Let's chat about sex, baby!

Leveraging chatbots for sexual health promotion

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CHAPTER 2

Effectiveness and Acceptability of Conversational Agents for Sexual Health Promotion: A Systematic Review and Meta-Analysis

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Abstract

Digital health interventions for sexual health promotion have evolved considerably alongside innovations in technology. Despite these efforts, studies have shown that they do not consistently result in the desired sexual health outcomes. This could be attributed to low levels of user engagement, which can hinder DHI effectiveness as users do not engage with the system enough to be exposed to the intervention components. It has been suggested that conversational agents (automated two-way communication systems, for example, Alexa) have the potential to overcome the limitations of prior systems and promote user engagement through the increased interactivity offered by bidirectional, natural language-based interactions. The present review therefore provides an overview of the effectiveness and user acceptability of conversational agents for sexual health promotion. A systematic search of seven databases provided 4,534 records and after screening, 31 articles were included in this review. A narrative synthesis of results was conducted for effectiveness and acceptability outcomes, with the former supplemented by a meta-analysis conducted on a subset of studies. Findings provide preliminary support for the effectiveness of conversational agents for promoting sexual health, particularly treatment adherence. These conversational agents were found to be easy to use and useful, and importantly resulted in high levels of satisfaction, use and intentions to reuse, while user evaluations regarding the quality of information left room for improvement. The results can inform subsequent efforts to design and evaluate these interventions, and offer insight into additional user experience constructs identified outside of current technology acceptance models which can be incorporated into future theoretical developments.

Digital health interventions (DHIs) are interventions delivered via digital technologies such as smartphones, websites, social media or text-messaging (Murray et al., 2016). DHIs have become increasingly popular for large-scale health promotion efforts. DHIs can be an innovative, cost-effective, and scalable solution for addressing key public health challenges such as staff shortages and budget constraints. They can be especially suited for the sexual health domain because there is the potential to reach at-risk groups e.g. adolescents (Bender & Fulbright, 2013), ethnic minorities (Marlow et al., 2015), sexual minorities (Harb et al., 2019), illicit drug-users (Edelman et al., 2013; MacAfee et al., 2020) and sex workers (Kurtz et al., 2005; Ma et al., 2017) are less likely to seek professional care due to limited resources, poor quality of services and stigmatization.

DHIs for sexual health promotion have evolved considerably over time alongside increased internet and mobile device adoption (Petrosyan, 2024) as well as new technologies. Early DHIs leveraging short-message service (SMS) (Burns et al., 2016; Catalani et al., 2013; L'Engle et al., 2016; Lim et al., 2008; Taylor et al., 2019; Velthoven et al., 2013) and digital media e.g. websites, video and CD-ROM (Bailey et al., 2015; Burns et al., 2016; Guse et al., 2012; Wadham et al., 2019) became widespread and were well-received by users. However, positive results were observed largely for sexual health knowledge and attitudes and less so for behaviors such as treatment adherence, human papilloma virus (HPV) vaccine uptake and condom use (Bailey et al., 2015; Burns et al., 2016; Guse et al., 2012; Taylor et al., 2019). Moreover, intervention effectiveness tended to decline over time. Smartphones, in spite of their pervasiveness and functionalities, failed to gain positive responses from the community with regards to mobile phone applications intended to promote STI prevention and care (Muessig et al., 2013). The use of emerging technologies such as serious gaming, virtual reality and social media faced resulted in similar outcomes (Cao et al., 2017; DeSmet et al., 2014; Gabarron & Wynn, 2016; Muessig et al., 2015), whereby little to no effects were observed for most sexual health behaviors with the exception of testing uptake. Ironically, while the motivation behind the dynamic adoption of technological innovations was likely *increased* user engagement, several authors have attributed the observed low intervention effectiveness to *reduced* immersion and flow i.e., feeling fully involved and focused on the activity (Hookham & Nesbitt, 2019). This is consistent with the notion that positive user engagement precedes positive interactions with intervention components, thereby leading to increased intervention efficacy.

Continuing in the footsteps of adopting new technologies, there has been a recent shift towards conversational agents (CAs) for delivering DHIs across healthcare domains such as substance abuse, mental health, exercise and even stress-reduction (Bérubé et al., 2021; Car et al., 2020b; Gaffney et al., 2019; Kocaballi et al., 2019; Montenegro et al., 2019; Vaidyam et al., 2019). For the purposes of this review, we adopt the definition of CAs as systems that can simulate conversation with users through natural language such as written text or voice thus permitting automated two-way communication between the user and system (Gaffney et al., 2019; Rapp et al., 2021). Examples of CAs range from the well-known open-domain virtual voice assistants such as Siri and Alexa(Sciuto et al., 2018) to customer service chatbots available through commercial websites and social media platforms such as Facebook (Adam et al., 2020) and even embodied CAs which employ computer-generated avatars (Provoost et al., 2017). It has been suggested that DHIs allowing two-way interactions can increase intervention efficacy by addressing both non-intentional and intentional forms of non-adherence to target health behaviors (Chiang et al., 2018; Wald et al., 2015), and promoting user engagement by encouraging users to explore their attitudes and feelings in a more productive and personally relevant manner (Baek et al., 2019; Go & Sundar, 2019). Furthermore, CAs particularly hold promise as a more innovative way to communicate with younger users (Pereira & Díaz, 2019; Skjuve & Brandtzæg, 2018) given their high digital literacy and familiarity with chat applications. Given the rate at which the field of natural language processing is advancing, CAs can also increase engagement by understanding the user and providing intelligent, relevant communication in real-time at all times to different target populations (Pereira & Díaz, 2019).

Prior reviews on CAs for sexual health have primarily addressed effectiveness (Bailey et al., 2015; Berendes et al., 2021; Guse et al., 2012; Swanton et al., 2015; Wadham et al., 2019; Zaneva et al., 2022) , often with emphasis on randomized controlled trials (Becasen et al., 2015; Berendes et al., 2021; Burns et al., 2016; Swanton et al., 2015) or peer-reviewed literature (L'Engle et al., 2016). However, this could have resulted in the exclusion of studies which could provide insight into the potential of CA-based interventions by assessing user acceptability or reporting preliminary findings given the rapid advances in conversational technology. As the effectiveness and user acceptability of DHIs are inextricably linked, the aim of the present systematic review is to summarize available evidence regarding both the effectiveness and acceptability of conversational agents across different target populations and sexual health outcomes.

Method

Literature Search

A systematic search of the literature was performed in October 2020 using PsycINFO, Web of Science, ACM Digital Library, IEEE Xplore, Medline, Embase and CMMC, not restricted by publication year or language. An updated search was performed in February 2021. Grey literature identified in those databases, including dissertations, theses, and conference proceedings, were also included for screening given the infancy of this field. Two sets of search terms were devised by the first reviewer (DB) and a librarian (SG) and customized for each selected database. The first set addressed conversational agents and included other related terms such as 'chatbots', 'relational agent', 'virtual assistant', 'dialog system' and 'mHealth'. The second set addressed sexual health and included other related terms such as 'HIV', 'sexually transmitted diseases', 'HPV' and 'syphilis'. The full search strategy can be found in the Supplementary Material. The protocol for this review was registered at the International Prospective Register of Systematic Review (PROSPERO; registration number CRD42021222969).

