size (overall response rate), follow-up	Overall: N = 265 <ul style="list-style-type: none"> • Intervention: n = 130 • Control: n = 135
Outcomes	Outcome measures	All outcomes assessed over preceding 3 months <ul style="list-style-type: none"> • Syphilis positivity rate: IRR 1.39 (95% CI 0.307 to 6.366); $p = 0.664$ • HIV-positive rate: IRR 1.56 (95% CI 0.258 to 9.557); $p = 0.842$ • Condom use during anal intercourse: $\beta = 20.7$ (SE = 0.058), $t = 3.536$; $p = 0.001$ • Recreational drug use: $\beta = -1.19$ (SE = 0.204), $t = -5.850$; $p < 0.001$
Details of intervention	Description	HIV prevention app targeting sexual risk behaviours and recreational drug use
	Technology	Smartphone/mobile app
	Timing and duration	App was used for 6 months; quiz and prize activity related to HIV testing, safe sex and drug use conducted every 3 weeks
	Target population	MSM
	Theoretical framework	Drew on the IMB model, which posits that information, behavioural motivation and skills influence HIV prevention behaviour. App content provided information that aimed to increase knowledge. Survey measures suggested that the intervention also targeted motivation (comprising attitudes towards reducing risky sexual behaviour and recreational drug use, and intention to change these behaviours) and behavioural skills for HIV prevention (including partner communication, negotiating safe sex, drug and unsafe sex refusal skills and correct condom use)
	Development	Informed by existing qualitative literature and by formative research. The latter included interviews with 10 MSM to inform initial development, then recommendations for refinement from five MSM and four experts
	Provider organisation	Not stated
	Content	App with five features: (1) log to record sexual behaviour and recreational drug use, which can output tables/figures showing changes over time, and links to PrEP resources; (2) information on HIV/STIs, safe sex strategies including partner

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Control	communication, recreational drug use including alternative strategies to enhance arousal before sex, and PrEP; (3) recommendations, links and a log to promote and record testing; (4) search, messaging and message board to interact with other users; and (5) presentation of most popular users, message boards and testing locations No programming offered to control arm
<i>Risk of bias</i>		
<i>Item</i>	<i>Reviewer judgement</i>	<i>Description</i>
Sequence generation: was the allocation sequence adequately generated?	Yes	Rolled dice and corresponded to random number table
Allocation concealment: was the allocation adequately concealed?	Yes	
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	Yes	
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Yes	
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Recruited participants from throughout the country
Programme: Sex Positive! (Hirshfield et al.¹²⁷)		
Methods	Overall study design Research questions/hypotheses	RCT Hypothesised that, compared with control participants, intervention participants would report significantly fewer CAI partners who were serodiscordant or of unknown HIV status ('known or unknown serodiscordant') at the 3- and 12-month follow-ups

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Timing and duration	Recruitment took place between June and December 2015. Following baseline assessment, core intervention was delivered. Follow-up assessments took place at 3, 6, 9 and 12 months post baseline. Following the 6-month follow-up, four booster videos were delivered weekly
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Not stated
	Concealment of allocation (RCTs)	Yes, randomisation took place automatically online
	Baseline equivalence	Arms did not differ on any key characteristics including sociodemographics, relationship status, recruitment source or number of male anal sex partners
Details of participants	Location: country	USA
	Target population	MSM living with HIV
	Sampling	Recruitment was conducted via advertisements on social and sexual networking websites, online bulletin boards, GPS-based apps and an e-mail blast to members of an online dating site for people living with HIV. Eligible participants were MSM identifying as black, white or Hispanic; were living with HIV, with a detectable viral load or suboptimal ART adherence; and reported CAI with known or unknown serodiscordant male partners
	Sample size (overall response rate), baseline	Overall: N = 830 eligible and randomised <ul style="list-style-type: none"> Intervention: n = 413 Control: n = 417
	Sexuality	Not stated; eligible participants were gay, bisexual and other MSM
	Gender identity	Not stated; eligible participants were assigned male at birth and identified as male or genderqueer
	Ethnicity	<ul style="list-style-type: none"> Intervention: 50% white, 27% black, 23% Hispanic Control: 50% white, 26% black, 24% Hispanic
	SES	Education <ul style="list-style-type: none"> Intervention: 11.6% high school or less, 40.2% some college or enrolled, 48.2% college degree or more Control: 10.8% high school or less, 46.4% some college or enrolled, 42.8% college degree or more

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
	<p>Annual income</p> <ul style="list-style-type: none"> <li>• Intervention: 17%, < US\$10,000; 18%, US\$10,000–19,999; 26%, US\$20,000–39,999; 16%, US\$40,000–59,999; 13%, US\$60,000–99,999; 9%, ≥ US\$100,000 <li>• Control: 17.1%, < \$10,000; 18.6%, US\$10,000–19,999; 27.2%, US\$20,000–39,999; 14.9%, US\$40,000–59,999; 15.6%, US\$60,000–99,999; 6.7%, ≥ \$100,000 <p>Region</p> <ul style="list-style-type: none"> <li>• Intervention: 19.1% north east, 24.2% south Atlantic, 12.6% north central, 22.5% south central, 5.8% mountain, 14.8% Pacific and 0.2% Puerto Rico <li>• Control: 16.3% north east, 24.9% south Atlantic, 14.1% north central, 17.0% south central, 5.8% mountain, 21.1% Pacific and 0.7% Puerto Rico <p>Age (years)</p> <ul style="list-style-type: none"> <li>• Intervention: 8% aged 18–24, 19% aged 25–29, 32% aged 30–39, 24% aged 40–49, 17% aged ≥ 50 <li>• Control: 8% aged 18–24, 16% aged 25–29, 30% aged 30–39, 28% aged 40–49, 19% aged ≥ 50 <p>Sample size (overall response rate), follow-up</p> <p>Overall</p> <ul style="list-style-type: none"> <li>• 3-month survey: $n = 667$ (80%) <li>• 12-month survey: $n = 606$ (73%) <p>Intervention</p> <ul style="list-style-type: none"> <li>• 3-month survey: $n = 327$ (79%) <li>• 12-month survey: $n = 292$ (71%) <p>Control</p> <ul style="list-style-type: none"> <li>• 3-month survey: $n = 340$ (81%) <li>• 12-month survey: $n = 314$ (75%)
Outcomes	<p>Outcome measures</p> <p>Regression models adjusted for baseline values of outcome measures</p> <p>Change in number of known serodiscordant CAI partners between baseline and 3 months ($n = 344$)</p> <ul style="list-style-type: none"> <li>• One or more fewer partners: risk difference = -3.7, risk ratio 0.84 (95% CI 0.55 to 1.26) <li>• No change: risk difference = 9.8, risk ratio 1.19 (95% CI 0.99 to 1.44) <li>• One or more additional partners: risk difference = -6.1, risk ratio 0.77 (95% CI 0.52 to 1.13) <li>• Unadjusted linear regression: $R^2 = 0.000$, $B = -0.006$, $SE(B) = 0.094$, $\beta = -0.003$, 95% CI -0.189 to 0.178; $p = 0.95$ <li>• Adjusted linear regression: $R^2 = 0.232$, $B = 0.005$, $SE(B) = 0.088$, $\beta = 0.003$, 95% CI -0.168 to 0.178; $p = 0.96$

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
	Change in number of known serodiscordant CAI partners between baseline and 12 months ($n = 281$)
	<ul style="list-style-type: none"> • One or more fewer partners: risk difference = -7.4, risk ratio 0.76 (95% CI 0.51 to 1.12) • No change: risk difference = -0.8, risk ratio 0.98 (95% CI 0.76 to 1.27) • One or more additional partners: risk difference = 8.3, risk ratio 1.36 (95% CI 0.92 to 2.01) • Unadjusted linear regression: $R^2 = 0.007$, $B = -0.156$, $SE(B) = 0.115$, $\beta = -0.081$, 95% CI -0.382 to 0.070; $p = 0.17$ • Adjusted linear regression: $R^2 = 0.374$, $B = -0.141$, $SE(B) = 0.097$, $\beta = -0.073$, 95% CI -0.332 to 0.051; $p = 0.15$
	Change in number of unknown serodiscordant CAI partners between baseline and 3 months ($n = 376$)
	<ul style="list-style-type: none"> • One or more fewer partners: risk difference = 6.0, risk ratio 1.20 (95% CI 0.90 to 1.60) • No change: risk difference = 4.0, risk ratio 1.09 (95% CI 0.88 to 1.35) • One or more additional partners: risk difference = -10.0, risk ratio 0.60 (95% CI 0.39 to 0.92) • Unadjusted linear regression: $R^2 = 0.006$, $B = 0.159$, $SE(B) = 0.106$, $\beta = 0.077$, 95% CI -0.049 to 0.366; $p = 0.13$ • Adjusted linear regression: $R^2 = 0.319$, $B = 0.146$, $SE(B) = 0.099$, $\beta = 0.071$, 95% CI -0.050 to 0.341; $p = 0.14$
	Change in number of unknown serodiscordant CAI partners between baseline and 12 months ($n = 299$)
	<ul style="list-style-type: none"> • One or more fewer partners: risk difference = -3.4, risk ratio 0.91 (95% CI 0.68 to 1.23) • No change: risk difference = -2.1, risk ratio 0.95 (95% CI 0.72 to 1.25) • One or more additional partners: risk difference = 5.5, risk ratio 1.27 (95% CI 0.84 to 1.93) • Unadjusted linear regression: $R^2 = 0.006$, $B = -0.162$, $SE(B) = 0.122$, $\beta = -0.076$, 95% CI -0.402 to 0.079; $p = 0.19$ • Adjusted linear regression: $R^2 = 0.334$, $B = -0.177$, $SE(B) = 0.113$, $\beta = -0.084$, 95% CI -0.399 to 0.045; $p = 0.12$
Details of intervention	Description
	Technology
	Video-based intervention to prevent onward HIV transmission
	Internet
continued	

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Timing and duration	Six videos, delivered weekly for 3 months, and four booster videos delivered weekly starting at 6 months. Full intervention was delivered over a 1-year period
	Target population	MSM living with HIV
	Theoretical framework	Informed by social cognitive theory and social learning theory, Sex Positive! aimed to prevent onward HIV transmission among MSM living with HIV. The dramatic series sought to optimise engagement by featuring stories and characters with which target users would identify. Informed by social learning theory, it used modelling to demonstrate risk reduction and health behaviours including HIV disclosure and discussions about safer sex. Content aimed to promote critical thinking about HIV disclosure, medication adherence, viral suppression, sex under the influence of drugs or alcohol and serodiscordant CAI. Authors' narrative and the constructs assessed in user surveys suggested that critical thinking was theorised to promote self-efficacy for safer sex and for HIV status disclosure to partners; promote perceived personal and partner responsibility for preventing HIV transmission; and shape outcome expectancies for condoms, anal intercourse and HIV disclosure. Modelling of self-regulation aimed to improve skills for regulating sexual compulsivity. These mediators were theorised to influence HIV treatment adherence, mental health, substance use, sexual behaviour and interpersonal violence outcomes. Four follow-up booster videos aimed to help sustain impact over time
	Development	Core intervention videos were newly produced, based in part on videos from the earlier HIV Big Deal project, which showed effectiveness in reducing instances of CAI. Content was informed by a community advisory committee. A video from the HIV Big Deal project was edited to create three booster videos; the fourth booster video came from a video-sharing website
	Provider organisation	Not stated
	Content	The intervention's dramatic video series 'Just a Guy' followed 'Guy', a gay man living with HIV in Brooklyn, New York. The intervention used modelling to demonstrate risk reduction and health behaviours, including HIV disclosure and discussions about safer sex. Four follow-up booster videos aimed to help sustain the intervention's impact over time

