mHealth in the prevention of sexually transmitted infections STIs

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Abstract *The objective of this study was to analyze in the literature how the applications were developed and how they influence the prevention of Sexually Transmitted Infections (STIs). PubMed, CAPES Periodicals and Bireme databases were searched using the descriptors sexually transmitted diseases and mHealth combined by the Boolean connector AND. The search considered studies published between 2013 to 2017 available online in Portuguese and English. The results of the studies showed formative research was the most used method and focus group was the most used technique for data collection in the development of an application. This technique aims at the exchange of experience and allows discussion about issues inherent to infections. The applications were built with methodological rigor with the participation of users and with instructional resources that influence the management of the prevention and control of infections.*

Key words *Sexually transmitted infection, mHealth, Technology*

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Introduction

The expansion of mobile health (mHealth) and the Internet in recent years has made the health-related applications market evolve rapidly, thus enhancing the potential of this sector[1].

Applications "apps" are computer programs designed for smartphones, tablets and other mobile devices that offer games, location-based services, access to sites for social and sexual relations and health care[2].

Thus, "apps" have great potential to disseminate health information for the population, especially among patients with stigmatizing diseases, such as sexually transmitted infections (STIs)[3]. There are an estimated 357 million new cases of curable STIs every year among people aged 15-49. The rate is similarly high for viral infections, with an estimated 417 million people infected[4].

This type of technology provides the user with many opportunities, such as the notification of sexual partners, the location of specialized health services, obtaining information on the modalities of transmission and on how to get treatment and on preventive measures[5,6].

With the popularization of applications for the promotion of sexual health, there has also been a growth in gay apps such as Grindr® and Tinder® designed to facilitate social and sexual encounters that can provide risky sexual behavior in certain contexts. On the other hand, they are also spaces where professionals can promote actions aimed at sexual health[7].

Latin American countries have approximately 332 million users with Internet access, 114 million of whom are Brazilians. The application most used by Brazilians is WhatsApp®, with 46 million users. Currently, the two largest application distribution platforms are the App Store and Google Play[8,9].

The result of this growth mobilizes the researchers' efforts to carefully evaluate the methodological and scientific aspects of the applications in order to ensure that their components can reflect on behavior change and maximize their effectiveness in controlling STI. However, producing research using mHealth is a complex process of intervention that involves specific characteristics of the Information and Communication Technology (ICT) field in all phases of the project[10,11].

Due to the importance of mobile technology, the use of this tool by a large number of people in the world and the scarcity of studies on applications for prevention, diagnosis, treatment and control of infectious diseases, question has been raised regarding the methodological approaches used for the development of the applications and on how they influence prevention of STIs.

In this context, this study sought to analyze in the literature the methods used in the design of the applications and their influence on the prevention of STIs.

Methodology

This is an integrative review as it allows the synthesis of multiple published studies and general conclusions regarding a particular area of study[12]. This study was conceived by defining a research question and formulating a hypothesis, establishing inclusion and exclusion criteria, categorizing studies, evaluating studies, interpreting results and synthesizing knowledge[12].

The following research question was selected for the study: How are applications developed and how can they influence STI prevention?

The electronic search was conducted in December 2017 on the databases of PubMed, CAPES Periodicals and Bireme. Articles published in the last five years (2013 to 2017) in English and Portuguese and fully available were selected. As there are no specific descriptors for this theme in the Health Sciences Descriptors (*Descritores em Ciências da Saúde – DeCS*), the following terms in English were used: sexually transmitted diseases and mHealth combined by the Boolean connector AND.

Inclusion criteria were qualitative studies that addressed the methodological process and the contributions of focus groups for sites and application for the prevention of STIs considering the reading of the titles, abstracts and published full-text articles. Quantitative studies were excluded as they did not use focus groups to analyze the participants' opportunities to design the technology. Review studies, theses, dissertations, and essays that were not fully available were also excluded.

The studies were organized using a chart containing data about the authors, year of publication, objective, method and results.