Inclusion and Exclusion Criteria

Included studies had to meet three criteria: (i) described conversational agents or synonymous systems that permitted two-way interactions that were fully automated (i.e. without any human mediation)[2], (ii) addressed any sexually-transmitted condition such as HIV/AIDS, HPV and other STIs or targeted aspects of sexual health promotion such as medication adherence and reducing risky sexual behavior and (iii) described an evaluation applied to the technology, focusing on either health outcomes or end-user evaluations (e.g. acceptability, usability, or satisfaction, but not cost-effectiveness and cost-analysis outcomes). Forms of one-way communication, human-mediated communication and systems without response contingency (e.g. quizzes, ecological momentary assessment, electronic diaries and computer-assisted self-interviewing) were excluded, as were studies which only evaluated the *idea* or *content* that will later be incorporated in the working system, as the actual technology does not undergo evaluation. Reviews, meta-analyses, protocol papers and poster abstracts were excluded, as were citations with missing abstracts. No restriction was placed on study design given the varied and dynamic nature of the field.

Screening procedures were piloted by the first and second reviewers (DB and LH). Once a sufficient kappa value(Cohen, 1960) was achieved (>0.6, indicating substantial inter-rater agreement), the initial screening of articles was conducted independently based on the information contained in the title and abstract. Conflicts were discussed between DB and LH, and unresolved conflicts were discussed with a third reviewer (GJ). The same procedure was applied for full-text screening. After this, citation tracking was conducted to ensure that all relevant studies were identified, resulting in 31 included studies (Figure 1).

2 Also includes systems that may not intuitively be considered CAs, namely automated two-way text-messaging systems – they can be considered "old school" CAs that use SMS instead of chat applications.

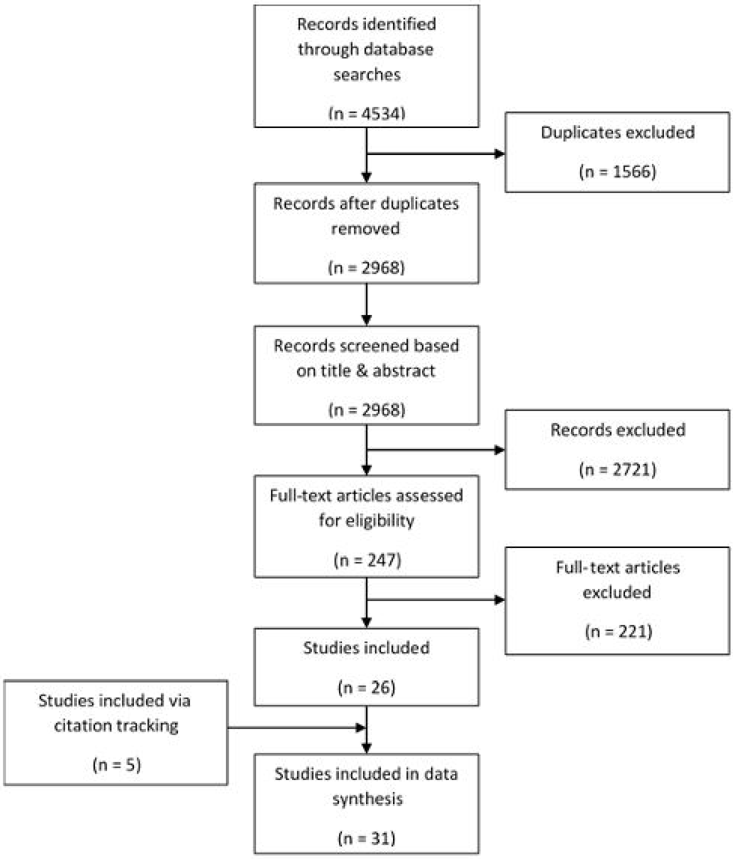

Figure 1. PRISMA Flow Diagram

Data Extraction and Synthesis

Data extraction was conducted by DB and reviewed by GJ for completeness. The following data from the included studies were extracted: title, author, year, study design, sample size, target health behavior, target population, interaction frequency, intervention duration, theoretical framework, technology platform and initiator and outcomes. Outcomes were classified as either health outcomes or user evaluations and were all summarized through a vote-counting strategy and are presented as a narrative synthesis of results. Health outcomes assessed in more than one study using a randomized controlled trial design were additionally analyzed through a meta-analysis. User evaluation outcomes, quantitative and qualitative, were organized around the components of a technology acceptance model (TAM), namely the DeLone and McLean Information Systems Success Model (D&M Model) (Delone & McLean, 2003) - *system quality, information quality, user satisfaction, actual use* & *intent to reuse* and *net benefits*.

Meta-analysis

Health outcomes assessed in more than one study using a randomized controlled trial design were additionally analyzed through a meta-analysis. For the meta-analysis, random effect models were used. Per included study, we calculated the effect size *d* and its standard error using suggested formulas for mean differences and odds ratio (Borenstein et al., 2021) in MacOS Numbers. For studies that had multiple outcome measures, an average effect size *d* and standard error was calculated using suggested formulas (Borenstein et al., 2021) and setting the multiple outcome correlation as $r = .50$. Heterogeneity was derived from the Q-statistic (Higgins et al., 2003) and publication bias from funnel plots and Egger's test(Egger et al., 1997). When publication bias was present, trim-and-fill analysis was conducted (Duval & Tweedie, 2000). We conducted the meta-analysis for the five RCT studies including all outcomes, all objective outcomes, and all objective ART outcomes respectively (so excluding (A. Y. Liu et al., 2019)) with the dmetar, meta, and metafor packages in RStudio (version 2021.09.1) for MacOS.

Results

Overview of Studies

Table 1 provides a summary of the included studies (n = 31). Thirteen RCTs were identified, and the remaining utilized either pre-post or post- study designs. Social Cognitive Theory was cited most often as the underlying theoretical framework (Chernick et al., 2020; T. Davis et al., 2020.; Garofalo et al., 2016; Moore, Pasipanodya, et al., 2018; Pot et al., 2017; Rodrigues et al., 2012, 2015), followed by the Information-Motivation-Behavioral Skills model (Christopoulos et al., 2018; M. Dworkin et al., 2018.; M. S. Dworkin et al., 2019; Ingersoll et al., 2015) and Motivational Interviewing (Chavez & Palfai, 2019; Jack et al., 2020; Naar-King et al., 2013). Seventeen out of 31 studies did not indicate an underlying theoretical framework.

The most common target health behavior was antiretroviral therapy (ART) adherence (15/31). In contrast to ART, only four studies focused on preventive treatment i.e. pre-exposure prophylaxis (PrEP) and post-exposure prophylaxis (PEP) knowledge, uptake and/or treatment adherence (Amith, Cui, et al., 2020; Fuchs et al., 2018; A. Y. Liu et al., 2019; Moore, Jain, et al., 2018). Other studies addressed general sexual health and safe sex practices (Bonnevie et al., 2021; Chavez & Palfai, 2019; Chernick et al., 2020; T. Davis et al., 2020; Jack et al., 2020), HIV/STI testing (Salvadori et al., 2020; Van Heerden et al., 2017) and HIV risk factors such as heavy drinking (Chavez & Palfai, 2019) and medication adherence for bipolar disorder (Moore et al., 2015). HPV vaccine attitude and uptake was the subject of three studies, targeting either mothers (Amith et al., 2019; Pot et al., 2017) or young adults (Amith, Lin, et al., 2020). Studies predominantly (24/31) took place in the United States. The populations of interest were broadly categorized as individuals at risk for HIV (Amith et al., 2019; Amith, Cui, et al., 2020; Amith, Lin, et al., 2020; Bonnevie et al., 2021; Chavez & Palfai, 2019; Chernick et al., 2020; T. Davis et al., 2020; Fuchs et al., 2018; Jack et al., 2020; A. Y. Liu et al., 2019; Mendu et al., 2018; Salvadori et al., 2020; Wells et al., 2015) and HIV-positive individuals who are initiating or taking ART, particularly those who have sub-par adherence (Christopoulos et al., 2018; Dowshen et al., 2012; M. Dworkin et al., 2018.; M. S. Dworkin et al., 2019; Garofalo et al., 2016; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015; King et al., 2017; Moore et al., 2015; Moore, Jain, et al., 2018; Naar-King et al., 2013; Rodrigues et al., 2012, 2015; Swendeman et al., 2020). Within these, groups which were targeted often were young people (Amith, Lin, et al., 2020; Chernick et al., 2020; Dowshen et al., 2012; M. Dworkin et al., 2018; M. S. Dworkin et al., 2019; Garofalo et al., 2016; A. Y. Liu et al., 2019; Naar-King et al., 2013), ethnic minorities (Bonnevie et al., 2021; T. Davis et al., 2020; M. Dworkin et al., 2018; M. S. Dworkin et al., 2019; Mendu et al., 2018; Wells et al., 2015), sexual minorities (Chavez & Palfai, 2019; M. Dworkin et al., 2018.; M. S. Dworkin et al., 2019; Fuchs et al., 2018; Moore, Jain, et al., 2018), women (Bonnevie et al., 2021; Chernick et al., 2020; T. Davis et al., 2020; Jack et al., 2020; Mendu et al., 2018; Wells et al., 2015) and substance users (Chavez & Palfai, 2019; Ingersoll et al., 2015; Moore, Jain, et al., 2018).