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Control	Attention-control video arm consisted of 10 videos on healthy living, of comparable duration to intervention videos (2–4 minutes) and delivered on the same schedule: weekly for 6 weeks, then weekly for 4 weeks following the 6-month assessment
<i>Risk of bias</i>		
Item	Reviewer judgement	Description
Sequence generation: was the allocation sequence adequately generated?	Not stated	
Allocation concealment: was the allocation adequately concealed?	Yes	Randomisation took place automatically online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	Not stated	
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Not stated	Outcomes were self-reported; did not state whether or not participants were blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	Protocol (Hirshfield <i>et al.</i> ¹⁰⁴) specified outcomes that were not reported in this paper
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Recruited nationally and from multiple sources
Programme: Sexpulse (Rosser <i>et al.</i>¹¹⁶)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Aimed to test whether or not an internet-based sexual health promotion intervention can reduce unprotected anal intercourse among MSM

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Details of participants	Timing and duration	Baseline and intervention completed over 3-week period (December 2007–January 2008), with 7 days to complete intervention activities followed by immediate post-intervention survey. Follow-up surveys at 3, 6, 9 and 12 months (April 2008–January 2009)
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Computer algorithm used to randomly assign participants to a study arm
	Concealment of allocation (RCTs)	Yes
	Baseline equivalence	No statistical tests of baseline equivalence reported
	Location: country	USA
	Target population	MSM
	Sampling	Recruited via banner advertisements on two of the largest websites for gay men in the USA, and via e-mails to past research participants. Eligible participants were male US residents aged ≥ 18 years, with recent history of unprotected anal intercourse with at least one other man
	Sample size (overall response rate), baseline	Overall: 650 participants completed baseline survey and were randomised (63% of those eligible)
	Sexuality	<ul style="list-style-type: none"> • Intervention: 337 began intervention • Control: 313 began control survey • Overall: 91.4% homosexual/gay/same-gender loving, 8.6% bisexual/straight/other • Intervention: 90.8% homosexual/gay/same-gender loving; 9.2% bisexual/straight/other • Control: 92.0% homosexual/gay/same-gender loving, 8.0% bisexual/straight/other
Gender identity	Not stated; eligible participants were MSM	
Ethnicity	<ul style="list-style-type: none"> • Overall: 68.2% white, 6.3% black or African American, 15.1% Latino/Spanish/other, 3.5% Asian, 6.9% other • Intervention: 71.2% white, 5.3% black or African American, 13.1% Latino/Spanish/other, 2.7% Asian, 7.7% other • Control: 64.9% white, 7.4% black or African American, 17.3% Latino/Spanish/other, 4.5% Asian, 6.1% other 	
SES	Education <ul style="list-style-type: none"> • Overall: 7.9% less than high school or high school graduate, 34.3% some college education, 22.6% college degree, 35.2% graduate/professional school 	

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
	<ul style="list-style-type: none"> Intervention: 8.6% less than high school or high school graduate, 34.7% some college education, 22.0% college degree, 34.7% graduate/professional school Control: 7.0% less than high school or high school graduate, 33.9% some college education, 23.3% college degree, 35.8% graduate/professional school
	<p>Annual income</p> <ul style="list-style-type: none"> Overall: 18.6%, < US\$20,000; 19.5%, US\$20,000–31,999; 18.0%, US\$32,000–44,999; 19.1%, US\$45,000–64,999; 20.5%, ≥ US\$65,000; 4.3% refused to answer Intervention: 19.3%, < US\$20,000; 18.1%, US\$20,000–31,999; 17.8%, US\$32,000–44,999; 20.2%, US\$45,000–64,999; 20.5%, ≥ \$65,000; 4.2% refused to answer Control: 17.9%, < US\$20,000; 21.1%, US\$20,000–31,999; 18.2%, US\$32,000–44,999; 17.9%, US\$45,000–64,999; 20.5%, ≥ US\$65,000; 4.5% refused to answer
	<p>Residence</p> <ul style="list-style-type: none"> Overall: 16.1% rural or small town, 16.4% medium-sized city, 24.0% suburb of a large-sized city, 43.5% downtown or central district of a large-sized city Intervention: 17.1% rural or small town, 18.0% medium-sized city, 24.0% suburb of a large-sized city, 41.0% downtown or central district of a large-sized city Control: 15.1% rural or small town, 14.7% medium-sized city, 24.0% suburb of a large-sized city, 46.2% downtown or central district of a large-sized city
Age (years)	<ul style="list-style-type: none"> Overall: 23.5% aged 18–25; 34.5% aged 26–35; 27.7% aged 36–45; 14.3% aged > 45 Intervention: 24.0% aged 18–25, 33.5% aged 26–35; 27.3% aged 36–45, 15.1% aged > 45 Control: 23.0% aged 18–25, 35.5% aged 26–35, 28.1% aged 36–45, 13.4% aged > 45
Sample size (overall response rate), follow-up	<p>Overall</p> <ul style="list-style-type: none"> Completed post-treatment/post-control survey: <i>n</i> = 587 (90%) Completed 3-month survey: <i>n</i> = 560 (86%) Completed 12-month survey: <i>n</i> = 554 (85%)

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		<p>Intervention</p> <ul style="list-style-type: none"> • Completed post-treatment survey: <i>n</i> = 276 (82%) • Completed 3-month survey: <i>n</i> = 267 (79%) • Completed 12-month survey: <i>n</i> = 276 (82%) <p>Control</p> <ul style="list-style-type: none"> • Completed post-control survey: <i>n</i> = 311 (99%) • Completed 3-month survey: <i>n</i> = 293 (94%) • Completed 12-month survey: <i>n</i> = 278 (89%)
Outcomes	Outcome measures	<p>Adjusted models adjust for age, race and income group</p> <p>Unprotected anal intercourse with male partner</p> <ul style="list-style-type: none"> • At 3-month follow-up <ul style="list-style-type: none"> ○ Full sample <ul style="list-style-type: none"> - Unadjusted: IRR 0.832 (95% CI 0.691 to 1.000); <i>p</i> = 0.050 - Adjusted: IRR 0.8444 (95% CI 0.704 to 1.1013); <i>p</i> = 0.068 ○ Non-zero risk at baseline (participants reporting > 0 unprotected anal intercourse partners at baseline) <ul style="list-style-type: none"> - Unadjusted: IRR 0.825 (95% CI 0.684 to 0.995); <i>p</i> = 0.044 - Adjusted: IRR 0.843 (95% CI 0.701 to 1.014); <i>p</i> = 0.069 • At 12-month follow-up <ul style="list-style-type: none"> ○ Full sample <ul style="list-style-type: none"> - Unadjusted: IRR 0.998 (95% CI 0.952 to 1.046); <i>p</i> = 0.921 - Adjusted: IRR 0.998 (95% CI 0.952 to 1.046); <i>p</i> = 0.937 ○ Non-zero risk at baseline (those reporting > 0 unprotected anal intercourse partners at baseline) <ul style="list-style-type: none"> - Unadjusted: IRR 0.991 (95% CI 0.945 to 1.040); <i>p</i> = 0.728 - Adjusted: IRR 0.993 (95% CI 0.947 to 1.042); <i>p</i> = 0.786
Details of intervention	<p>Description</p> <p>Technology</p> <p>Timing and duration</p> <p>Target population</p> <p>Theoretical framework</p>	<p>Modular HIV prevention intervention to reduce instances of unprotected anal intercourse</p> <p>Internet</p> <p>Multimodule intervention was to be completed over a 7-day period</p> <p>MISM</p>

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
		Guided by the sexual health model, which posits that people are more likely to make sexually healthy decisions when they themselves are sexually healthy. Intervention addressed the following aspects of the model: (1) mental and emotional health, (2) physical health, (3) intimacy, (4) relationships, (5) sexuality and (6) spirituality. Content covered other specified topics, but their relationships to the sexual health model and to the intervention were not clear. Based on the authors' description, the theory underpinning the intervention seemed to be that addressing aspects of broader sexual health would support safer sexual health decision-making
	Development	Designed by health professionals, computer scientists, and e-learning specialists; and developed by an e-learning company. Sexpulse was informed by formative research with 2716 MSM (recruited online) and developed by adapting an existing sexual health curriculum for MSM from a seminar to an online setting. Module prototypes were reviewed by experts, tested with MSM and refined
	Provider organisation	Not stated
	Content	Sexpulse was a flexible intervention and incorporated video segments, interactive text and animations. Examples of modules included a 'hot sex calculator' demonstrating decision-making, a virtual gym where users could explore body image concerns, an online chat simulation to explore evasive and ambiguous communication and a 'reflective journey' exploring past experiences, long-term goals and spirituality. The intervention addressed a range of topics including mental, emotional and physical health; intimacy; relationships; sexuality; and spirituality. Modules were supplemented with FAQs, virtual peers sharing their experiences, cartoons and interactive polls
	Control	Wait-list null control; participants randomised to the control arm completed an additional sexual health survey between baseline and post-intervention assessments
Risk of bias		
Item	Reviewer judgement	Description
Sequence generation: was the allocation sequence adequately generated?	Yes	Computer algorithm used to randomly assign participants to a study arm
Allocation concealment: was the allocation adequately concealed?	Yes	
continued		

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Participants were not blinded; did not state whether or not personnel were blinded
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	No	Outcomes were self-reported and participants were not blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	Attrition roughly balanced between arms, > 70% in each arm
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	All outcomes reported as described
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to adjust for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Used multiple recruitment methods and did not target one single geographic region
Programme: SOLVE (Christensen et al.¹⁰¹)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Hypothesised that intervention participants will report immediate reductions in shame, compared with wait-list control, which will predict change in unprotected anal intercourse over 3 months; and that shame will mediate relationship between study arm and change in CAI
	Timing and duration	Participants were enrolled from February to November 2012
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Online data collection software automatically generated random allocation sequence and assigned participants to study condition
	Concealment of allocation (RCTs)	Allocation conducted by online data collection software
	Baseline equivalence	Arms did not differ significantly on any baseline measures
Details of participants	Location: country	USA
	Target population	Young adult MSM
	Sampling	Recruited via clickable banner advertisements on websites used by MSM. Eligible participants were black/African

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
Sample size (overall response rate), baseline	<p>American, Hispanic/Latino or white/Caucasian MSM aged 18–24 years, who reported a prior HIV-negative test result and reported CAI with a non-primary male partner in the previous 3 months</p> <p>Overall: 935 participants allocated to study and completed baseline (46% of those randomised)</p> <ul style="list-style-type: none"> Intervention: 444 received allocated intervention and completed baseline measures (35% of those randomised) Control: 491 received allocated control and completed baseline measures (67% of those randomised)
Sexuality	<ul style="list-style-type: none"> Intervention: 74.5% gay/homosexual, 14.7% bisexual, 10.4% other Control: 76.6% gay/homosexual, 11.4% bisexual, 11.6% other
Gender identity	Not stated; eligible participants were MSM
Ethnicity	<ul style="list-style-type: none"> Intervention: 76.1% white/Caucasian, 12.4% Latino/Hispanic, 11.5% black/African American Control: 71.1% white/Caucasian, 15.5% Latino/Hispanic, 13.4% black/African American
SES	<p>Education</p> <ul style="list-style-type: none"> Intervention: 83.6% have at least some post-secondary education Control: 80.2% have at least some post-secondary education <p>Residence</p> <ul style="list-style-type: none"> Intervention: 12.8% live in a rural geographic area Control: 13.4% live in a rural geographic area
Age (years), mean (SD)	<ul style="list-style-type: none"> Intervention: 21.3 (1.8) Control: 21.3 (1.7)
Sample size (overall response rate), follow-up	<p>Overall: $N = 628$ (67% of those completing baseline)</p> <ul style="list-style-type: none"> Intervention: $n = 294$ (66%) Control: $n = 334$ (68%)
Outcomes	<p>Outcome measures</p> <p>Shame change predicted CAI change ($n = 921$)</p> <ul style="list-style-type: none"> $\beta = 0.73$, $SE = 0.36$, 95% bias-corrected 95% CI 0.03 to 1.45 <p>Indirect effect on CAI change</p> <ul style="list-style-type: none"> Point estimate = -0.10, 95% bias-corrected 95% CI -0.01 to -0.23