The level of scientific evidence of the studies included in the research was measured using the Evidence Based Medicine (EBM) instrument, which seeks to obtain relevant studies and critically analyze the quality of publication[13] classifying the studies in:

Grade A: studies supported by good evidence (level of evidence 1- systematic review of ran-

domized controlled trials or meta-analyses of randomized clinical trials) favorable or contrary to the recommended intervention.

Grade B: studies supported by reasonable evidence (level of evidence 2 - prospective comparative studies, meta-analyses of level 2 studies or level 1 studies with inconsistent results or level 3 studies - retrospective cohort studies, case-control studies or observational studies with control).

Grade C: studies with conflicting or poor quality evidence (level 4 - observational studies without control or extrapolations of levels 2 or 3 studies).

Grade D: studies without sufficient evidence for recommendations and often derived from level 4 evidence or inconsistent or inconclusive studies of any level.

Results

The search for studies in December 2017 in the selected databases yielded 416 studies (20 in Bireme, 148 in CAPES and 248 in Medline), 20 of which were duplicates and were hence withdrawn, thus remaining 396 studies for the general evaluation. A total of 364 studies were excluded based on the title and because the subjects addressed were unrelated to the subject of interest. Thus, 32 studies were fully read to assess their eligibility for inclusion in the study. After reading the 32 studies, 17 were excluded because they did not describe the qualitative approach used for the design of the applications. Therefore, a total of 15 studies were selected for analysis as shown in Figure 1.

The selected studies were carefully organized and evaluated with regard to their methodological quality and relevance of the information. The 15 studies selected for review are described in Chart 1.

Of the 15 studies selected, one was published in 2017[14], five were published in 2016[15-19], six were published in 2015[20-25], one was published in 2014[26] and two were published in 2013[27,28]. Most studies were conducted in the United States[14-16,18-21,23-27], the United Kingdom[17,22] and in Africa[28]. All the studies were published in English.

With regard to the methodological processes used in the development of the 15 studies analyzed in this review, nine studies used formative research[15,16,18-20,22,23,27,28], one study used mixed methods[25], and five studies used qualitative approaches[14,17,21,24,26].

All the studies use the focus group technique to obtain data[14-28]. Two studies deepened the findings by carrying out individual interviews[21,28] and six studies also collected quantitative data[15,16,19,20,25,28].

It should be noted that 14 studies were about apps with information about HIV prevention and treatment[14-21,23-28]. mHealth interventions have been promising to improve patient-professional communication in addition to providing health education and supporting self-management of HIV[27,28].

One of the studies describes the development of an application for the prevention of chlamydia[22]. Chlamydia infection is highly prevalent among the young population aged 15 to 24 years. It is frequently asymptomatic in 70% of women and 50% of men and can lead to serious reproductive health-related morbidities[29].

A total of eight applications are for men who have sex with men (MSM)[14-16,19,20,23,26,27]. Gays or bisexuals and MSM are among the groups in which HIV is out of control worldwide. These are 24 times more likely to be infected with HIV than men in the general population. The prevalence of HIV among MSM is 15% higher[30,31].

Of the analyzed studies, three were designed for the prevention of HIV among black MSM[14,20,27]. HIV has disproportionately affected MSM since the onset of the epidemic. Currently, almost 40% of people living with HIV in the United States are African American[32].

However, HIV prevention and treatment strategies do not delay the epidemic because they require significant involvement of a health system that addresses the needs of black MSM by removing barriers such as racism and homophobia during consultations and the discomfort and mistrust associated with the disclosure of sexual behavior by health professionals[20,32].

Discussion

The applications analyzed used different methods with comprehensive and convergent information that influence the prevention of STIs. Some of the methods that should be highlighted were the qualitative approach for the development of the studies and the focus group technique for the design of the applications. In this regard, formative research consisted of the most appropriate method for the effective conception and implementation of mHealth with the participation of the population and health professionals at all phases of the project[16,27,28].