Mobile phone was the most common platform to deliver the interventions (22/31), which included short-message service (SMS) (Chavez & Palfai, 2019; Chernick et al., 2020; Christopoulos et al., 2018; T. Davis et al., 2020; Dowshen et al., 2012; Fuchs et al., 2018; Garofalo et al., 2016; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015; King et al., 2017; A. Y. Liu et al., 2019; Moore et al., 2015; Moore, Jain, et al., 2018; Moore, Pasipanodya, et al., 2018; Salvadori et al., 2020), interactive voice response (IVR) (Rodrigues et al., 2012, 2015; Swendeman et al., 2020), instant messaging (IM)(Van Heerden et al., 2017) and smartphone application (app) (M. Dworkin et al., 2018; M. S. Dworkin et al., 2019). The remaining interventions were delivered via computer, either through websites (Bonnevie et al., 2021; Jack et al., 2020; Pot et al., 2017) or desktop/tablet applications (Amith, Cui, et al., 2020; Amith et al., 2019; Amith, Lin, et al., 2020; Mendu et al., 2018; Naar-King et al., 2013; Wells et al., 2015). While all of the included systems permitted two-way interactions, seventeen out of 31 studies allowed multi-turn interactions i.e., either the CA or user was able to respond more than once within the same conversation (Amith, Cui, et al., 2020; Amith et al., 2019; Amith, Lin, et al., 2020; Bonnevie et al., 2021; Chavez & Palfai, 2019; Chernick et al., 2020; Christopoulos et al., 2018; T. Davis et al., 2020; M. Dworkin et al., 2018; M. S. Dworkin et al., 2019; Garofalo et al., 2016; Jack et al., 2020; Mendu et al., 2018; Moore et al., 2015; Naar-King et al., 2013; Van Heerden et al., 2017; Wells et al., 2015) and the remainder which were one-turn-only interactions (Dowshen et al., 2012; Fuchs et al., 2018; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015; King et al., 2017; A. Y. Liu et al., 2019; Moore, Jain, et al., 2018; Moore, Pasipanodya, et al., 2018; Pot et al., 2017; Rodrigues et al., 2012, 2015; Salvadori et al., 2020; Swendeman et al., 2020). Systems generally initiated interactions with users at fixed times e.g. daily (T. Davis et al., 2020; Dowshen et al., 2012; Garofalo et al., 2016; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015; Moore et al., 2015; Moore, Jain, et al., 2018; Moore, Pasipanodya, et al., 2018; Rodrigues et al., 2012, 2015; Salvadori et al., 2020; Swendeman et al., 2020), twice a week (Chernick et al., 2020), thrice a week (Chavez & Palfai, 2019; Christopoulos et al., 2018), weekly (Fuchs et al., 2018; King et al., 2017; A. Y. Liu et al., 2019; Rodrigues et al., 2012) and monthly (Naar-King et al., 2013). Some were user-initiated (Bonnevie et al., 2021; M. S. Dworkin et al., 2019; Jack et al., 2020; Pot et al., 2017) while the rest were only used once to assess user acceptability outcomes.

Out of 31 studies, 26 looked at one or more user acceptability outcomes and 20 studies addressed intervention effectiveness through appropriate health outcomes.

Table 1. Overview of Included Studies

Authors	Year	Study Design	Pilot	Health Eval	User Eval	Sample	Duration	Freq	Digital Platform	Initiator	Health Behavior	Underlying Theoretical Framework
Amith et al.	2020	Post	No	Yes	Yes	Young adults	N/A	Once	Computer - App	User	HPV vaccine uptake	None
Amith et al.	2020	Post	No	No	Yes	PEP and PrEP users	N/A	Once	Computer - App	User	Increasing knowledge about PEP and PrEP	None
Amith et al.	2019	Post	No	No	Yes	Mothers of young children	N/A	Once	Computer - App	User	HPV vaccine uptake	None
Mendu et al.	2015	Post	No	No	Yes	Hispanic women in rural communities	N/A	Once	Computer - App	User	Cervical cancer education	None
Wells et al.	2018	Post	No	No	Yes	Hispanic women in rural communities	N/A	Once	Computer - App	User	Cervical cancer education	None
Bonnevie et al.	2020	Post	No	No	Yes	16-25 year old Black and Hispanic women	18 months	N/A	Computer - Website	User	General sexual health	None
Chavez & Palfai	2020	Pre-post	Yes	Yes	Yes	Heavy Drinking MSM at risk	4 weeks	Thrice a week	Phone - SMS	System	Safe sex behaviors, reduction of drinking behavior	Personalized Cognitive Counseling, Motivational Interviewing
Chernick et al.	2020	Pre-post	No	Yes	Yes	Adolescent (14-24 years) girls	10 weeks	Twice a week	Phone - SMS	System	Safe sex behaviors	Motivational Interviewing, Social Cognitive Theory
Christopoulos et al.	2018	RCT	No	Yes	Yes	HIV+ persons with history of poor retention/ART initiators	12 months	Thrice a week	Phone - SMS	System	ART adherence and retention in care	Behavioral Model for Vulnerable Populations, Information-Motivation-Behavior Skills model, Health Care Empowerment model, revised Stress and Coping Theory

Table 1. Overview of Included Studies *(continued)*

Authors	Year	Study Design	Pilot	Health Eval	User Eval	Sample	Duration	Freq	Digital Platform	Initiator	Health Behavior	Underlying Theoretical Framework
Davis et al.	2019	Post	Yes	No	Yes	Black female adolescents	8 weeks	Daily	Phone - SMS	System	General sexual health	Social Cognitive Theory, Theory of Gender and Power
Dowshen et al.	2012	Pre-post	Yes	Yes	Yes	Youth living with HIV (YLH)	24 weeks	Daily	Phone - SMS	System	ART adherence	None
Dworkin et al.	2019	Pre-post	No	Yes	Yes	Young HIV-positive AAMSM	12 weeks	N/A	Phone - App	Both	ART adherence	Information-Motivation-Behavioral Skills Model of Antiretroviral Adherence
Dworkin et al.	2018	Post	Yes	No	Yes	HIV+ MSM aged 18-34 years on ART	N/A	Once	Phone - App	Both	ART adherence	Information-Motivation-Behavioral Skills Model of Antiretroviral Adherence
Fuchs et al.	2018	Pre-post	Yes	Yes	Yes	MSM PReP users	12 weeks	Weekly	Phone - SMS	System	PReP adherence	None
Garofalo et al.	2016	RCT	No	Yes	Yes	Poorly Adherent Youth Living with HIV (16-29 years)	6 months	Daily	Phone - SMS	System	ART adherence	Social Cognitive Theory
Hardy et al.	2011	RCT	No	Yes	Yes	Poorly Adherent HIV+ individuals	6 weeks	Daily	Phone - SMS	System	ART adherence	None
Harris et al.	2010	Post	No	No	Yes	Individuals initiating or changing two medications on the HAART regimen	3 months	Daily	Phone - SMS	System	ART adherence	None