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Details of intervention	Description	Animated game for HIV prevention, simulating situations typically confronted by young adult MSM on first dates or 'hook-ups'
	Technology	Computer download
	Timing and duration	30 minutes
	Target population	Young adult MSM
	Theoretical framework	Via multiple theorised pathways, SOLVE aimed to decrease instances of unprotected anal intercourse, thereby reducing HIV risk. Informed by the notion that shame due to 'sexual stigma' can contribute to HIV risk behaviours, SOLVE simulated shame-inducing situations; promoted conscious acknowledgement and normalisation of a user's desires; and role-modelled positive attitudes towards one's self, as well as comfort with a user's sexuality and desires. The authors' description suggested that this aimed to decrease shame by normalising the desires of MSM, increasing self-worth and self-acceptance, and reducing isolation and feelings of inferiority. Drawing on neuroscience research suggesting that emotions play a critical role in decision-making, SOLVE aimed to increase self-awareness of goals, emotions and barriers to safer sex; promote recognition of the consequences of a user's desires; interrupt affect-based decision-making; and increase self-regulation. Other components aimed to increase HIV knowledge and hone HIV risk reduction skills and strategies
	Development	This interactive, media-based intervention was informed by an approach previously developed and tested by a co-author of this report and their colleagues, and delivered in SOLVE as a downloadable three-dimensional animated game. SOLVE's content was based on qualitative and quantitative pilot studies
	Provider organisation	Not stated
	Content	SOLVE aimed to decrease instances of unprotected anal intercourse, thereby reducing HIV risk. In this three-dimensional animated game, users took the role of a customisable avatar and made decisions that affected the narrative in simulated settings presenting risky situations and barriers to safer sex that young adult MSM typically confront on first dates or 'hook-ups'. The intervention simulated shame-inducing situations, and the avatar

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details		Characteristics of outcome evaluations	
		Control	Wait-list control
<i>Risk of bias</i>			
Item	Reviewer judgement		Description
Sequence generation: was the allocation sequence adequately generated?	Yes		Online data collection software automatically generated random allocation sequence and assigned participants to study condition
Allocation concealment: was the allocation adequately concealed?	Yes		Allocation conducted by online data collection software
Blinding of participants/personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No		Researchers were blind to allocation at enrolment, but some were subsequently unblinded to avoid participant re-enrolment. Did not state whether or not participants were blinded
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Not stated		All outcomes were self-reported; did not state whether or not participants were blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	No		Retention was < 70%
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No		No direct estimate on unprotected anal intercourse provided, nor was one calculable
Accounted for clustering: did the study adequately account for effects of clustering?	Yes		No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	No		Analytic methods used to estimate mediational pathways are biased, including use of residualised change scores

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations		
Programme: TXT-Auto (Reback et al.^{114,115})			
Methods	Overall study design	RCT	
	Research questions/hypotheses	Tested the efficacy of text messages to reduce methamphetamine use and HIV risk. Hypothesised that, among this sample of non-treatment-seeking methamphetamine-using MSM, magnitude of change would be greater from interactive text messages transmitted by peer health educators than by unidirectional text messages automatically transmitted; and that the latter would produce significantly greater reductions than an assessment-only attentional control condition	
	Timing and duration	Enrolment took place between March 2014 and January 2016. Baseline assessment took place at intake and follow-up assessments took place at 8 weeks and at 3, 6 and 9 months post enrolment	
	Allocation	Individual	
	Generation of allocation sequence (RCTs)	Not stated	
	Concealment of allocation (RCTs)	Not stated	
	Baseline equivalence	Identified significant differences between arms in baseline patterns of HIV sexual risk behaviours	
	Details of participants	Location: country (region)	USA (Hollywood area of Los Angeles, CA)
		Target population	Non-treatment-seeking methamphetamine-using MSM
		Sampling	Street- and venue-based outreach, social media and dating app advertising, flyers, posters and participant referral. Eligible participants were non-treatment-seeking methamphetamine-using MSM aged 18–65 years reporting CAI with non-primary male partner(s)
Sample size (overall response rate), baseline		Overall: 286 participants were randomised <ul style="list-style-type: none"> • Intervention: $n = 99$ • Control: 94 participants randomised to comparison intervention (ineligible for this review) and 93 randomised to control 	
Sexuality		<ul style="list-style-type: none"> • Overall: 67.1% gay identified, 32.9% non-gay identified • Intervention: 68.7% gay identified, 31.3% non-gay identified • Comparison intervention: 70.2% gay identified, 29.8% non-gay identified • Control: 62.4% gay identified, 37.6% non-gay identified 	
	Gender identity	Not stated; eligible participants were MSM	

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
Ethnicity	<ul style="list-style-type: none"> • Overall: 19.6% Caucasian/white, 43.7% African American/black, 25.2% Hispanic/Latino, 11.5% multiracial/other • Intervention: 16.2% Caucasian/white, 45.5% African American/black, 29.3% Hispanic/Latino, 9.1% multiracial/other • Comparison intervention: 21.3% Caucasian/white, 42.6% African American/black, 21.3% Hispanic/Latino, 14.9% multiracial/other • Control: 21.5% Caucasian/white, 43.0% African American/black, 24.7% Hispanic/Latino, 10.8% multiracial/other
Education level	<ul style="list-style-type: none"> • Overall: 17.7% less than high school graduate/GED, 30.5% high school graduate/GED, 33.0% some college, 18.8% • Intervention: 17.5% less than high school graduate/GED, 33.0% high school graduate/GED, 27.8% some college, 21.7% college graduate • Comparison intervention: 17.2% less than high school graduate/GED, 28.0% high school graduate/GED, 34.4% some college, 20.4% college graduate • Control: 18.5% less than high school graduate/GED, 30.4% high school graduate/GED, 37.0% some college, 14.1% college graduate
Age (years), mean (SD)	<ul style="list-style-type: none"> • Overall: 41.5 (10.9) • Intervention: 41 (11.1) • Comparison intervention: 42 (11.3) • Control: 41.4 (10.2)
Sample size (overall response rate), follow-up	<p>Overall</p> <p>8-week follow-up: $n = 237$ (83%)</p> <p>3-month follow-up: $n = 251$ (88%)</p> <p>6-month follow-up: $n = 240$ (84%)</p> <p>9-month follow-up: $n = 255$ (89%)</p> <p>Intervention</p> <p>8-week follow-up: $n = 82$ (83%)</p> <p>3-month follow-up: $n = 82$ (83%)</p> <p>6-month follow-up: $n = 83$ (84%)</p> <p>9-month follow-up: $n = 85$ (86%)</p> <p>Comparison intervention</p> <p>8-week follow-up: $n = 76$ (81%)</p> <p>3-month follow-up: $n = 86$ (92%)</p> <p>6-month follow-up: $n = 79$ (84%)</p>

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
Outcomes	Outcome measures
	<p>9-month follow-up: $n = 86$ (92%)</p> <p>Control</p> <p>8-week follow-up: $n = 79$ (85%)</p> <p>3-month follow-up: $n = 83$ (89%)</p> <p>6-month follow-up: $n = 78$ (84%)</p> <p>9-month follow-up: $n = 84$ (90%)</p> <p>Episodes of CAI with male partner (insertive or receptive)</p> <ul style="list-style-type: none"> • Interaction effects: condition \times time point, coefficient (95% CI) <ul style="list-style-type: none"> ○ Main partners <ul style="list-style-type: none"> - TXT-PHE \times time: -0.19 (-0.35 to -0.02); $p \leq 0.05$ - TXT-Auto \times time: -0.16 (-0.31 to 0.003); $p \leq 0.10$ - Constant: 0.40 (-0.10 to 0.90) ○ Casual partners <ul style="list-style-type: none"> - TXT-PHE \times time: 0.01 (-0.04 to 0.06) - TXT-Auto \times time: -0.01 (-0.06 to 0.03) - Constant: 0.11 (-0.11 to 0.32) ○ Anonymous partners <ul style="list-style-type: none"> - TXT-PHE \times time: -0.03 (-0.08 to 0.02) - TXT-Auto \times time: -0.05 (-0.10 to 0.003); $p \leq 0.10$ - Constant: 0.17 (-0.06 to 0.40) ○ Partners for transactional sex <ul style="list-style-type: none"> - TXT-PHE \times time: 0.02 (-0.13 to 0.17) - TXT-Auto \times time: -0.03 (-0.18 to 0.11) - Constant: 0.21 (-0.26 to 0.68) ○ Main effects: random condition assignment, coefficient (95% CI) <ul style="list-style-type: none"> ○ Main partners <ul style="list-style-type: none"> - TXT-PHE: -0.04 (-0.43 to 0.36) - TXT-Auto: -0.08 (-0.48 to 0.31) ○ Casual partners <ul style="list-style-type: none"> - TXT-PHE: -0.04 (-0.19 to 0.12) - TXT-Auto: -0.01 (-0.16 to 0.14) ○ Anonymous partners <ul style="list-style-type: none"> - TXT-PHE: -0.09 (-0.25 to 0.07) - TXT-Auto: -0.05 (-0.20 to 0.11) ○ Partners for transactional sex <ul style="list-style-type: none"> - TXT-PHE: 0.00 (-0.37 to 0.38) - TXT-Auto: 0.17 (-0.20 to 0.55)

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations
	<p>Episodes of sex while on methamphetamine</p> <p>Interaction effects: condition × time point, coefficient (95% CI)</p> <ul style="list-style-type: none"> <li>• TXT-PHE × time: 0.03 (−0.03 to 0.09) <li>• TXT-Auto × time: −0.05 (−0.11 to 0.009); significant at $p \leq 0.10$ <li>• Constant: −0.10 (−0.39 to 0.19) <li>• TXT-PHE: 0.05 (−0.14 to 0.25) <li>• TXT-Auto: 0.11 (−0.07 to 0.30) <p>Days of methamphetamine use</p> <ul style="list-style-type: none"> <li>• Interaction effects: condition × time point, coefficient (95% CI) <ul style="list-style-type: none"> <li>○ TXT-PHE × time: 0.03 (−0.02 to 0.09) <li>○ TXT-Auto × time: 0.01 (−0.04 to 0.06) <li>○ Constant: 0.08 (−0.22 to 0.38) <li>• Main effects: random condition assignment, coefficient (95% CI) <ul style="list-style-type: none"> <li>○ TXT-PHE: −0.12 (−0.37 to 0.12) <li>○ TXT-Auto: −0.03 (−0.21 to 0.14)
Details of intervention	<p>Description</p> <p>Text message-based intervention to reduce substance use and HIV risk</p> <p>Technology</p> <p>Text messaging</p> <p>Timing and duration</p> <p>Five messages per day for 8 weeks, delivered at peak hours of high-risk activities (Monday and Tuesday 12.00–20.00, Wednesday and Thursday 12.00–01.00, Friday 12.00–02.00, Saturday 15.30–02.00 and Sunday 15.30–00.00). Weekly self-monitoring assessments</p> <p>Target population</p> <p>Out-of-treatment methamphetamine-using MSM</p> <p>Theoretical framework</p> <p>Text message content was based on social support theory, social cognitive theory and the health belief model, which the authors described as complementary theories. Messages aimed to increase knowledge, and the authors' description suggested that they might also aim to increase self-efficacy. A brief weekly text-based assessment asking about methamphetamine use and HIV sexual behaviours in the previous 7 days aimed to increase self-monitoring</p> <p>Development</p> <p>Pilot research identified peak times for high-risk activities. Text messages were written in collaboration with community/peer focus groups. An mHealth development company programmed the text messaging software and hosted the system</p> <p>Provider organisation</p> <p>Research activities took place at a community research centre with a long history of working with methamphetamine-using MSM</p>

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details		Characteristics of outcome evaluations	
	Content	TXT-Auto aimed to reduce substance use and HIV risk by decreasing methamphetamine use and instances of sex during methamphetamine use and CAI. A baseline survey assessed a user's risk profile in relation to HIV status, ART adherence, drug use and sexual behaviours. Users then received five automated scripted text messages per day, which included both general messages and messages tailored to their risk profile. A brief weekly text-based assessment asking about methamphetamine use and HIV sexual behaviours in the previous 7 days aimed to increase self-monitoring	
	Control	Participants in the assessment-only condition received the same welcome message and brief weekly text-based assessments on their methamphetamine use and HIV sexual behaviours in the previous 7 days, and follow-up appointment reminders. This provided an 'attentional control'	
Risk of bias			
Item	Reviewer judgement	Description	
Sequence generation: was the allocation sequence adequately generated?	Not stated		
Allocation concealment: was the allocation adequately concealed?	Not stated		
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Neither participants nor study personnel were blinded	
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	No	Outcomes were self-reported and participants were not blinded	
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	Yes	Attrition rate was low and consistent across arms	
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	Yes	All outcomes reported	
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering	
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	Yes	Used multiple methods of recruitment with the aim of recruiting a diverse sample	