Studies found in the databases (n=416)
PubMed=248
CAPES Periodicals=148
Bireme=20

Identification

Exclusions
of duplicates
(n=20)

Selection

Studies selected for general
evaluation (n=396)

Studies excluded
based on the title
(n=364)

Elegibility

Studies fully read to check eligibility
(n=32)

Excluded studies
(n=17)

Inclusion

Studies included in the
review (n=15)
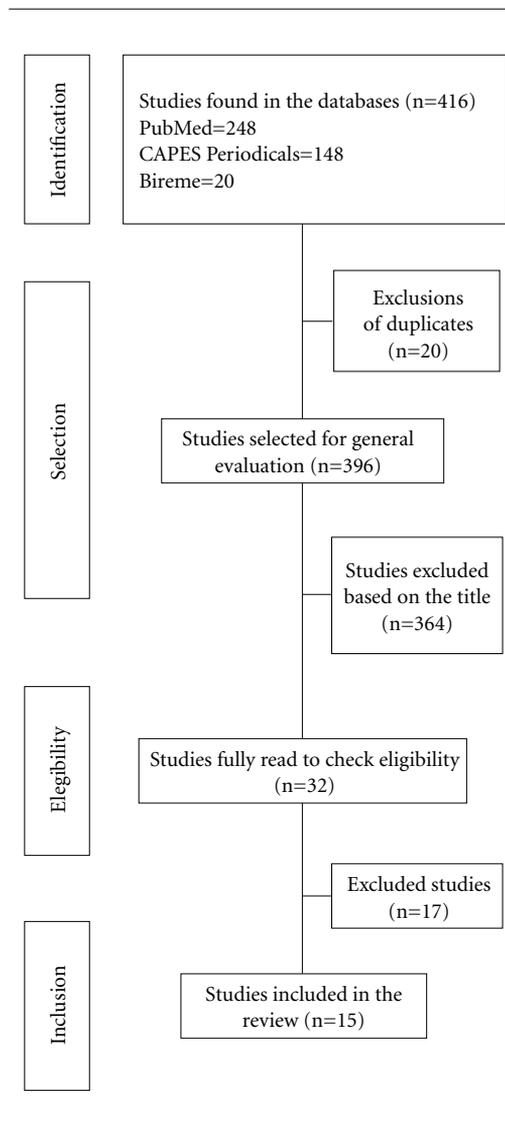
Figure 1. Flow diagram of the study selection process. Fortaleza, Ceará, December 2017.

Source: own construction.

In the initial phases of the development of the intervention, the formative research used focus groups and interviews with populations and stakeholders to determine users' barriers, capacities and motivations[33]. In the final phases, this method could be used to evaluate material acceptability, literacy level, content, and forms of implementation[34]. These steps facilitate the effective development of the intervention and allow specialists to analyze whether the intervention can be adapted to new settings or populations[35].

All the studies used the focus group technique in order to understand the preferences for functions and interface[15,16,22,23,26,27] of applications for HIV prevention, treatment and testing promotion[14,17,18,20,21,24,28] and adherence to antiretroviral therapy[19,25].

Focus groups consist of the ability to share experiences with others and thus identify barriers to treatment and assess the positive and negative aspects of applications for STIs[14,17,24]. However, given the stigmatizing and discriminatory nature of the topic, the lack of anonymity and the sharing of sexual experiences with community members can generate discomfort that interferes with the participants' responses[17,21,24].

Maximizing the benefits and minimizing the harm to the participants involved in the study is one of the research team's ethical responsibilities. Stakeholders can bring valuable contributions regarding potential social harms from participating in clinical trials. This is of particular importance in the case of vulnerable, marginalized, stigmatized individuals or groups who hold less power in society[36].

Even so, the participation of users allows understanding the resources and functions that should be featured in application for HIV/ STI prevention[15,18,20,22,23,27], facilitates communication among health professionals[20], encourages adherence to antiretroviral therapy[16,19] and provides information on the care of patients with HIV/ AIDS[28].

The Community-Based Participatory Research (CBPR), which is based on the Health Beliefs Model construct, allowed community involvement in building the design and content of applications for HIV prevention and treatment of patients receiving primary care[21] and young Africans living in the United Kingdom[17]. This model addresses environmental vulnerabilities for the implementation of new technologies for HIV prevention[37].