Table 1. Overview of Included Studies *(continued)*

Authors	Year	Study Design	Pilot	Health Eval	User Eval	Sample	Duration	Freq	Digital Platform	Initiator	Health Behavior	Underlying Theoretical Framework
Ingersoll et al.	2015	RCT	Yes	Yes	Yes	Substance-using non-adherent individuals	12 weeks	Daily	Phone - SMS	System	ART adherence	Information, Motivation and Behavior Skills Model of Adherence, Social Action Theory
Jack et al.	2020	RCT	No	Yes	Yes	AA women	12 months	N/A	Computer - Website	User	Safe sex behaviors	Motivational Interviewing
King et al.	2017	Pre-post	No	Yes	No	High-risk HIV-positive persons	12 months	Weekly	Phone - SMS	System	ART adherence	None
Liu et al.	2018	RCT	No	Yes	Yes	Young individuals at risk for HIV initiating PReP	36 weeks	Weekly	Phone - SMS	System	PReP adherence	None
Moore et al.	2015	RCT	No	Yes	Yes	HIV+ persons with co-occurring bipolar disorder	30 days	Daily	Phone - SMS	System	ART adherence	None
Moore et al.	2018	RCT	Yes	Yes	No	Persons living with HIV (PLWH) + METH use disorder	6 weeks	Daily	Phone - SMS	System	ART adherence, METH use	Health Belief Model, Theory of Planned Behavior, Social Cognitive Theory
Moore et al.	2018	RCT	No	Yes	No	MSM and Transgender women	48 weeks	Daily	Phone - SMS	System	PrEP adherence	None
Naar-King et al.	2013	RCT	Yes	Yes	Yes	Youth living with HIV (YLH) initiating ART	2 months	Once a month	Computer - App	User	ART adherence	Motivational Interviewing
Pot et al.	2017	RCT	No	Yes	Yes	Mothers of young girls	8 weeks	N/A	Computer - Website	User	HPV vaccine uptake (mothers)	Theory of Planned Behavior, Social Cognitive Theory

Table 1. Overview of Included Studies *(continued)*

Authors	Year	Study Design	Pilot	Health Eval	User Eval	Sample	Duration	Freq	Digital Platform	Initiator	Health Behavior	Underlying Theoretical Framework
Rodrigues et al.	2015	Post	No	No	Yes	Treatment naïve people living with HIV	84 weeks	Daily	Phone - IVR	System	ART adherence	Social Cognitive Theory
Rodrigues et al.	2012	Pre-post	Yes	No	Yes	HIV+ individuals on ART	6 months	Weekly	Phone - IVR	System	ART adherence	Social Cognitive Theory
Salvadori et al.	2020	RCT	No	Yes	No	Individuals at risk for HIV (based on counsellor)	17.8 months	Daily	Phone - SMS	System	HIV retesting uptake	None
Swendeman et al.	2020	RCT	Yes	Yes	No	Persons living with HIV (PLWH)	6 months	Twice daily	Phone - IVR	System	ART adherence	None
van Heerden et al.	2017	Post	No	Nao	Yes	N/A	N/A	Once	Phone - IM	User	HIV Self-Testing	None

2

Effectiveness

Out of 11 studies that assessed antiretroviral therapy outcomes, studies which used self-report measures (Dowshen et al., 2012; M. S. Dworkin et al., 2019; Garofalo et al., 2016; Hardy et al., 2011; Moore et al., 2015; Naar-King et al., 2013; Swendeman et al., 2020) found support for intervention effectiveness whereas those employing pill count (M. S. Dworkin et al., 2019; Hardy et al., 2011; Ingersoll et al., 2015; Moore et al., 2015; Moore, Pasipanodya, et al., 2018; Swendeman et al., 2020) and biomarker measures (Christopoulos et al., 2018; Dowshen et al., 2012; Garofalo et al., 2016; King et al., 2017; Naar-King et al., 2013; Swendeman et al., 2020) did not support this. Pre-exposure prophylaxis outcomes were assessed in three studies also using self-report (Fuchs et al., 2018), pill count (Fuchs et al., 2018) and biomarker measures (A. Y. Liu et al., 2019; Moore, Jain, et al., 2018), all of which indicated significant effects. Positive findings were observed for multi-dimensional attitude towards HPV vaccine in two studies (Amith et al., 2019; Pot et al., 2017), of which one found an additional near-significant effect for HPV vaccine uptake behavior (Pot et al., 2017). For condom use, two studies found no significant effects for condom use behavior (Chavez & Palfai, 2019; Chernick et al., 2020), of which one found an improvement in condom use attitude but not intention (Chavez & Palfai, 2019). One intervention was targeted at promoting a range of safe sex practices for women during pre-conception and was found to be effective for reducing the number of risks associated with (sexually transmitted) infectious diseases (Jack et al., 2020).

Meta-analysis

The included RCTs looked at medication adherence for either antiretroviral therapy (Christopoulos et al., 2018; Garofalo et al., 2016; Moore et al., 2015; Naar-King et al., 2013) or pre-exposure prophylaxis (A. Y. Liu et al., 2019). Table 2 summarizes the results for the conducted meta-analyses. For all analyses conducted, the forest plots are provided in Figures 2, 3 and 4 and the funnel plots did not indicate publication bias (see Figures 5, 6 and 7). For the five RCTs (n = 582), there was a small and significant effect on medication adherence, $d+$ = 0.23, 95% CI [0.037; 0.4213], p = .030, favoring the chatbot intervention (Figure 2). This effect was not present after repeating the analysis for only objective outcomes ($d+$ = 0.19, 95% CI [-0.096; 0.484], p = .137), and with only ART studies ($d+$ = 0.10, 95% CI [-0.232; 0.424], p = .419).

Table 2. Summary of Meta-Analysis Results

	k	*n*	Effect Size			Heterogeneity			Egger's Test
			d	95% CI	*p*	*Q*	I^2	*p*	*p*
All RCTs (All Outcomes)	5	582	0.23	0.037 to 0.421	**.03***	4.48	10.7%	.345	.405
All RCTs (Objective)	5	582	0.19	-0.096 to 0.484	.137	5.22	23.3%	.266	.144
ART-Only RCTs (Objective)	4	461	0.1	-0.232 to 0.424	.419	2.28	0.0%	.516	.714

Note: (1) All RCTs (All Outcomes) – included all RCTs addressing antiretroviral therapy (ART) and pre-exposure prophylaxis (PrEP), utilised self-report, pill count and biomarker measures; (2) All RCTs (Objective) – included all RCTs addressing ART and PrEP but only utilised pill count and biomarker measures; (3) ART-Only RCTs (Objective) – excluded 1 study conducted on pre-exposure prophylaxis use and only utilised pill count and biomarker measures