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations		
Programme: WRAPP (Bowen et al.⁹⁹)			
Methods	Overall study design	RCT	
	Research questions/hypotheses	Sought to examine initial efficacy of the intervention, identify effects of specific modules and determine whether or not modules have dose-response effect on cognitive variables. Hypothesised that knowledge and knowledge-related self-efficacy would increase following the knowledge module significantly more than following the other two modules, and that cognitive variables would increase significantly more following participation in all three modules than participation in one module	
	Timing and duration	Pre-test and post-test assessments following each of three intervention modules	
	Allocation	Individual	
	Generation of allocation sequence (RCTs)	Not stated	
	Concealment of allocation (RCTs)	Randomisation appeared to have taken place automatically online	
	Baseline equivalence	Not stated	
Details of participants	Location: country (region)	USA (rural)	
	Target population	Rural MSM	
	Sampling	Banner advertisements nationwide. Eligible participants were rural MSM aged ≥ 18 years reporting sex with a man in the prior 12 months	
	Sample size (overall response rate), baseline	425 participants completed the pre test and were randomised (69% of those eligible)	
	Sexuality	Completers (completing all intervention and questionnaire components): 84.4% gay, 15.3% bisexual, 0.3% heterosexual	
	Gender identity	Not stated; eligible participants were MSM	
	Ethnicity	Completers (completing all intervention and questionnaire components): 77.2% non-Hispanic white, 8.8% Hispanic, 13.9% Asian/Asian Pacific Islander, African American, Native American or other	
	SES	Completers (completing all intervention and questionnaire components) <ul style="list-style-type: none"> • Education <ul style="list-style-type: none"> ○ 19.7% high school or less; 80.3% some college or more • Employment <ul style="list-style-type: none"> ○ 55.7% full time, 17.9% part time, 26.5% unemployed/retired • Income <ul style="list-style-type: none"> ○ 36.7% < US\$15,000; 25.9% US\$15,000–24,999; 27.9% US\$25,000–49,999; 9.5% \geq US\$50,000 	
			continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Age (years)	Completers (completing all intervention and questionnaire components): 46.8% aged 18–24; 31.1% aged 25–34; 15% aged 35–44; 7.2% aged 45–80
	Sample size (overall response rate), follow-up	Completers (completed all intervention and questionnaire components): $n = 294$ (69% of those randomised) Note that sample sizes differed by outcome because of variable construction
Outcomes	Outcome measures	<p>Changes measured from pre-test to post-test assessment 3</p> <p>Anal sex index (% of partners with whom had anal intercourse)</p> <ul style="list-style-type: none"> • Overall ($n = 154$): paired t-test = 2.50 ($p < 0.05$) • By number of intercourse partners in previous 30 days at pre test <ul style="list-style-type: none"> ◦ 1 ($n = 84$): paired t-test = 2.60 ($p < 0.01$) ◦ ≥ 2 ($n = 70$): paired t-test = 0.86 (p not < 0.05) <p>Condom use index (% of anal intercourse partners with whom used condom)</p> <ul style="list-style-type: none"> • Overall ($n = 108$): paired t-test = -4.95 ($p < 0.001$) • By number of intercourse partners in previous 30 days at pre test <ul style="list-style-type: none"> ◦ 1 ($n = 61$): paired t-test = -3.82 ($p < 0.001$) ◦ ≥ 2 ($n = 47$): paired t-test = -4.95 ($p < 0.001$)
Details of intervention	Description	Online modular HIV risk reduction intervention for MSM in rural areas
	Technology	Internet
	Timing and duration	Three modules, each comprising two 20-minute interactive sessions. There had to be at least 48 hours between sessions, meaning the minimum time to complete the intervention was 10 days. Results found that participants took an average of 19.39 days to complete the entire intervention
	Target population	Sexually active, internet-using MSM in rural areas
	Theoretical framework	The WRAPP was informed by social cognitive theory and the IMB model. The 'knowledge' module aimed to increase HIV knowledge. The 'partner' module aimed to increase motivation (comprising outcome expectancies for risk reduction and willingness to reduce HIV risk behaviours). The 'contexts of risk' module aimed to develop behavioural skills. In turn, knowledge, motivation and behavioural skills were theorised to increase sexual self-efficacy (comprising mechanical self-efficacy, such as self-efficacy for correct condom use, and self-efficacy to refuse CAI), theorised to be a direct precursor of behaviour change

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Development	Earlier report described development (Bowen <i>et al.</i> ⁹⁸): content was identified from focus groups in 2001 and from a web-based assessment conducted from January 2002 to January 2003. Intervention format was informed by two focus groups conducted in May 2003
	Provider organisation	Not stated
	Content	<p>Online modular HIV risk reduction intervention. Module content included information tailored for rural MSM and was presented as conversations between gay men. Dialogue was interspersed with interactive activities and graphics. The first module featured a conversation between a HIV-positive gay man who represented an 'expert' and an 'inexperienced' HIV-negative gay man who had recently had a high-risk sexual encounter; the conversation primarily addressed HIV prevention during sex and living with HIV. It featured links to websites with further information</p> <p>The second module featured a conversation between five gay male friends, with one representing the user, and aimed to increase motivation, and a third module targeting behavioural skills in a similar format was introduced. Both allowed users to print a summary of their responses to interactive components. The 'motivation' module helped users identify reasons for not using condoms and ways to address these to support a user's pursuit of their life goals. The 'behaviour' module addressed approaches for reducing sexual risk with partners met online or in a bar</p>
	Control	NA
Risk of bias		
	Item	Reviewer judgement
	Sequence generation: was the allocation sequence adequately generated?	Not stated
	Allocation concealment: was the allocation adequately concealed?	Yes
	Blinding of participants/personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	Not stated
	Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	Not stated
		<p>Randomisation appeared to have taken place automatically online</p> <p>Did not state whether or not participants or personnel were blinded to intervention allocation</p> <p>All outcomes were self-reported; information on participant blinding was not stated</p>
continued		

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete data provided?	No	Attrition rate varied by arm and was < 70% overall
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	No concrete estimates for between-group differences presented
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	Not need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	No	No clear evidence of efficacy presented; no control group; no accounting for high rates of attrition
Programme: WRAPP (Schonnesson et al.¹¹⁷)		
Methods	Overall study design	RCT
	Research questions/hypotheses	Aimed to test the efficacy of an internet-based intervention to decrease HIV sexual risk behaviour among Swedish MSM
	Timing and duration	Pre-test and 1-month post-test assessment
	Allocation	Individual
	Generation of allocation sequence (RCTs)	Not stated
	Concealment of allocation (RCTs)	Randomisation appeared to have taken place automatically online
	Baseline equivalence	No significant differences in sample characteristics between arms
Details of participants	Location: country	Sweden
	Target population	Swedish MSM
	Sampling	Recruited via banners on Swedish website popular among LGBTQ people. Eligible participants were males aged ≥ 15 years who were fluent in Swedish and reported sex with a man in the previous 12 months
	Sample size (overall response rate), baseline	112 participants completed the pre-test questionnaire and were randomised (83% of those eligible) <ul style="list-style-type: none"> • Intervention: <i>n</i> = 58 • Control: <i>n</i> = 54
	Sexuality	93% gay
	Gender identity	Not stated; eligible participants were MSM
	Ethnicity	Not stated
	SES	<ul style="list-style-type: none"> • Education: 88% completed more than high school • Employment: 79% employed; remainder unemployed or on sick leave • Residence: 55% lived in a city; others lived in a town or in the countryside

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Age (years), mean (SD)	32 (12.09)
	Sample size (overall response rate), follow-up	30-day questionnaire: <ul style="list-style-type: none"> • Overall: $n = 55$ (49% of those randomised) • Intervention: $n = 25$ (43% of those randomised) • Control: $n = 33$ (61% of those randomised)
Outcomes	Outcome measures	Anal sex index, casual partner ($n = 32$): $t = 2.19, p = 0.04$
Details of intervention	Description	Online modular HIV risk reduction intervention for MSM
	Technology	See the Bowen <i>et al.</i> ⁹⁹ section previously in this table
	Timing and duration	Three modules each contained two 20-minute sessions. Sessions had to be completed 24–48 hours apart
	Target population	Sexually active, internet-using MSM
	Theoretical framework	See the Bowen <i>et al.</i> ⁹⁹ section previously in this table
	Development	See the Bowen <i>et al.</i> ⁹⁹ section previously in this table. The Swedish adaptation ¹¹⁷ was informed by 20 in-depth interviews with Swedish MSM (HIV positive and HIV negative) and a presentation of the intervention to professionals at HIV prevention and treatment organisations. Information tailored to Swedish context was reviewed by an experienced HIV physician
	Provider organisation	None stated
	Content	Module content included information tailored for rural MSM and was presented as conversations between gay men. It used the Swedish language, including reflecting language expressions, and content was consistent with Swedish health care and HIV programmes. Dialogue was interspersed with interactive activities and graphics. The first module featured a conversation between a HIV-positive gay man who represented an 'expert' and an 'inexperienced' HIV-negative gay man who had recently had a high-risk sexual encounter; the conversation primarily addressed HIV prevention during sex and living with HIV. It also included information about STIs and about Swedish public health legislation. This module featured links to websites with further information The second module featured a conversation between five gay male friends, with one representing the user, and aimed to increase motivation, and a third module targeting behavioural skills in a similar format was introduced. Both allowed users to print a summary of their responses to

continued

TABLE 15 Summary of outcome evaluation characteristics and risk of bias (continued)

Study details	Characteristics of outcome evaluations	
	Control	<p>interactive components. The 'motivation' module helped users identify reasons for not using condoms and ways to address these to support a user's pursuit of their life goals. The 'behaviour' module addressed approaches for reducing sexual risk with partners met online or in a bar</p> <p>Wait-list control. Those randomised to the control group waited 30 days, then completed the post-test questionnaire, then could access the intervention</p>
<i>Risk of bias</i>		
<i>Item</i>	<i>Reviewer judgement</i>	<i>Description</i>
Sequence generation: was the allocation sequence adequately generated?	Not stated	
Allocation concealment: was the allocation adequately concealed?	Yes	Randomisation appeared to have taken place automatically online
Blinding of participants/ personnel: was knowledge of intervention allocation adequately prevented during the study regarding participants and study personnel?	No	Neither participants nor study personnel were blinded
Blinding of outcome assessors: was knowledge of intervention allocation adequately prevented during the study regarding outcome assessors?	No	All outcomes were self-reported and participants were not blinded
Complete outcome data: were complete data for each outcome reported, and, if not, were adequate reasons for incomplete outcome data provided?	No	Attrition rate uneven, and high across both arms
No selective outcome reporting: were the findings of the study free of selective outcome reporting?	No	Only the outcome of anal sex index (casual partner) was examined because the sample sizes for the other three sex risk variables were too small
Accounted for clustering: did the study adequately account for effects of clustering?	Yes	No need to account for clustering
Reduced other sources of bias: did authors aim to reduce other forms of bias that might have entered the study?	No	Change scores were computed for primarily outcome variables and intermediate cognitive outcome variables by subtracting pre-test from post-test scores
<p>AIDS, acquired immunodeficiency syndrome; ART, antiretroviral therapy; FAQ, frequently asked question; GED, General Educational Development Test; GPS, Global Positioning System; IRR, incidence rate ratio; ITT, intention-to-treat; LGBTQ, lesbian, gay, bisexual, transgender and queer; MANOVA, multivariate analysis of variance; mHealth, mobile health; MSM, men who use the internet to seek sex with men; mITT, modified intention-to-treat; NA, not applicable.</p>		
<p>Note This table has been adapted with permission from Melendez-Torres <i>et al.</i>⁵⁸ This is an Open Access article distributed in accordance with the terms of the Creative Commons Attribution (CC BY 4.0) license, which permits others to distribute, remix, adapt and build upon this work, for commercial use, provided the original work is properly cited. See: https://creativecommons.org/licenses/by/4.0/.</p>		