The Information, Motivation, and Behavioral Skills (IMB) model used in designing an application for MSM has identified the content, characteristics and functions of an application for HIV prevention. This approach was designed to facilitate the development of technology for a vulnerable demographic group[23].

The IMB includes three features that influence behavior change for adherence to antiretroviral therapy: (1) information - knowledge about drugs; (2) motivation - personal and social motivations; and (3) behavioral skills - the person's ability to perform the tasks required for adherence[38].

Chart 1. Characterization of the studies included in the study. Fortaleza, December 2017.

Authors/Year	Objectives	Method	Main Results
Holloway et al., 2017.[14]	To understand MSM preferences for HIV prevention and treatment.	Qualitative research	The participants prefer health interventions that address privacy and confidentiality and functions that may address psychosocial health problems.
Mitchell et al., 2016.[15]	To get information for developing an app that encourages people to get tested for HIV.	Formative research	Men reported cost, safety, and efficiency as major reasons for influencing an app download.
Schnall et al., 2016.[16]	To explore the use of the Information Systems Research (ISR) framework as a guide to the design of an mHealth application.	Formative research	The study identified the barriers and facilities for using mHealth and the content and functional features to guide the development of future apps.
Evans et al., 2016.[17]	To develop an mHealth-based intervention to promote HIV testing.	Qualitative research	The results suggested that messages should: cover other STIs, be adapted and tailored from a trustworthy source, and focus on support and health benefits.
Sheoran et al., 2016.[18]	To develop an app to support young homeless people without access to health for STI prevention.	Formative research	The app was well rated by the participants who suggested interface and icon improvements and the addition of a peer rating system.
LeGrand et al., 2016.[19]	To develop an app for adherence to antiretroviral therapy in adolescents with HIV.	Formative research	The participants suggested the inclusion of medication reminders, therapy adherence reminders, educational modules, virtual interactions with other users, and gamification elements.
Levy et al., 2015.[20]	To assess the acceptability and perceptions regarding an intervention using an HIV prevention app.	Formative research	The participants' perceptions were generally favorable because they believed getting advice from a doctor on the social media was a reliable method.
Cordova et al., 2015.[21]	To develop an app to prevent HIV/STIs and drug abuse in adolescents.	Qualitative research	Topics raised by the participants: 1 acceptability of the application, 2 inclusion of a risk assessment, 3 incorporation of HIV/STI and drug use content, 4 interactivity and 5 appearance.
Gkatzidou et al., 2015.[22]	To identify the design requirements for an app for Chlamydia.	Formative research	Four broad themes emerged: privacy and security, credibility, and user support.

However, software building integrates users' contributions for the design of the application interface, which provides the research team with opportunities to share conceptual models with participants from the beginning of the design process in order to collect feedback and make the necessary changes[21].

Thus, qualitative evaluation, social learning theory and software development can complement each other and are important components for the development of a culturally personalized and clinically relevant application[39].

In order to obtain methodological rigor for the design of the applications, Information Systems Research (ISR) associated with Human Computer Interaction (HCI) incorporated the feedback from members of the target population into the design preferences, barriers and facilities that encourage or limit the use of technology for the prevention and treatment of HIV[16]. The structure of ISR consists of three interrelated cycles: (1) relevance, (2) rigor and (3) project[40].

Design guidelines play an important role in HCI as they guide the development of the system and provides data for heuristic evaluation through which HCI specialists eliminate remaining flaws in the system[22]. It is an interdisciplinary area of research and practice based on the traditions of

Chart 1. Characterization of the studies included in the study. Fortaleza, December 2017.