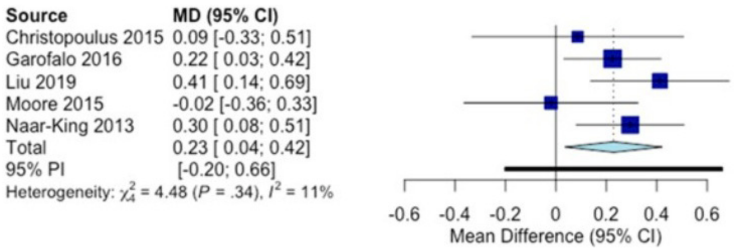

Figure 2. Forest Plot – all RCTs with all measures

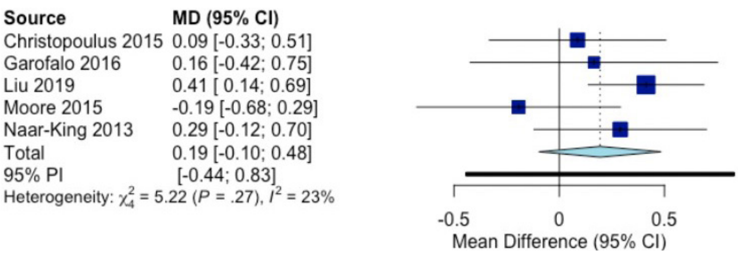

Figure 3. Forest Plot – all RCTs with objective measures only

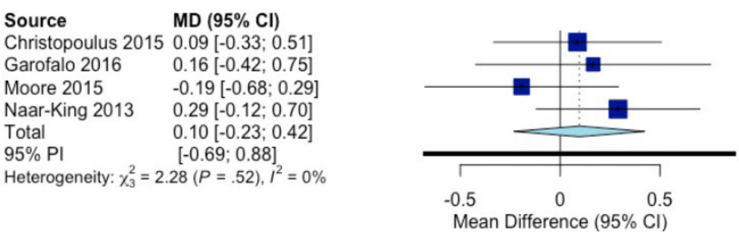

Figure 4. Forest Plot – RCTs addressing ART with objective measures only

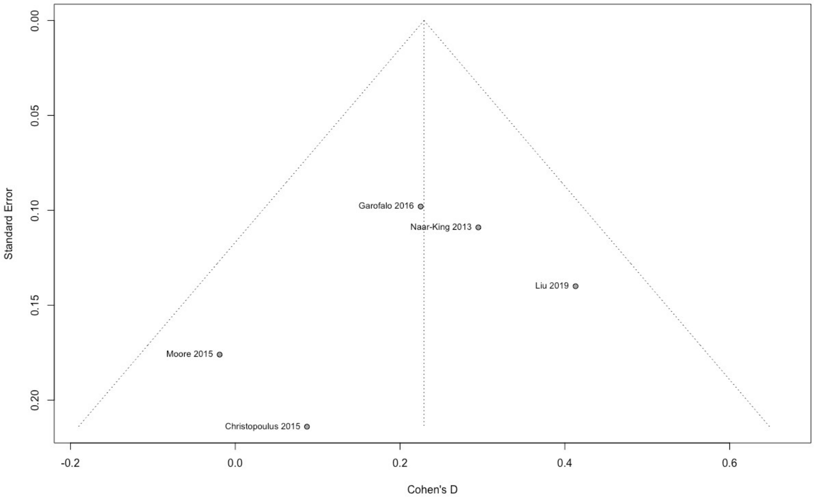

Figure 5. Funnel Plot – All RCTs with all measures

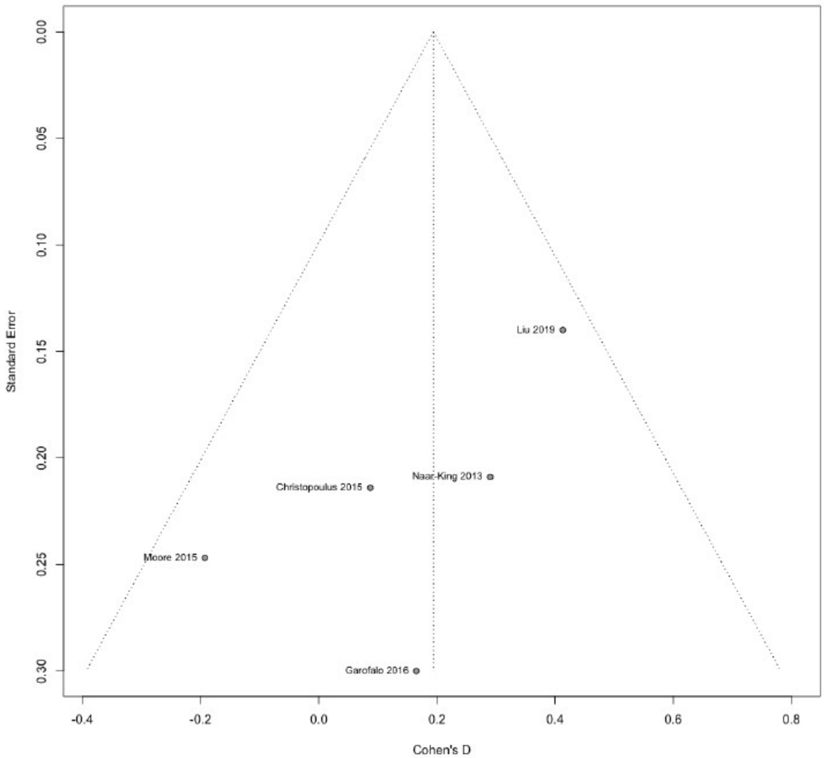

Figure 6. Funnel Plot – all RCTs with objective measures only

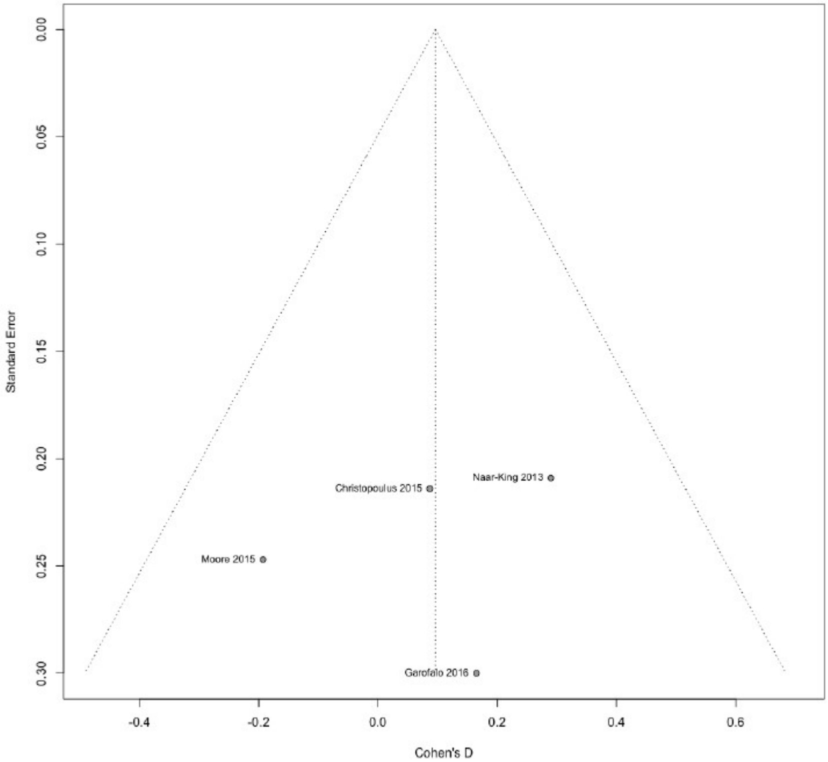

Figure 7. Funnel Plot – RCTs addressing ART with objective measures only

User Acceptability

System Quality

Nine out of 26 studies evaluated *system quality* (Amith, Cui, et al., 2020; Amith et al., 2019; Amith, Lin, et al., 2020; M. S. Dworkin et al., 2019; Hardy et al., 2011; Harris et al., 2010; Jack et al., 2020; Rodrigues et al., 2012; Van Heerden et al., 2017). While ease of use was the most common measure (7/10), system quality was also evaluated through overall usability (Amith, Lin, et al., 2020), pragmatic quality (Amith, Cui, et al., 2020) and response speed (Amith et al., 2019; Van Heerden et al., 2017). Users generally found the systems straightforward and easy to use. This was attributed to technological capabilities such as quick replies in instant messaging (Van Heerden et al., 2017) and the general familiarity of mobile phone interfaces which ensured that the chatbot understood them. Interestingly, response speed was evaluated negatively in two studies, whereby users found it to be either unrealistically fast (Van Heerden et al., 2017) or too slow and not efficient enough for a *machine* (Amith et al., 2019).