Appendix 11 Characteristics of theories of change

TABLE 16 Summary of intervention theories of change

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
China-Gate HIV Prevention Program Online Intervention	Cheng <i>et al.</i> ¹²⁴	Informed by the theory of planned behaviour, the intervention targeted attitudes, subjective norms, perceived control and behavioural intention, which are posited as key determinants of health behaviours. It aimed to increase knowledge and reduce misconceptions. Part I aimed to engage participants and increase HIV risk perceptions by presenting realistic scenarios and to increase awareness of community norms by presenting peer attitudes towards behavioural decisions. Part II addressed basic HIV/AIDS knowledge and transmission; presented information about the HIV epidemic among MSM, aiming to further increase perceptions of consequences of CAI and to promote safer sex; and addressed misconceptions about sexual behaviours	Not stated	Theory of planned behaviour	Not stated

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Cognitive Vaccine Approach (tailored and non-tailored versions)	Davidovich <i>et al.</i> ¹⁰²	<p>There were two versions of this online cognitive-behavioural intervention promoting negotiated safety (i.e. CAI between steady partners who are both HIV negative). A non-tailored version delivered all modules, and a tailored version delivered general content considered relevant for all users in addition to selected modules considered relevant to the user based on a baseline questionnaire assessing their barriers to safe sex. Each module targeted specific cognitive determinants of behaviour. Informed by the IMB model, modules addressed information, motivation and behavioural skills; the motivation component was further informed by other behaviour change theories. The intervention did not focus on promoting condom use, but did provide information on condoms and recommended their use when negotiated safety was not feasible</p> <p>Information modules addressed how to practise negotiated safety, aiming to increase response efficacy (comprising knowledge of and belief in benefits of this approach for protecting against HIV). Informed by the theory of planned behaviour, motivation modules aimed to correct faulty beliefs in order to shape attitudes, and, informed by the health belief model, motivation modules aimed to increase users' perceptions of HIV testing benefits, as well as users' sense of vulnerability to contracting HIV from steady partners. In turn, attitudes were theorised to increase condom use intentions; and attitudes, sense of vulnerability and perceived benefits of HIV testing were theorised to increase</p>	Modules were guided by the IMB model and content was informed by empirical research	IMB model, operationalising the 'motivation' component by drawing on components of the theory of planned behaviour and the health belief model	Content was based on past research on determinants of sexual risk behaviour in steady relationships. Authors highlighted that the IMB model has been effective in promoting HIV prevention behaviours among various groups, including among gay men

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Gay Cruise	Kok <i>et al.</i> ¹⁰⁵	<p>intentions to practise negotiated safety (comprising its three components of HIV testing, reaching agreements about sex outside the relationship and warning the partner if sexual risk outside the relationship occurred)</p> <p>In this online interactive simulated cruise ship, users (MISM) select a virtual character to guide them through the intervention using scripted, tailored dialogue. This guide introduced strategies to promote consistent condom use by making condom use an automatic behaviour. The intervention addressed knowledge (about dating, sex and safer sex) via active learning; risk perceptions via consciousness-raising and feedback; skills via instruction (including video instruction), feedback and reinforcement; self-efficacy via this skill-building and via modelling, reinforcement and building on a learner's perspective; and access to condoms via addressing where to buy condoms and offering a sample package. The intervention also aimed to influence attitudes about condoms, personal and subjective norms and anticipated regret</p> <p>Intermediate outcomes included making the decision to use condoms, purchasing condoms and lubricant, negotiating condom use during online chatting, expressing the wish to use condoms in a user's chat profile, carrying enough condoms and lubricant when on a date, correctly using condoms and lubricant and using condoms consistently even in difficult circumstances</p>	As part of the systematic 'intervention mapping' process for intervention development, researchers searched the literature for behaviour change methods that could address programme objectives; drew on existing theory; and, in consultation with experts in MSM, chatting, e-dating and the internet, selected theoretically informed strategies to achieve programme objectives	Transtheoretical model and social cognitive theory	Not stated

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
HealthMindr	<ul style="list-style-type: none"> Sullivan <i>et al.</i>¹¹⁸ Jones <i>et al.</i>¹²⁸ 	<p>Features of this mobile app included risk assessments used to provide tailored prevention suggestions, with customisable assessment reminders; screeners assessing eligibility for PrEP and nPEP; tailored recommendations for HIV testing frequency; identification of HIV testing options tailored to participant preferences and testing location details and map; a HIV test planner with customisable reminders; test kit, condom and lubricant ordering; substance use/mental health screening; service directory; and a feature allowing users to submit questions to study staff. Based on social cognitive theory, risk assessments are theorised to lead to feedback and self-regulation, and for each of several targeted health behaviours, app features were designed to promote four mechanisms of change: goal-setting, self-efficacy, outcome expectations and self-regulation. Among the targeted health behaviours were making a HIV testing plan; using condoms; self-screening for PrEP; and, for those living with HIV, seeking HIV care. The authors described the theory of change for the behaviour of HIV testing as an example: the 'make a plan' feature promoted goal-setting, presenting information and several testing options promoted self-efficacy, information about the benefits of testing promoted positive outcome expectations, and a customisable reminder system for testing promoted self-regulation</p>	Not stated	Social cognitive theory	Not stated

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Hot and Safe M4M (website name)	Carpenter <i>et al.</i> ¹⁰⁰	Based on the IMB model, this module-based intervention aimed to reduce risk of HIV and other STIs by addressing information, motivation and behavioural skills. The information component aimed to increase knowledge of risk factors. Intervention activities assessed readiness to change and incorporated stage-based and (informed by motivational interviewing approaches) decisional balance exercises to increase motivation. Informed by motivational interviewing, the intervention also assessed HIV risk factors and targeted feedback based on user responses, and identified perceived barriers to change to increase self-efficacy for change. Skills training addressed skills for safer behaviour; topics addressed in communication skills training included communication about HIV status, condom use negotiation, sexual rights, differences in communication styles and sexual safety contracts	Not stated	IMB model and motivational interviewing	Authors cited references for IMB model as an effective approach for HIV prevention
Internet-based safer sex intervention (no name)	Milam <i>et al.</i> ¹¹⁰	This intervention aimed to reduce STIs and HIV transmission by targeting the following behaviours among HIV-positive MSM: condom use, disclosure to sex partners, ART initiation and reduced use of drugs and alcohol. Based on their responses to monthly sexual behaviour surveys, users were directed to static web pages tailored to their risk of STI and HIV transmission. Informed by social cognitive theory and the transtheoretical model, the intervention used messaging that took into account a user's current behaviour and intent related to the targeted behaviour change	Not stated	Social cognitive theory and the transtheoretical model	Not stated

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Keep it Up!	<ul style="list-style-type: none"> • Mustanski <i>et al.</i>^{112,113,122} • Greene <i>et al.</i>¹⁰³ • Madkins <i>et al.</i>¹³⁰ 	<p>Participants were recruited to this online modular HIV prevention intervention following a negative HIV test, a time when they were believed to be particularly receptive to HIV prevention efforts. Informed by the IMB model, intervention activities were theorised to engender knowledge, motivation and behavioural skills and self-efficacy. In the model, self-efficacy comprised both confidence in enacting safer sex behaviours, such as condom use and discussing safer sex with a sex partner, and the ability to avoid CAI when condoms were not available or when facing pressure from a partner. Activities involving reflection were theorised to influence behavioural intentions, examination of safer sex practices (e.g. pros and cons of condom use), perceived social norms (among partners, friends and family) and a sense of vulnerability, which, along with identifying sources of support, were theorised to contribute to motivation. Booster sessions were designed to reinforce learning and provide additional information on HIV prevention</p>	Not stated	IMB model	Not stated

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
MOTIVES	Linnemayr <i>et al.</i> ¹⁰⁶	This text message-based HIV prevention intervention aimed to provide prevention information and to have participants engage with and retain it, increase HIV testing frequency and support users in staying HIV negative. Weekly, the user received a text message providing HIV prevention information. Informed by behavioural economics, which suggests that 'nudges' can be effective in changing behaviours, a follow-up text message 2 days later asked the user a question about the information received and told them that a correct answer would increase their chance of winning a prize. The 'nudge' of an opportunity to win a prize was theorised to incentivise ongoing engagement with the intervention, increasing knowledge retention and supporting behaviour change. Informed by behavioural economics research suggesting that prompt and frequent feedback is important for behaviour change and can help keep users engaged, users received a message immediately after sending their response that indicated whether or not they were correct and provided a link with more information. If they were correct, the messages also told them they had increased their chances of winning the next prize draw. Informed by principles of behavioural economics, the intervention provided frequent prizes to increase salience, which the authors theorised kept the desired behaviour high on a user's list of priorities. Users also received a text message reminder every 2.5 months to test	Not stated	Behavioural economics	Studies suggest that lotteries can be effective in influencing a range of health behaviours, including sexual behaviour, and there are promising early results from a study aiming to improve ART adherence using this approach. Other studies suggest that behavioural economics approaches of delivering feedback promptly and frequently can support engagement and is important for behaviour change

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
myDEX	Bauermeister <i>et al.</i> ^{97,123}	<p>for HIV. The intervention also aimed to increase self-efficacy as a mediator of behaviour change</p> <p>The theory underpinning this intervention also accounted for variation depending on participant characteristics, identifying sociodemographics, acculturation, mental health and substance use as potential moderators of its impact</p> <p>This online module-based comprehensive sex education intervention aimed to improve psychological well-being and reduce HIV risk via behaviour change (increasing condom use, increasing HIV/STI testing and reducing instances of condomless anal sex), increasing PrEP awareness/uptake/adherence and decreasing alcohol and drug use before sex. It was informed by the notion that decision-making is shaped by both affective and cognitive motivations, that affective motivations can be processed more quickly, and therefore might drive decision-making, and that, when cognitive and affective motivations are less aligned, there is less of a correspondence between intentions and behaviour. The intervention therefore aimed to increase users' cognitive motivations and to influence affective motivations. Content included information provision, activities and videos; via the last two videos, it also aimed to build HIV risk reduction skills and promote self-reflection</p> <p>Content targeting cognitive motivations focused on risk reduction attitudes (comprising attitudes towards consistent condom use, status disclosure and HIV/STI</p>	Not stated	Dual-processing cognitive-emotional decision-making framework, and the IMB model	Research suggests that decision-making can be affectively, rather than analytically, driven because affective motivations might be processed more quickly than cognitive motivations. The authors also noted that intentions correspond less with behaviour when affective and cognitive motivations conflict, and that anticipation of an emotional reaction following an unintentional behaviour is associated with less risk-taking among MSM

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
		<p>testing), risk reduction norms (comprising subjective norms, personal norms such as anticipated regret and descriptive norms, i.e. perceived prevalence of behaviours within one's social group) and perceived behavioural control to engage in risk reduction behaviours (i.e. the ability to elicit/disclose HIV status, negotiate condom use and delay sexual intercourse). Attitudes and norms were theorised to each influence each other, and all three constructs were theorised to influence behavioural intentions</p> <p>Acknowledging the influence of affective motivations on behavioural intentions, the intervention also addressed relationship ideation, anticipated regret, limerence and decisional balance to forgo condoms. Behavioural intentions were theorised, in turn, to directly influence HIV risk reduction behaviours</p> <p>The theory underpinning this intervention also accounted for variation depending on participant characteristics: psychological risk correlates, which include sexuality-related stressors (e.g. internalised homophobia), psychological distress (e.g. depression, anxiety, loneliness and low self-esteem) and substance use and abuse were theorised to influence regulation of affective motivations, and therefore behavioural control, affecting risk behaviours. Type of sexual partner (e.g. casual encounter, romantic interest or friend with benefits) was theorised to affect perceived behavioural control and the relationship between behavioural intentions and actual behaviours</p>			