Authors/Year	Objectives	Method	Main Results
Aliabadi et al., 2015.[23]	To identify the content, features, and functions of an HIV prevention app for MSM.	Formative research	The participants identified the need for information related to HIV prevention: drug distribution centers, support groups and treatment information.
Broaddus et al., 2015.[24]	To measure the participants' perceptions about the risks and benefits of a text message intervention for vulnerable people with STIs/HIV.	Qualitative research	The benefits of the intervention were: the convenience and ubiquity of text messages, which avoided negative judgments by group members and ensured privacy.
Swendeman et al., 2015.[25]	To develop a theoretical model for the potential benefits of self-monitoring and self-management of drug therapy adherence in people with HIV.	Qualitative research	Multiple self-monitoring functions can influence perceptions, motivations, and risk abilities to support the activation of behavioral states.
Goldenberg et al., 2014.[26]	To understand the functionality, format, and design of an HIV prevention app.	Qualitative research	The app is comprehensive and incorporates innovative ideas for HIV prevention.
Muessig et al., 2013.[27]	To understand mobile phone standards among young people.	Formative research	HIV prevention apps should be useful and entertaining, confidential and interactive.
Chang et al., 2013.[28]	To explore considerations of acceptability, feasibility and design of an intervention for people with HIV.	Formative research	The results included topics on current care challenges, perceived benefits from using mHealth, and acceptance of intervention.

Humanities, Computer Science, Information Systems, Psychology, Sociology and Visual Design. HCI is about designing technologies centered on the users and their daily needs and routines[41].

Another aspect analyzed was the low-fidelity prototype, which allowed exploring users' preferences regarding content, tool performance and information for the elaboration of functional requirements[16]. The prototype usability test aims to identify bugs, provides feedback on interface and navigability[19]. Prototypes are essential tools in the product design process and can help minimize design errors that may occur at the beginning and end of the process[42].

The applications presented similar features and functions related to HIV/STI prevention and treatment[14,16,19,23,28], interaction with health professionals[14,18,20,23,27], online forum with other users[14,18,23,24,27], reminders of the dates to take the HIV test[15,20] and days of consultations[27], medication schedules[19,20,27], side effects of antiretroviral therapy[16,19,28], information about safe sex[20,21,23,26,27] and use of illicit substances[18,27], and the location of health care facilities[14-16,20,23,27].

One feature that should be highlighted is the Short Message Service (SMS), which is an interactive, quick, easy and personalized intervention[15,17,24,27]. The benefits of this intervention include the convenience and omnipresence[24] that allow sending reminders for consultations and medication time and the provision of tips for reducing the risk of getting HIV and interaction with the health professional[27]. However, frequent messages are unnecessary and irritating and hence increase the likelihood of interrupting the use of the application[19]. Therefore, it is necessary that the user can control the frequency and type of messages received[27].

On the other hand, messages intended to motivate adherence to antiretroviral therapy may have undesired effects among HIV patients who have not yet accepted the diagnosis[19]. Thus, positive and reassuring messages should be included to avoid exclusive focus on HIV[17]. SMS has been used in South Africa for health promotion among patients living in rural and urban areas with the aim of improving HIV care[43].

Self-monitoring and self-management of sexual behavior via SMS offer new opportunities to involve HIV patients in the period between clinical visits and the daily routine[25]. However, this component should be considered educational and not just a record of sexual activities[15]. SMS offers users a source of information about HIV,

adherence to antiretroviral therapy and communication with health professionals[44].

The language should be professional, fun and allow customized adaptations made by the users. However, this option may not be feasible as it would require twice the work to adjust the application. A cost-effective option may be the incorporation of two formal and informal languages[26]. Programmers need to understand the limitations related to the population's perception as the information presented in the application can be intelligible[45].

The studies pointed out that in order to involve users applications must incorporate innovative ideas[26] using a visually attractive design[16,20], be intuitive, contain games[18], incorporate social media platforms[26,28] with clear texts[18], and be cheap or free[15,20].

The requirements for downloading an application consist of gratuity, data security and privacy, intuitive interface, proper functioning, control of sounds and other resources, good ratings given by other users and absence of constant system updates[14,15,27]. These findings are in line with other studies which refer to the gratuity and positive evaluation by other users as requirements for downloading an application[46,47].

Social privacy allows users to control access to personal information in their devices through passwords, intimate partner notification and visual identity without any association to the theme. Institutional privacy is the unauthorized collection and disclosure of users' personal data by outsourced organizations[22].