Information Quality

Information quality was assessed in twelve out of 26 studies along content relevance (Chavez & Palfai, 2019; Christopoulos et al., 2018; T. Davis et al., 2020; M. Dworkin et al., 2018; Jack et al., 2020), content quantity (T. Davis et al., 2020; M. Dworkin et al., 2018; Harris et al., 2010), clarity (Amith et al., 2019; M. Dworkin et al., 2018; Wells et al., 2015), language style (T. Davis et al., 2020; M. Dworkin et al., 2018; Van Heerden et al., 2017), interaction intensity (depth, frequency and duration) (Chavez & Palfai, 2019; T. Davis et al., 2020; Garofalo et al., 2016; Rodrigues et al., 2015) and repetitiveness (Amith et al., 2019; Christopoulos et al., 2018; Harris et al., 2010). While participants largely found the content relevant and useful for the target behavior (Chavez & Palfai, 2019; Chernick et al., 2020; T. Davis et al., 2020; Jack et al., 2020) (e.g. "these questions are things that all girls think about…made me think about my behaviors (Chernick et al., 2020)"), they voiced the desire for additional personalization of content (Chavez & Palfai, 2019; Christopoulos et al., 2018). Across three studies that assessed content quantity (T. Davis et al., 2020; M. Dworkin et al., 2018; Harris et al., 2010), two reported that users wanted additional content on other health topics (e.g. side effects of ART (M. Dworkin et al., 2018)) and on non-health topics (e.g. communication and relationships (T. Davis et al., 2020)). Language style was evaluated in three studies, two of which found that language style should be more appropriate. For example, it is important to avoid sensitive phrases (e.g. using AIDS interchangeably with HIV) as well as graphic images portraying sickness (M. Dworkin et al., 2018). For voice-based systems, users discouraged any harsh or judgmental intonation and wanted "straight talk" like from friend or relative (T. Davis et al., 2020; M. Dworkin et al., 2018). Van Heerden and colleagues (Van Heerden et al., 2017) instead found that users thought the language was too formal and incongruent with real life conversations. Qualitative feedback indicated that the clarity of some systems can be further improved by rewording and using visuals to complement the verbal and/or audio-visual dialogue (Amith et al., 2019; M. Dworkin et al., 2018; Wells et al., 2015). Studies looking at repetitiveness (Amith et al., 2019; Christopoulos et al., 2018; Harris et al., 2010) found that some users were irritated when the system did not exhibit the variety that is characteristic of natural conversations. Users expressed room for improvement regarding interaction intensity in four studies (Chavez & Palfai, 2019; T. Davis et al., 2020; Garofalo et al., 2016; Rodrigues et al., 2015) – they wanted the conversations to occur more often i.e. daily or more and last longer (T. Davis et al., 2020; Rodrigues et al., 2015) while others would have appreciated more or less messages sent to them depending on their preferences (Chavez & Palfai, 2019; Garofalo et al., 2016).

User Satisfaction

Nine out of 26 studies assessed overall user satisfaction. Two studies (Chavez & Palfai, 2019; Naar-King et al., 2013) made use of the Client Satisfaction Questionnaire while others enquired about satisfaction (Garofalo et al., 2016; Hardy et al., 2011; Harris et al., 2010;

Ingersoll et al., 2015; Pot et al., 2017) or acceptability (Chernick et al., 2020; Wells et al., 2015) using one or more survey items. Across all studies, users reported above-average scores and that they found their experiences with the technology satisfying or enjoyable.

Use

Intent to reuse the system in the future was assessed in eight studies and most users (around 78% across studies) responded positively, expressing that they would like to continue receiving the intervention after the study or be open to using such a system in their daily lives. *Actual use* was assessed quantitatively in 10 studies through message response rate for SMS-based systems (Chavez & Palfai, 2019; Chernick et al., 2020; Dowshen et al., 2012; Garofalo et al., 2016; Harris et al., 2010; Ingersoll et al., 2015; Moore et al., 2015) and through usage metrics for smartphone applications and websites (Bonnevie et al., 2021; M. S. Dworkin et al., 2019; Pot et al., 2017). The average message response rate was around 69%, ranging from 47% to 68% on the lower end (Dowshen et al., 2012; Harris et al., 2010) to 92% on the higher end (Chavez & Palfai, 2019; Moore et al., 2015). Usage metrics indicated that an average of 88% participants accessed the systems (M. S. Dworkin et al., 2019; Pot et al., 2017) at least once and each interaction lasted around 10 minutes, and another system (Bonnevie et al., 2021) received 4,390 topic-relevant messages with an average of three questions per session, indicating reasonable use of the system.

Net Benefits

Perceived net benefits were evaluated in more than half of the studies (14/26) through perceived usefulness (Amith et al., 2019; Chavez & Palfai, 2019; Chernick et al., 2020; Dowshen et al., 2012; Fuchs et al., 2018; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015; A.Y. Liu et al., 2019; Mendu et al., 2018; Rodrigues et al., 2012, 2015; Van Heerden et al., 2017) and the likelihood of recommending the system to other individuals (Chernick et al., 2020; Christopoulos et al., 2018; Dowshen et al., 2012; M. S. Dworkin et al., 2019; Garofalo et al., 2016; Ingersoll et al., 2015; A. Y. Liu et al., 2019; Wells et al., 2015). Qualitative feedback from users indicated that the systems were useful for promoting a range of sexual health behaviors such as condom use ("these questions are things that all girls think about…"), HIV testing ("it could save time not having to wait at a clinic for a counsellor") and HPV vaccine uptake ("…provided useful information and reinforced important points"). Some studies found that the systems targeting treatment adherence were only useful if users were facing difficulties with adequate adherence (Fuchs et al., 2018; Rodrigues et al., 2015), consistent with the otherwise positive evaluations of perceived usefulness regarding systems targeting either individuals initiating treatment (Harris et al., 2010; A. Y. Liu et al., 2019) or exhibiting poor adherence (Garofalo et al., 2016; Hardy et al., 2011; Harris et al., 2010; Ingersoll et al., 2015). Reminders were cited as being most useful feature by providing different strategies (Chavez & Palfai, 2019), minimizing forgetfulness when they were busy or at work (Dowshen et al., 2012; Rodrigues et al., 2015) and that the reminders did not stop until they texted back (Hardy et al., 2011). Overall, users were also highly likely (86% across all studies) to recommend the systems they used to others who are HIV-positive, to a friend, or to others in general.