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
MyPEEPs Mobile	Kuhns <i>et al.</i> ¹²⁹	Delivered via games, scenarios and role plays in four sequential modules, this app aimed to reduce sexual HIV risk and promote health behaviours among adolescent sexual minority men. Content delivered information on HIV/STIs among young MSM, promoted skill-building (for condom use, emotional regulation and negotiating interpersonal and substance-related risks) and aimed to raise awareness about minority stress. A goal-setting activity running throughout the intervention aimed to build knowledge, self-awareness and self-efficacy by asking participants to establish and regularly reconsider their limits and the risk they are willing to accept for different types of sexual acts. The authors also stated that content addressed psychosocial and contextual factors important to young people's vulnerability to risk, including affect dysregulation (psychosocial), and family, peer and partner relationships (contextual)	Not stated	Social-personal framework, which authors say builds on social learning theory	Intervention was based on a group-based intervention effective in reducing sexual risk behaviour

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Online mindfulness-based cognitive therapy (no name)	Avellar ⁹⁶	Although the target population was not restricted to those who had experienced bullying, the rationale supporting the intervention posited that anti-LGBQ bullying could lead to internalised homophobia (also referred to as internalised homonegativity), which could cause self-stigma, undermine self-worth and cause avoidance of emotions, thoughts and situations. In this online modular intervention, sessions 1–4 focused on teaching users to identify and understand emotional and cognitive patterns causing distress, and sessions 5–8 taught users how to handle these and their effect on mood, that is skills for awareness, moving attention to breathing, then expanding this attention to the whole body. Via practices such as increasing awareness of ingrained routines, paying attention to and accepting sensations/feelings/thoughts in each moment without judgement, developing a third-person awareness and prioritising 'being' over 'doing' or goal attainment, and by developing an understanding of the relationship between thoughts and moods, the intervention aimed to develop skills for reducing rumination about unpleasant experiences and reducing the time that unpleasant thoughts stay in the mind, and alleviating unpleasant thoughts, feelings and emotions. Via these skills, and by reducing internalised homophobia, the intervention aimed to reduce the recurrence of depression and to improve mental health	Intervention was modelled on an existing 8-week mindfulness-based cognitive therapy protocol found to be effective for addressing symptoms of depression and anxiety	Mindfulness-based cognitive therapy combines mindfulness and cognitive-behavioural techniques to alleviate depressive symptoms	A 2012 study ¹⁶¹ found that acceptance commitment therapy, of which mindfulness was a key mechanism, was effective in improving outcomes including internalised homonegativity, depression, anxiety and stress among LGBQ participants experiencing self-stigma related to their sexual orientation. Furthermore, the online mindfulness-based cognitive therapy intervention was modelled on an existing protocol effective for addressing symptoms of depression and anxiety

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
People Like Us	Tan <i>et al.</i> ¹³¹	Sexual health messages incorporated into this web drama series aimed to increase HIV/STI knowledge and risk perception; provide information on HIV/STI testing and its benefits, as well as resources for HIV/STI testing and other mental health services; address homophobia and sexual identity disclosure; increase self-efficacy for negotiating safer sex; and promote positive attitudes, skills and self-efficacy related to safer sex. Content incorporated modelling of safer sex behaviours. The intervention aimed to affect perceived homophobia; internalised homophobia; self-concealment of sexual orientation; connectedness to the LGBT community; HIV knowledge; HIV/STI risk perceptions; consistent condom use; STI incidence; and HIV/STI testing intentions, behaviours, self-efficacy and social norms	Not stated	Not stated	Not stated
Queer Sex Ed	Mustanski <i>et al.</i> ¹¹¹	This comprehensive sexual health curriculum for LGBT youth, delivered via online modules, was guided by the IMB model. The IMB model posits that health behaviours result from information, motivation and behavioural skills. The authors highlighted motivation as particularly important for adolescents and posited that motivation consisted of perceived vulnerability to health problems, as well as attitudes, intentions and perceived social norms. The intervention also aimed to influence sexual health behaviours by increasing self-efficacy (specified in relation to coming out and to creating and adhering to sexual agreements); a sense of connectedness to and belonging in the LGBT community; knowledge; and	Intervention was informed by prior mixed-methods research	IMB model	None stated

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Rainbow SPARX	Lucassen <i>et al.</i> ¹⁰⁸	<p>behavioural skills. Specific targeted outcomes mapped on to the topics of the first four intervention modules (note that outcomes were not assessed for the fifth module, addressing goal-setting) and comprised sexual identity, sex education, healthy relationships and safer sex</p> <p>Rainbow SPARX, a computerised CBT programme designed as a computer game, introduced six core CBT skills that were theorised to support users in addressing harmful core beliefs that affect mental health. The main CBT skills covered in the intervention were as follows: relax (relaxation training), do it (e.g. behavioural training), sort it (e.g. social skills training), spot it (recognising or naming cognitive distortions), solve it (problem-solving) and swap it (e.g. cognitive restructuring). Content tailored to issues and experiences of sexual minority youth targeted particular challenges facing this population, such as internalised homophobia and exposure to negative attitudes about same-sex attraction. Author descriptions suggested that the intervention was theorised to work via behavioural and relaxation training and via teaching users to recognise and challenge cognitive distortions. Each user could customise their avatar using any of the customisable options, regardless of whether the options were traditionally female or male, with the rationale that negative repercussions often faced by this population for non-gender-conforming behaviours could contribute to internalised negative attitudes about behaviours that were natural for these young people</p>	The general approach of CBT was adapted to address challenges faced by sexual minority young people	CBT theory	Authors cited evidence that CBT is effective in treating depression among adolescents

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Role-playing game	Coulter <i>et al.</i> ¹²⁶	<p>This role-playing game aimed to improve the health of bullied sexual and gender minority youth by improving help-seeking and productive coping strategies to reduce substance use, victimisation and mental health issues. The user played a customisable character who built a team with non-playable characters to defeat robots in the 'Holo-chamber Challenge'. The user was tasked with helping each non-playable character with challenges such as bullying, confidence or anger; if successful, that character joined their team. Elements of social cognitive theory, stress and coping theory and the social and emotional learning framework were embedded in the game</p> <p>Pairing the player with lonely characters was theorised to increase help-seeking intentions, self-efficacy and behaviours. Active listening and helping another character overcome anger were theorised to increase productive coping strategies (assessed as problem-solving coping) and coping flexibility (assessed as 'evaluative coping', or how well a user monitors and evaluates the outcomes of coping, and 'adaptive coping', or how well a user uses an alternative coping strategy to achieve a desired outcome). Collating information about bullying and external resources was theorised to increase knowledge and use of web-based resources. The intervention also aimed to decrease non-productive coping (assessed as passive avoidant coping)</p> <p>Drawing on social cognitive theory, the authors suggested that self-efficacy and social skills could be developed via</p>	Not stated	Social cognitive theory, stress and coping theory and the social and emotional learning framework	Not stated

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
		<p>behavioural rehearsal, witnessing outcomes of one's choices and feedback. Although not linked directly to intervention components in the authors' narrative, these techniques were embedded in intervention design, which included supporting non-playable characters in productive coping (rehearsal), receiving reports on the outcomes for each character based on the user's decisions (witnessing outcomes) and receiving hints about how to better help other characters when appropriate (feedback)</p> <p>Loneliness, internalised gender minority stigma and internalised sexual minority stigma were also assessed, although their relationships to other outcomes was not specified</p>			
Safe Behaviour and Screening	Chiou <i>et al.</i> ¹²⁵	The app drew on the IMB model, which posits that information, behavioural motivation and skills influence HIV prevention behaviour. App content provided information that aimed to increase knowledge. Survey measures suggested that the intervention also targeted motivation (comprising attitude towards reducing risky sexual behaviour and recreational drug use, and intention to change these behaviours) and behavioural skills for HIV prevention (including partner communication, negotiating safe sex, drug and unsafe sex refusal skills and correct condom use)	Not stated	IMB model	Not stated

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Sex Positive!	Hirshfield <i>et al.</i> ^{104,127}	Informed by social cognitive theory and social learning theory, this intervention aimed to prevent onward HIV transmission among MSM living with HIV. Following the character 'Guy', a gay man living with HIV, a six-video dramatic series sought to optimise engagement by featuring stories and characters with which target users would identify. Content focused on HIV transmission, and was informed by social learning theory (which posits that people learn by observing others' attitudes and behaviours and the outcomes of their behaviours); it used modelling to demonstrate risk reduction and health behaviours including HIV disclosure, medication adherence and discussions about safer sex. Content aimed to promote critical thinking about medication adherence, viral suppression, HIV disclosure, sexual decision-making under the influence of drugs/alcohol and serodiscordant CAI. Via modelling, the videos also depict cognitive dissonance and expectation failure. Authors' descriptions of social learning and social cognitive theories combined with the constructs assessed in user surveys suggested that critical thinking was theorised to promote self-efficacy for safer sex and for HIV status disclosure to	Not stated	Social cognitive theory and social learning theory; authors also noted that elements of both social learning and attitude change theories informed the intervention	Not stated

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Sexpulse	<ul style="list-style-type: none"> • Rosser <i>et al.</i>¹¹⁶ • Wilkerson <i>et al.</i>¹²⁰ 	<p>a user's partners; promote perceived personal and partner responsibility for preventing HIV transmission; and shape outcome expectancies for condoms, anal sex and HIV disclosure. The report also suggested that modelling of self-regulation aimed to improve skills for regulating sexual compulsivity. Taken together, these mediators were theorised to influence HIV treatment adherence, mental health, substance use, sexual behaviour and interpersonal violence outcomes. Four follow-up booster videos aimed to help sustain intervention impact over time</p> <p>This modular HIV prevention intervention was guided by the sexual health model, which posits that people are more likely to make decisions that are sexually healthy when they themselves are sexually healthy. The intervention addressed the following aspects of the model: (1) mental and emotional health, (2) physical health, (3) intimacy, (4) relationships, (5) sexuality and (6) spirituality. Content covered other specified topics such as body image and communication, among others, but their relationship to the sexual health model and to the intervention was not clear. Based on the authors' description, the theory underpinning the intervention seemed to be that addressing aspects of broader sexual health would support safer sexual health decision-making</p>	Not stated	Sexual health model	Not stated

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
Smartphone self-monitoring (no name)	Swendeman <i>et al.</i> ¹¹⁹	<p>In this smartphone-based intervention, customisable alarms prompted the user to fill in self-monitoring surveys and participants could access a web-based visualisation tool to view their survey responses over time and by location, as well as associations between variables. Daily surveys asked about alcohol, tobacco and other drug use; sexual behaviours; and medication adherence. Surveys four times per day asked about physical and mental health. The intervention also included event-based reporting about stressful events, and text diary entries, both of which could be done at any time</p> <p>Self-monitoring was theorised to support self-management via a user's response to feedback deriving from self-observation. Although authors highlighted that mechanisms of self-monitoring interventions are not well understood, their description suggested that processes such as a user reflecting on their behaviours in comparison with particular criteria (e.g. perceived norms or personal standards) could lead to reinforcement via self-reward or self-critique, resulting in self-regulation and, ultimately, self-management in four domains of HIV-related health outcomes: medication adherence, mental health, substance use and sexual risk behaviours</p>	Not stated	Underpinned by the notion that self-monitoring can support self-management. We note that self-monitoring is a core construct of social cognitive theory ¹³⁶	In studies of alcohol, tobacco and drug abuse and sexual risk reduction HIV interventions, changes among control groups suggest that self-monitoring (via assessments) can effectively improve targeted outcomes. Evidence suggests that self-monitoring is a key component of evidence-based interventions for a range of conditions, and some evidence from meta-analyses suggests that self-monitoring can be particularly effective for changing and maintaining behaviours