Researchers should protect participants' data from potential privacy violations, including disclosure of participation in the study or personal health information, especially on delicate topics such as HIV status and sexual behavior and orientation[48]. Applications should be designed to have a discreet, neutral, non-theme-linked, and password-protected interface. These requirements are necessary to avoid stigma related to STIs and to encourage the use of technology[49].

Regarding the personal information inserted in an application, studies point to the need for a credible source that clarifies the terms of description and privacy of users' data, otherwise, it could generate users' distrust and hesitation to download it[14,15,17,18,20-24,26-28]. Therefore, before extending interventions using mHealth, it is essential for researchers to demonstrate that applications keep the privacy of patient data[27].

Clearly defined privacy policies on the handling of user information are important to safeguard users' privacy[47]. The involvement of health professionals during application development does not necessarily guarantee their effectiveness; it probably provides a greater insight into patients' needs rather and suggests that the content is trustworthy[50].

Applications can be integrated into care routines for the prevention and treatment of STIs[14,22] among hard-to-reach populations[27] such as MSM who have occasionally reported racist and homophobic judgments made by health professionals working in primary care[20,14].

Tackling HIV-related stigma in health care settings and addressing related effects will require more than interventions targeted at health professionals or individuals with HIV. Although interventions to reduce stigma among people with HIV can mitigate some individual effects on health, they do not address their social insertion that promotes such promulgated stigma[51].

Smartphones are tools used by MSM on a daily basis for SMS, online video chatting, status postings, blogs and more. Many men use the tool to find sexual partners and also HIV/STI information[27]. There is no consensus in the literature about the association of sexual encounters using applications and increased exposure to HIV. It is believed that applications facilitate multiple partnerships and act as a catalyst for risky sexual behavior[52].

Websites and applications allow users to create profiles with images on a social network to chat, share media files, and locate sexual partners using the global positioning system[27]. Some of the most accessed social networks are Facebook®, Twitter®[14,27] and Instagram®[14]. Jack'd®, Grind® and Adam4Adam®[14,27] are applications of geosocial networks. Social or sexual sites are Craigslist®[14] and Black Gay Chat®[27] and text messaging and chat applications such as Oovoo®, Tango®, and Skype®[27].

Recently, Facebook® and Grindr®, social media platforms, partnered with researchers to disseminate information on HIV prevention, promote testing, and provide information about medical care for MSM[53,54]. Studies conducted in the United States and the United Kingdom have shown that promotion of HIV testing can be conducted through geosocial applications[55,56].

Final considerations

The studies analyzed prioritized formative research, which uses a qualitative and quantitative

approach for a comprehensive understanding of cultural, social, gender, sexuality, political and structural factors aspects of the population. It establishes important planning for the development of applications for the prevention of STIs which can reduce the spread of infection and guide the identification and treatment of sexual partners.

The technique most used in the studies was the focus group, which broadened the context experienced by the health professionals and the users' expectations. This technique aims at the exchange of experience during the intervention and allows the discussion of issues inherent to the human being with HIV/STIs. This technique helps researchers to elaborate applications focused on the needs of the users and also allows to understand the prevention, follow up and treatment of infected people.

The studies showed the importance of applications for self-monitoring and self-management of care for people with HIV/STIs. The participants identified the need to incorporate information on prevention, antiretroviral therapy, online forum with health professionals and other users, reminders of consultations and testing and location of health care facilities. In addition, applications must contain a discreet interface, be interactive, free or inexpensive, protect the privacy of users' data and use trustworthy sources.

Researchers integrate features and information from geospatial networks that use the Global Positioning System (GPS) to locate sexual partners for the purpose of promoting health surveillance measures aimed at the prevention and treatment of STIs.

Therefore, obtaining mHealth technology to assist health professionals in providing care to STI patients is an important step in the control, prevention and treatment and in the design of STI epidemiological surveillance programs.

Collaborators

RO Sales and RM Silva participated in the conception, planning, analysis, interpretation and writing of the work.

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