Additional User Acceptability Outcomes

There were constructs identified in the set of user acceptability outcomes that did not fall under any component of the D&M Model and are therefore summarized below. Constructs associated with *privacy* and anonymity were assessed in five studies (M. Dworkin et al., 2018; A. Y. Liu et al., 2019; Rodrigues et al., 2012, 2015; Van Heerden et al., 2017), whereby a minority of users voiced a desire for additional measures (e.g. the ability to hide the application screen quickly, minimize attention from alerts and reminders) to avoid unintentional disclosure in three studies (M. Dworkin et al., 2018; A. Y. Liu et al., 2019; Rodrigues et al., 2015). Two studies (Jack et al., 2020; Wells et al., 2015) assessed *trust* in the system and received positive feedback from users. Questions regarding general feelings of *comfort* and the lack of stigma were administered to users in five studies (Chernick et al., 2020; M. Dworkin et al., 2018; M. S. Dworkin et al., 2019; Jack et al., 2020; Van Heerden et al., 2017) out of which four revealed that users indeed felt safe and comfortable in their interactions with the system. One study (M. S. Dworkin et al., 2019) found that a small number of users faced instances of potential embarrassment and stigma when using the system in public and near their friends. In five studies, users were asked about the extent to which they felt *emotionally supported*, or cared for, by the system, all of which reported positive findings (Chernick et al., 2020; Christopoulos et al., 2018; M. S. Dworkin et al., 2019; Fuchs et al., 2018; Rodrigues et al., 2015). Out of the seven studies that looked at social presence, users expressed desire for increased *social presence* or actual human interaction in three studies (Amith et al., 2019; T. Davis et al., 2020; Mendu et al., 2018) while the remainder, most of which utilized a static or embodied avatar, reported good or sufficient social presence (M. Dworkin et al., 2018; Harris et al., 2010; Van Heerden et al., 2017; Wells et al., 2015).

Discussion

Digital health interventions (DHIs) for sexual health promotion are becoming increasingly commonplace and are particularly attractive because at-risk groups are often unable to or are reluctant to seek out professional advice. In the spirit of adopting new technologies, DHIs using conversational agents (CAs) have begun to receive more attention for their added capacity to imitate natural interactions with humans. The CAs included in this review exhibited a marked variety in how the technology interacted with users. Of interest were the relatively large number of CAs that allowed multi-turn interactions, which come across as more natural and are characterized by increased interactivity and feedback. These were particularly pronounced in the more recent years, likely explained by the rapid technological advances that have been made in the field of artificial intelligence (Baclic et al., 2020). Understandably, the included studies were largely pilot studies which indicated the infancy of this growing field but resulted in the lack of rigorous study designs utilizing appropriate control groups that would have aided in more empirical analysis. As the interest in CAs for sexual health is evidently rising, the present review situates itself well in summarizing the available evidence of their effectiveness and acceptability.

Most of the studies targeted medication adherence, either antiretroviral therapy (ART) or pre-exposure prophylaxis (PrEP), and meta-analytic findings supported the effectiveness of CA interventions for adherence when considering both self-report and objective measures as well as both medications. However, this result became non-significant upon excluding self-report measures and the single PrEP study, suggesting the need to consider how these systems can result in more tangible improvements for ART adherence. In general, CAs targeting ART adherence fall under the umbrella of *treatment* (Bazzi et al., 2019) and were able to help individuals who already have HIV to manage their symptoms through interactive reminders and information provision. In contrast, there were markedly fewer interventions addressing *prevention* (Bazzi et al., 2019) of sexual health-related diseases, namely pre-exposure prophylaxis (PrEP), condom use, human papilloma virus (HPV) vaccine uptake and sexually-transmitted disease (STD) testing. Based on this limited number of studies, CA interventions resulted in positive outcomes for attitudes towards condom use and HPV vaccination uptake and testing behavior. Given the difficulties in getting individuals to engage in precautionary behaviors (Geense et al., 2013; Kelly et al., 2016), additional studies are needed to explore how CAs can effectively support such behaviors.

Through the lens of the DeLone and McLean Information System Success Model(Delone & McLean, 2003), the CA interventions were found to be acceptable to users in terms of ease of use, perceived usefulness, satisfaction and intent to reuse, which is likely to translate into actual use according to the D&M model (McGill et al., 2003; Ojo, 2017; Petter & McLean, 2009) and other technology acceptance models (Huang et al., 2007; Turner et al., 2010; Venkatesh & Davis, 2000; X. Wang & Goh, 2017). In addition to reminders, CAs were seen as being capable of providing on-demand emotional support and useful information in an anonymous manner without human contact, consistent with proposed drivers of CAs for healthcare (Pereira & Díaz, 2019). However, they were found to be lacking in aspects of information quality such that users desired additional, personalized, and clearer content communicated in an appropriate language style. While not included in traditional technology acceptance models as a separate construct, the heavy reliance on textual content and communication principles (Grice, 1975) in conversational systems lends to the importance of information quality, a point that is further supported by the number of included studies that evaluated this construct in some form.

The study identified an additional set of constructs that may play a role in user acceptability within this domain. *Trust* and *privacy* can be thought of as contemporary challenges that have permeated emerging technologies (Benjumea et al., 2020; Price & Cohen, 2019; Sax, 2021) and have been discussed in other extended TAM models within(Hernandez, 2019; Laumer et al., 2019) and outside of healthcare (de Cosmo et al., 2021; Kasilingam, 2020; van der Goot & Pilgrim, 2020). Users both expected and were largely satisfied with the degree of privacy and trustworthiness exhibited by the systems, although the demand for security appears abundantly strong that additional features may be needed to motivate long-term use. *Social presence* was found to be sufficient in only half of the studied systems, which could be attributed to the use of multimedia and embodiment through avatars (Araujo, 2018; Go & Sundar, 2019; Tsai et al., 2021). An interesting issue arises in incorporating social presence into a system that is often touted for its capacity to enable anonymous, “non-human” and therefore self-disclosing interactions (Croes & Antheunis, 2021a; Nadarzynski et al., 2021b; H. Park & Lee, 2021; Pereira & Díaz, 2019), suggesting the need to achieve a delicate balance. While social presence has been implicated in the user acceptance of conversational agents across many domains (Adam et al., 2020; Araujo, 2018; Bickmore et al., 2010; Croes & Antheunis, 2021b; Diederich et al., 2019; Jain et al., 2018; Vardoulakis et al., 2012; Zamora, 2017), its role in the domain of sexual health remains to be disentangled. *Comfort* and *emotional support* have not received as much attention in the literature but these findings suggest that they may be important in specific domains such as domestic violence (de Gennaro et al., 2020; B. Liu & Sundar, 2018), sexual issues(Crutzen et al., 2011; Hussain et al., 2019) and mental health (van Wezel et al., 2021) where individuals need to feel safe and accepted while engaging with the system. While this review underscores the potential importance of these constructs, future studies can explore their role in user acceptance and inform their inclusion in extended TAM models for sexual health and related domains.

Conclusion

Despite the limited body of evidence, these findings support the notion that CAs for sexual health may not only be effective but that users also find these useful and satisfying for a range of sexual health behaviors. While CAs are already capable of supporting antiretroviral therapy adherence through simple two-way interactions, more studies are required to understand how the potential of CAs can be leveraged for more complex behaviors. This review also emphasizes the value of rigorous, holistic, and mixed-method evaluations of CA-based DHIs to gain deeper insight into how the intervention components are perceived by users as a driver of intervention efficacy. To that end, the findings serve as a good starting point for how we might go about enhancing the user experience for these interventions and highlight the need for theoretical developments regarding technology acceptance models which are more applicable to sensitive domains. The question still remains for further research as to whether and under what circumstances individuals would voluntarily adopt CAs outside the research context and in what way they can be reached in practice.

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Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The authors confirm that the search strategy used in this study is available within the article and/or its supplementary materials. The data supporting this systematic review and meta-analysis are from previously reported studies and datasets, which have been cited. The processed data are available from the corresponding author upon request.