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
SOLVE	Christensen <i>et al.</i> ¹⁰¹	<p>In this three-dimensional animated game, the user took the role of a customisable avatar and made decisions that affected the narrative in simulated settings presenting risky situations and barriers to safer sex that young adult MSM typically confront on first dates or 'hook-ups.' Via multiple theorised pathways, the intervention aimed to decrease instances of CAI, thereby reducing HIV risk</p> <p>Informed by the notion that shame due to 'sexual stigma' can contribute to HIV risk behaviours, the intervention simulated shame-inducing situations; promoted conscious acknowledgement and normalisation of a user's desires; and role-modelled positive attitudes towards one's self, as well as comfort with a user's sexuality and desires. Guide characters and sex partners within the game were accepting of a user's desires and also shared them. Although the relationship between specific aspects of the intervention and theorised mechanisms was not explicit, the authors' description suggested that these features of the intervention aimed to decrease shame by normalising the users' desires, increasing self-worth and self-acceptance and reducing isolation and feelings of inferiority</p> <p>In addition, drawing on neuroscience research suggesting that emotions play a critical role in decision-making, SOLVE aimed to increase self-awareness of goals, emotions and barriers to safer sex; promote recognition of the consequences of a user's desires; interrupt affect-based</p>	Not stated	Theory of planned behaviour, social cognitive theory and neuroscience research suggesting that emotions play a critical role in decision-making	Two prior RCTs of similar interventions were effective in reducing instances of unprotected anal intercourse

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
TXT-Auto	Reback <i>et al.</i> ¹¹⁵	<p>decision-making; and increase self-regulation. Authors' descriptions seemed to suggest that these were accomplished by challenging user choices and exploring their consequences within the simulated scenarios. Other components of the intervention aimed to increase HIV knowledge and hone HIV risk reduction skills and strategies</p> <p>TXT-Auto aimed to reduce substance use and HIV risk among out-of-treatment methamphetamine-using MSM. Users received five automated scripted text messages per day, which included both general messages and messages tailored to a user's risk profile. Risk profile was determined based on responses to a baseline survey assessing risks in relation to HIV status, ART adherence, drug use and sexual behaviours. Text message content was based on social support theory, social cognitive theory and the health belief model, which the authors described as complementary theories, although the constructs drawn from each theory and the intended mechanisms of change were not described. Text messages aimed to increase knowledge, and an example provided of messaging informed by social cognitive theory suggested that they might also aim to increase self-efficacy. A brief weekly text-based assessment asking about methamphetamine use and HIV sexual behaviours in the previous 7 days aimed to increase self-monitoring. Taken together, intervention activities aimed to decrease methamphetamine use, instances of sex during methamphetamine use and instances of CAI</p>	The theoretical constructs underpinning the intervention were selected during a pilot study, informed by evidence-based behavioural change theories with complementary designs	Text messages were based on social support theory, social cognitive theory and the health belief model	Authors noted that the theoretical principles on which each behavioural change theory rests have been proven effective in multiple studies

continued

TABLE 16 Summary of intervention theories of change (continued)

Intervention name	Reports	Summary of theory of change, including key constructs and mechanisms	How theory of change was developed	Existing theories drawn on	Evidence supporting the theory of change
WRAPP	<ul style="list-style-type: none"> • Bowen <i>et al.</i>^{98,99} • Williams <i>et al.</i>¹²¹ • Schonnesson <i>et al.</i>¹¹⁷ 	<p>The WRAPP was informed by social cognitive theory and the IMB model, and each of its three modules corresponded to one aspect of this model. The 'knowledge' module was designed as the 'information' component and primarily addressed living with HIV and HIV prevention, aiming to increase HIV knowledge. The 'partner' module aimed to increase motivation (comprising outcome expectancies for risk reduction and willingness to reduce HIV risk behaviours). It addressed risk with both new and casual partners, supporting participants in clarifying long-term life goals and in considering whether or not these were consistent with unsafe sex. The 'contexts of risk' module targeted behavioural skills, supporting the user in adopting risk reduction behaviours with sexual partners met online or in a bar</p> <p>Knowledge, motivation and behavioural skills were theorised to increase sexual self-efficacy (comprising mechanical self-efficacy, such as self-efficacy for correct condom use, and self-efficacy to refuse CAI), which was theorised to be a direct precursor of behaviour change</p>	Not stated	Social cognitive theory and the IMB model	Evidence was not discussed directly, but in a later iteration ⁹⁹ the authors noted that their work extended an earlier iteration that improved HIV-related knowledge, condom use outcome expectancies and condom use self-efficacy

AIDS, acquired immunodeficiency syndrome; ART, antiretroviral therapy; LGBQ, lesbian, gay, bisexual and queer; MSM, men who use the internet to seek sex with men.

Note

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Appendix 12 Quality assessment of theory reports

TABLE 17 Quality assessment of reports on intervention theories of change

Intervention name	Clear pathways from intervention components to outcomes	Constructs or concepts clearly defined	Clearly describes how constructs are inter-related	Clearly explains mechanisms underlying inter-relationships between constructs	Engages with how mechanisms and outcomes might vary by context	Initial agreement between reviewers (%)
China–Gate HIV Prevention Program Online Intervention (no name)						
Cheng <i>et al.</i> ¹²⁴	Yes	Yes	No	No	No	100
Cognitive Vaccine Approach						
Davidovich <i>et al.</i> ¹⁰²	Yes	Yes	Yes	Yes	Yes	100
Gay Cruise						
Kok <i>et al.</i> ¹⁰⁵	Yes	Yes	No	No	No	20
HealthMindr						
Sullivan <i>et al.</i> ¹¹⁸	No	No	No	No	No	80
Jones <i>et al.</i> ¹²⁸	Yes	Yes	Yes	No	No	80
Hot and Safe M4M (website name)						
Carpenter <i>et al.</i> ¹⁰⁰	Yes	No	Yes	No	No	60
Internet-based safer sex intervention (no name)						
Milam <i>et al.</i> ¹¹⁰	No	No	No	No	No	100
Keep it Up!						
Mustanski <i>et al.</i> ¹²²	No	Yes	No	No	No	80
Greene <i>et al.</i> ¹⁰³	Yes	Yes	No	No	No	80
Mustanski <i>et al.</i> ¹¹²	No	No	No	No	No	80
Mustanski <i>et al.</i> ¹¹³	No	No	No	No	No	100
Madkins <i>et al.</i> ¹³⁰	No	Yes	No	No	No	80
MOTIVES						
Linnemayr <i>et al.</i> ¹⁰⁶	Yes	No	No	No	Yes	60
myDEx						
Bauermeister <i>et al.</i> ⁹⁷	No	Yes	Yes	Yes	Yes	100
Bauermeister <i>et al.</i> ¹²³	Yes	Yes	Yes	No	Yes	100

continued

TABLE 17 Quality assessment of reports on intervention theories of change (continued)

Intervention name	Clear pathways from intervention components to outcomes	Constructs or concepts clearly defined	Clearly describes how constructs are inter-related	Clearly explains mechanisms underlying inter-relationships between constructs	Engages with how mechanisms and outcomes might vary by context	Initial agreement between reviewers (%)
MyPEEPS Mobile						
Kuhns <i>et al.</i> ¹²⁹	No	Yes	No	No	No	80
Online mindfulness-based cognitive therapy (no name)						
Avellar ⁹⁶	Yes	Yes	No	No	No	60
People Like Us						
Tan <i>et al.</i> ¹³¹	No	Yes	No	No	No	100
Queer Sex Ed						
Mustanski <i>et al.</i> ¹¹¹	No	Yes	Yes	No	No	60
Rainbow SPARX						
Lucassen <i>et al.</i> ¹⁰⁸	Yes	Yes	No	No	No	100
Role-playing game						
Coulter <i>et al.</i> ¹²⁶	Yes	Yes	Yes	No	No	80
Safe Behaviour and Screening						
Chiou <i>et al.</i> ¹²⁵	No	Yes	No	No	No	100
Sex Positive!						
Hirshfield <i>et al.</i> ¹⁰⁴	Yes	Yes	No	No	No	80
Hirshfield <i>et al.</i> ¹²⁷	No	No	No	No	No	100
Sexpulse						
Rosser <i>et al.</i> ¹¹⁶	No	No	No	No	No	80
Wilkerson <i>et al.</i> ¹²⁰	No	No	No	No	No	0
Smartphone self-monitoring (no name)						
Swendeman <i>et al.</i> ¹¹⁹	Yes	Yes	Yes	Yes	No	100
SOLVE						
Christensen <i>et al.</i> ¹⁰¹	Yes	Yes	Yes	Yes	No	100
TXT-Auto						
Reback <i>et al.</i> ¹¹⁵	No	No	No	No	No	100
WRAPP						
Bowen <i>et al.</i> ⁹⁸ (internet-delivered risk reduction; no name; preliminary work to WRAPP)	No	Yes	Yes	No	No	60
Bowen <i>et al.</i> ⁹⁹	Yes	Yes	Yes	No	No	100

TABLE 17 Quality assessment of reports on intervention theories of change (continued)

Intervention name	Clear pathways from intervention components to outcomes	Constructs or concepts clearly defined	Clearly describes how constructs are inter-related	Clearly explains mechanisms underlying inter-relationships between constructs	Engages with how mechanisms and outcomes might vary by context	Initial agreement between reviewers (%)
Williams <i>et al.</i> ¹²¹ (Hope Project; extends WRAPP)	No	Yes	No	No	No	80
Schonnesson <i>et al.</i> ¹¹⁷ (SMART; Swedish adaptation of WRAPP)	Yes	Yes	Yes	No	No	100

Note

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Appendix 13 Intervention typology, colour-coded by theory of change grouping

TABLE 18 Intervention typology, colour-coded by theory of change grouping

Intervention category	Subcategory			Intervention name [report author(s)]	Outcomes addressed						
	1	2	3		Sexual health	Mental health	Substance use				
Time-limited/modular	Interactive	Online modular (n = 9)	Cognitive therapy (n = 1)	Online mindfulness-based cognitive therapy (Avellar ⁹⁶)		X					
				Comprehensive sexual education for young people (n = 2)	myDEX (Bauermeister <i>et al.</i> ^{97,123})	X	X	X			
					Queer Sex Ed (Mustanski <i>et al.</i> ¹¹¹)	X					
					China-Gate HIV Prevention Program Online Intervention (Cheng <i>et al.</i> ¹²⁴)	X					
				HIV prevention/sexual health (n = 6)	Hot and Safe M4M (Carpenter <i>et al.</i> ¹⁰⁰)	X					
					Keep it Up! (Mustanski <i>et al.</i> , ¹²² Greene <i>et al.</i> , ¹⁰³ Mustanski <i>et al.</i> ¹¹² / Mustanski <i>et al.</i> ¹¹³ / Madkins <i>et al.</i> ¹³⁰) ^a	X		X			
						MyPEEPS Mobile (Kuhns <i>et al.</i> ¹²⁹)	X		X		
				Sexpulse (Rosser <i>et al.</i> ¹¹⁶ /Wilkerson <i>et al.</i> ¹²⁰) ^a	X						
				Computer games (n = 4)				WRAPP (Bowen <i>et al.</i> , ^{98,99} Williams <i>et al.</i> , ¹²¹ Schonnesson <i>et al.</i> ¹¹⁷)	X		
								Gay Cruise (Kok <i>et al.</i> ¹⁰⁵)	X		
								Rainbow SPARX (Lucassen <i>et al.</i> ¹⁰⁸ / Lucassen <i>et al.</i> ¹⁰⁷) ^a		X	
								Role-playing game (Coulter <i>et al.</i> ¹²⁶)		X	X
								SOLVE (Christensen <i>et al.</i> ¹⁰¹)	X		

continued

TABLE 18 Intervention typology, colour-coded by theory of change grouping (continued)

Intervention category	Subcategory			Intervention name [report author(s)]	Outcomes addressed		
	1	2	3		Sexual health	Mental health	Substance use
Open-ended	Non-interactive (n = 4)	Online modular (n = 2)		Cognitive Vaccine Approach, non-tailored (Davidovich <i>et al.</i> ¹⁰²) ^b	X		
				Cognitive Vaccine Approach, tailored (Davidovich <i>et al.</i> ¹⁰²) ^b	X		
		Video series (n = 2)		Sex Positive! (Hirshfield <i>et al.</i> ¹⁰⁴ /Hirshfield <i>et al.</i> ¹²⁷) ^a	X	X	X
				People Like Us (Tan <i>et al.</i> ¹³¹)	X		
	Content organised by assessment (n = 2)	SMS (n = 1)		TXT-Auto (Reback <i>et al.</i> ¹¹⁴ /Reback <i>et al.</i> ¹¹⁵ /Reback <i>et al.</i> ¹³²) ^a	X		X
				Static website (n = 1)	Internet-based safer sex intervention (Milam <i>et al.</i> ¹⁰⁹ /Milam <i>et al.</i> ¹¹⁰) ^a	X	
	General content (n = 4)	Mobile multifeature app (n = 2)		HealthMindr (Sullivan <i>et al.</i> , ¹¹⁸ Jones <i>et al.</i> ¹²⁸)	X		
				Safe Behaviour and Screening (Chiou <i>et al.</i> ¹²⁵)	X		X
		Self-monitoring (n = 1)		Smartphone self-monitoring (Swendeman <i>et al.</i> ¹¹⁹)	X	X	X
				SMS (n = 1)	MOTIVES (Linnemayr <i>et al.</i> ¹⁰⁶)	X	X
Total (n)					20	7	10

a References separated by a forward slash report on the same research study.

b Davidovich *et al.*¹⁰² reports on two similar, but distinct, interventions.