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Supplementary Material I: Search Strategy

PsycINFO (Ovid)

#1 Artificial agents
artificial intelligence/ OR
electronic health services/ OR
human computer interaction/ OR
intelligent agents/ OR
mobile applications/ OR
mobile health/ OR
(Bot OR
bots OR
chat agent* OR
chatbot* OR
conversation* agent* OR
digital assistant* OR
ehealth OR
mHealth OR
mobile application* OR
mobile health OR
relational agent* OR
virtual agent* OR
virtual assistant* OR
virtual coach*).ti,ab,id.
25.323 hits (February 4, 2021)

#2 Sexual health
AIDS/ OR
gonorrhea/ OR
herpes genitalis/ OR
HIV/ OR
human papillomavirus/ OR
sexual health/ OR
sexually transmitted diseases/ OR
syphilis/ OR
(AIDS OR
gonorrhea OR
herpes genitalis OR
HIV OR

HPV OR
papillomavirus OR
sexual health OR
sexually transmitted disease* OR
sexually transmitted infection* OR
STD* OR
STI OR
STIs OR
syphilis OR
venereal disease*).ti,ab,id.
83.081 hits (February 4, 2021)

#1 AND #2 = 494 hits limit to yr 1860-2020 => 492 hits (February 4, 2021)

Medline (Ovid)

#1 Artificial agents
artificial intelligence/ OR
mobile applications/ OR
user-computer interface/ OR
(bot OR
bots OR
chat agent* OR
chatbot* OR
conversation* agent* OR
digital assistant* OR
ehealth OR
electronic health service* OR
human computer interaction* OR
intelligent agent* OR
mHealth OR
mobile application* OR
mobile health OR
relational agent* OR
virtual agent* OR
virtual assistant* OR
virtual coach*).ti,ab,kf.
83.474 hits (February 4, 2021)

#2 Sexual health
Acquired Immunodeficiency Syndrome/ OR
gonorrhea/ OR
herpes genitalis/ OR
HIV/ OR
papillomavirus infections/ OR
sexual health/ OR
sexually transmitted diseases/ OR
syphilis/ OR
(Acquired Immunodeficiency Syndrome OR
AIDS OR
gonorrhea OR
herpes genitalis OR
HIV OR
HPV OR
papillomavirus OR
sexual health OR
sexually transmitted disease* OR
sexually transmitted infection* OR
STD* OR
STI OR
STIs OR
syphilis OR
venereal disease*).ti,ab,kf.
551.825 hits (February 4, 2021)

#1 AND #2 = 1.789 hits limit to yr 1860-2020 => 1.773 hits (February 4, 2021)

Embase (Ovid)

#1 Artificial agents
artificial intelligence/ OR
mobile applications/ OR
user-computer interface/ OR
(bot OR
bots OR
chat agent* OR
chatbot* OR
conversation* agent* OR
digital assistant* OR

ehealth OR
electronic health service* OR
human computer interaction* OR
intelligent agent* OR
mHealth OR
mobile application* OR
mobile health OR
relational agent* OR
virtual agent* OR
virtual assistant* OR
virtual coach*).ti,ab,kw.
80.079 hits (February 4, 2021)

#2 Sexual health
Acquired Immunodeficiency Syndrome/ OR
gonorrhea/ OR
herpes genitalis/ OR
HIV/ OR
papillomavirus infections/ OR
sexual health/ OR
sexually transmitted diseases/ OR
syphilis/ OR
(Acquired Immunodeficiency Syndrome OR
AIDS OR
gonorrhea OR
herpes genitalis OR
HIV OR
HPV OR
papillomavirus OR
sexual health OR
sexually transmitted disease* OR
sexually transmitted infection* OR
STD* OR
STI OR
STIs OR
syphilis OR
venereal disease*).ti,ab,kw.
710.643 hits (February 4, 2021)

#1 AND #2 = 1.874 hits limit to Conference abstracts or Embase => 1.218 hits limit to yr 1883-2020 => 1.208 hits (February 4, 2021)

Web of Science (Clarivate Analytics)

#1 Artificial agents

TOPIC: ("bot" OR "bots" OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR "ehealth" OR "mHealth" OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*")

27.952 hits (February 4, 2021)

#2 Sexual health

TOPIC: ("AIDS" OR AIDS NEAR/3 HIV OR AIDS NEAR/5 syndrome OR "gonorrhea" OR "herpes genitalis" OR "HIV" OR "HPV" OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR "STD" OR "STDs" OR "STI" OR "STIs" OR "syphilis" OR "venereal disease*")

597.626 hits (February 4, 2021)

#1 AND #2 = 1.061 hits Timespan 1975-2020 => 1.058 hits (February 4, 2021)

ACM Digital Library

Abstract:(((bot OR bots OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR ehealth OR mHealth OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*")) AND (AIDS OR gonorrhea OR "herpes genitalis" OR HIV OR HPV OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR STD OR STDs OR STI OR STIs OR syphilis OR "venereal disease*"))))

76 hits limit to yr 2003*-2020 => **76 hits (February 4, 2021)**

IEEE xplore

#1 Artificial agents

("All Metadata":agent OR agents OR assistant OR assistants OR bot OR bots OR chatbot* OR ehealth OR mHealth OR "mobile application" OR "mobile applications" OR "mobile health" OR "virtual coach" OR "virtual coaches")

106.377 hits (February 4, 2021)

#2 Sexual health

("All Metadata":AIDS NEAR/3 HIV OR AIDS NEAR/5 syndrome OR gonorrhea OR herpes OR HIV OR HPV OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR STDs OR STI OR STIs OR syphilis OR "venereal disease*")

3.456 hits (February 4, 2021)

#1 AND #2 = 157 hits limit to yr 1988*-2020 (February 4, 2021)

Communication & Mass Media Complete (Ebsco)

#1 Artificial agents

AB (("bot" OR "bots" OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR "ehealth" OR "mHealth" OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*")) OR KW (("bot" OR "bots" OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR "ehealth" OR "mHealth" OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*")) OR SU (("bot" OR "bots" OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR "ehealth" OR "mHealth" OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*")) OR TI (("bot" OR "bots" OR "chat agent*" OR chatbot* OR "conversation agent*" OR "conversational agent*" OR "digital assistant*" OR "ehealth" OR "mHealth" OR "mobile application*" OR "mobile health" OR "relational agent*" OR "virtual agent*" OR "virtual assistant*" OR "virtual coach*"))

997 hits (February 4, 2021)

#2 Sexual health

AB (("AIDS" OR "gonorrhea" OR "herpes genitalis" OR "HIV" OR "HPV" OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR "STD" OR "STDs" OR "STI" OR "STIs" OR "syphilis" OR "venereal disease*")) OR KW (("AIDS" OR "gonorrhea" OR "herpes genitalis" OR "HIV" OR "HPV" OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR "STD" OR "STDs" OR "STI" OR "STIs" OR "syphilis" OR "venereal disease*")) OR SU (("AIDS" OR "gonorrhea" OR "herpes genitalis" OR "HIV" OR "HPV" OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR "STD" OR "STDs" OR "STI" OR "STIs" OR "syphilis" OR "venereal disease*")) OR TI (("AIDS" OR "gonorrhea" OR "herpes

genitalis" OR "HIV" OR "HPV" OR "human immunodeficiency virus" OR papillomavirus OR "sexual health" OR "sexually transmitted disease*" OR "sexually transmitted infection*" OR "STD" OR "STDs" OR "STI" OR "STIs" OR "syphilis" OR "venereal disease*"))
6.098 hits (February 4, 2021)

#1 AND #2 = 15 hits limit to yr 2011*-2020 => 15 hits (February 4, 2020)