Note

Synthesised theory groupings: dark purple = cognitive/skills; light purple = no grouping, but contributed to cognitive/skills synthesised theory of change; blue = self-monitoring; orange = cognitive therapy; white = no grouping, did not contribute to synthesised theories of change.

Appendix 14 Coding structures for the process evaluation report on the online mindfulness-based cognitive therapy intervention

This appendix shows the coding structures developed independently by each of two reviewers (CB and RM) for the report on the process evaluation of the online mindfulness-based cognitive therapy intervention.⁹⁶ In each coding structure, the broadest codes assigned are left-aligned. Below each are more detailed subcodes, and, in the coding structure developed by Rebecca Meiksin, additional subcodes are depicted by further indentations. The coding structure developed by Chris Bonell contains two levels of coding. The coding structure developed by Rebecca Meiksin contains four levels of coding.

Coding structure developed by Chris Bonell

Facilitators:

- Intervention contents perceived as pleasant/enjoyable/interesting.
- Choice of options regarding intervention contents.
- Specific for gay/same-sex-attracted men.
- Easy to use.
- Contents clear and up to date.

Barriers:

- Insufficient monetary incentives.
- Intervention too long/pacing too slow.
- Intervention contents perceived as boring.
- Intervention contents perceived as limited value/relevance to own life.
- Intervention contents perceived as repetitive/common-sense only.
- Intervention contents perceived as gay-stigmatising.
- Technical problems accessing contents, for example on mobile devices.

Coding structure developed by Rebecca Meiksin

Intervention:

- Negatives –
 - Content:
 - Content not enjoyable.
 - Content too difficult, or confusing.
 - Content was boring, common sense, repetitive.

- Format and presentation:
 - Media (-).
- Language, terms:
 - Unsure how sexuality would be treated.
- Length, pacing and time:
 - Too long or slow.
- Tailoring and applicability:
 - Not applicable to their life.
 - Not personal or tailored enough.
- Technical:
 - Not optimised for mobile.
 - Technical problems.
- Positives –
 - Content:
 - Content was clear.
 - Enjoyed content.
 - Information, knowledge.
 - Intervention structure.
 - Learning skills.
 - Up to date.
 - Mechanisms:
 - Opportunity for reflection.
 - Format:
 - Format, interface.
 - Materials.
 - Media (+).
 - Tailoring and applicability:
 - Tailored to demographic.
 - Technical:
 - Few technical issues.

Participants

- Intervention engagement, completion.

Appendix 15 Coding structure for process evaluation synthesis

TABLE 19 Primary, secondary and tertiary codes used for process evaluation synthesis

Primary codes	Secondary codes	Tertiary codes
HIV testing nPEP Ordering condoms Ordering HIV test kits PrEP content Reminders	Features	Intervention factors affecting variation in intervention receipt: intervention features
Boring Cheesy/strange Content not enjoyable Content suggestions Content too difficult, or confusing Content boring, common sense, repetitive Intrusive Too easy Unclear	Content	Intervention factors affecting variation in intervention receipt: barriers
Media (–) Not enough media Required additional materials Want less talking and dialogue, more game play	Format and presentation	
Pacing Too busy to complete Too long or slow	Length, pacing and time	
Age-inappropriate, for example 'babied' participants For games, level of challenge inappropriate, for example for age Limited value/relevance to own life Not personal or tailored enough	Tailoring and applicability	
Insufficiently gay-specific For interventions also targeting LGBTQ women, irrelevant content for men Insufficient content for trans people	Inappropriate orientation to gender or sexual identity/behaviour	

continued

TABLE 19 Primary, secondary and tertiary codes used for process evaluation synthesis (continued)

Primary codes	Secondary codes	Tertiary codes
Not optimised for mobile	Technical	
Technical aspects	Technical problems	
Intrusive, too personal, privacy concerns		
Language and terms, including gay stigmatising	Other barriers	
Omitting key issues, for example PrEP		
Approach	Content	Intervention factors affecting variation in intervention receipt: facilitators
Content was clear, understandable and up to date		
Does not use scare tactics		
Enjoyed content		
Information, knowledge		
Information not available elsewhere; about mental health; about broad sexual, emotional, relationship health and sexual function, not just STIs		
Intervention structure		
Learning skills		
Liked characters		
Liked content, found it interesting		
Not just information		
Encouraged adherence to a plan, encouraged communication/closeness with partner	Mechanisms	
Opportunities for reflection		
Opportunities for self-expression		
Reflection: own behaviour/risks		
Reflection: inter-relations between substance use, sexual health and/or substance use		
Can do at home	Format	
Characters		
Format, interface		
Interaction		
Materials		
Media pleasant/attractive, variety of media/formats, enjoyable/fun/interesting		
Daily vs. less frequent self-monitoring; regularity valued for monitoring-based approach	Length, pacing and time	
For games, liked approach of game relevant to real life		

TABLE 19 Primary, secondary and tertiary codes used for process evaluation synthesis (continued)

Primary codes	Secondary codes	Tertiary codes
Length of modules/sections appropriate		
Own pace, self-directed		
Pacing appropriate		
Characters relatable/like own friends	Tailoring and applicability	
Realistic and relevant scenarios		
Tailored to demographic		
Tailored to individual		
Easy to use, did not require technical assistance	Technical	
A few said that there were a few technical issues, a few technical problems accessing content		
Trusted that data were secure	Other facilitators	
Tone and language, not patronising, balance between personal/colloquial and professional language		
Age	Demographic characteristics	Participant factors affecting variation in intervention receipt
Region		
Race/ethnicity		
Education level		
Intervention engagement, completion	Other personal characteristics	
Level of ART adherence		
Receiving external therapy		
Internet speed	Internet speed	Contextual factors affecting variation in intervention receipt

ART, antiretroviral therapy; LGBTQ, lesbian, gay, bisexual, transgender and queer.

Note

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Appendix 16 Quality assessment of economic evaluation

TABLE 20 Quality assessment of economic evaluation

Quality assessment items		Programme: TXT-Auto (Reback <i>et al.</i> ¹³²)				
		Assessor				
		Alec Miners		Chris Bonell		Overall
Item	Sub-item	Overall item assessment	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment
Well-defined question in answerable form?	Did the study examine both costs and effects of the programme(s)?	Yes	Yes	Yes	Yes	Yes
	Did the study involve a comparison of alternatives?		Yes		Yes	
	Was a viewpoint for the analysis stated and was the study placed in a decision-making context?		Yes		Yes	
Comprehensive description of competing alternatives?	Were there any important alternatives omitted?	Yes	Unclear	Yes	No	Yes
	Was routine practice considered?		No		No	
Effectiveness of programme assessed?	Was effectiveness assessed through a randomised, controlled clinical trial? If so, did the trial protocol reflect what would happen in regular practice?	Yes	Yes	Yes	Yes	Yes
	Were observational data or assumptions used to assess effectiveness? If so, are there potential biases in results?		No		No	
All important and relevant costs and consequences for each alternative identified?	Was the range of outcomes wide enough for the research question at hand?	No	Yes	No	No	
	Did the consequences cover all relevant viewpoints? (Possible		No			No

continued

TABLE 20 Quality assessment of economic evaluation (continued)

Quality assessment items		Programme: TXT-Auto (Reback <i>et al.</i> ¹³²)				
		Assessor				
		Alec Miners		Chris Bonell		Overall
Item	Sub-item	Overall item assessment	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment
	viewpoints include the community or social viewpoint, and those of patients and third-party payers. Other viewpoints may also be relevant depending on the particular analysis)					
	Were the capital costs, as well as operating costs, included?		Yes			Yes
Costs and consequences measured accurately in appropriate physical units?	Were any of the identified items omitted from measurement? If so, does this mean that they carried no weight in the subsequent analysis?	No. Total costs, disaggregated to a detailed degree, are reported	No	No	No	No
	Were there any special circumstances (e.g. joint use of resources) that made measurement difficult?	Resource use was measured as part of the RCT, but it is unclear how unit costs were derived/ what the sources were	No		No	
	Were these circumstances handled appropriately?		NA		NA	
	Were unit and total costs transparently reported?		No		Yes	
	Were the methods and sources of resource use credible?		Yes		Yes	
	Costs and consequences valued credibly?	Were the sources of all values clearly identified?	Yes	Yes	Yes	Yes
	Were market values employed for changes involving resources gained or depleted?		Yes		Yes	
	When market values were absent or did not reflect actual values, were adjustments made to approximate market values?		NA		NA	

TABLE 20 Quality assessment of economic evaluation (continued)

Quality assessment items		Programme: TXT-Auto (Reback <i>et al.</i> ¹³²)				
		Assessor				
		Alec Miners		Chris Bonell		Overall
Item	Sub-item	Overall item assessment	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment
	Was the valuation of consequences appropriate for the question posed?		NA		NA	
Costs and consequences adjusted for differential timing?	Were costs and consequences that occur in the future 'discounted' to their present values? If so, were they both discounted at 3.5% per annum?	NA	NA	NA	NA	NA
	Was there any justification given for the discount rate used?		NA		NA	
Incremental analysis of costs and consequences of alternatives performed?	Were the additional (incremental) costs generated by one alternative over another compared with the additional effects, benefits, or utilities generated?	Yes	Yes	Yes	Yes	Yes
Allowance made for uncertainty in estimates of costs and consequences?	If data on costs and consequences were stochastic, were appropriate statistical analyses performed?	No	No	No	No	No
	If a sensitivity analysis was employed, was justification provided for choice of variables and the range of values?		No		Yes	
	Were the study results sensitive to changes in the values?		No, the sensitivity analysis was reported only for the average costs, not for the ICERs		Yes	
Discussion of results includes all issues of concern to users?	Were the conclusions of the analysis based on some overall index or ratio of costs to consequences? If so, was the index interpreted intelligently or in a mechanistic fashion?	No	No	Yes	No	No

continued

TABLE 20 Quality assessment of economic evaluation (continued)

Quality assessment items		Programme: TXT-Auto (Reback <i>et al.</i> ¹³²)				
		Assessor		Chris Bonell		Overall
Item	Sub-item	Alec Miners	Chris Bonell	Alec Miners	Chris Bonell	Overall
		Overall item assessment	Sub-item assessment	Overall item assessment	Sub-item assessment	Overall item assessment
	Did the conclusions follow from the data reported?		No		Yes	
	Were the results compared with those of others who have investigated the same question? If so, were allowances made for potential differences in study methodology?		No		No	
	Did the study discuss the generalisability of the results to other settings and patient/client groups?		Yes		Yes	
	Did the study allude to, or take account of, other important factors in the choice or decision under consideration?		Yes		Yes	
	Did the study discuss issues of implementation, such as the feasibility of adopting the 'preferred' programme given existing financial or other constraints, and whether or not any freed resources could be redeployed to other worthwhile programmes?		No		No	
NA, not applicable.						

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