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A Review of mHealth and eHealth Interventions to Combat Increasing Rates of STIs and HIV Among Adolescents

By

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Master of Public Health

Hubert Department of Global Health

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By

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B.S., California State University Channel Islands, 2009

Thesis Committee Chair: Sophia Hussen, MD, MPH

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Abstract

A Review of mHealth and eHealth Interventions to Combat Increasing Rates of STIs and HIV Among Adolescents

By Andrew Wilson

Interventions to curb increasing rates of sexually transmitted infections (STIs) and HIV among adolescents/young adults are being developed every year around the world. A specific subset of these interventions includes the utilization of mobile phone technologies and the internet in the areas of disease prevention, treatment, and behavior change. The terms ‘mHealth’ and ‘eHealth’ have been coined to describe such interventions. Globally, the number of internet users was estimated to reach 3 billion users at the end of 2014, and there are an estimated 6 billion cell phone subscriptions [2]. Technology utilization, including the internet and mobile phones, among youth is extremely high. One study suggests that up to 93% of the adolescent population In the United States have regular internet access, and upwards of 75% have a mobile phone [1]. According to the Centers for Disease Control and Prevention (CDC), adolescents account for almost half of the 20 million new cases of STDs annually, here in the United States [3]. By better understanding the ways in which adolescents interact on their mobile phones and the internet, new and innovative technology based applications can be developed and implemented to improve STI and HIV related outcomes. This review aims to examine the scientific literature in relation to mHealth and/or eHealth and STI/HIV prevention, treatment and behavior change in order to provide an assessment of the state of the science and directions for future exploration.

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Chapter 1: Introduction

Forward

Interventions to curb increasing rates of sexually transmitted infections (STIs) among adolescents/young adults are being developed every year around the world. A specific subset of these interventions includes the utilization of mobile phone technologies and the internet in the areas of disease prevention, treatment, and behavior change. The terms 'mHealth' and 'eHealth' have been coined to describe such interventions. Globally, the number of internet users was estimated to reach 3 billion users at the end of 2014, and there are an estimated 6 billion cell phone subscriptions [2]. Technology utilization, including the internet and mobile phones, among youth is extremely high. One study suggests that up to 93% of the adolescent population In the United States have regular internet access, and upwards of 75% have a mobile phone [1]. According to the Centers for Disease Control and Prevention (CDC), adolescents account for almost half of the 20 million new cases of STDs annually, here in the United States [3]. By better understanding the ways in which adolescents interact on their mobile phones and the internet, new and innovative technology based applications can be developed and implemented to improve STI related outcomes. This review aims to examine the scientific literature in relation to mHealth and/or eHealth and STI/HIV prevention, treatment and behavior change in order to provide an assessment of the state of the science and directions for future exploration.

Defined terms

Adolescents. According to the WHO, adolescence is a period of time in human growth and development characterized by rapid growth and change and represents one of the critical transitions in the life span [4]. Many different organizations classify this age group differently,

and adolescence has been described as spanning anywhere from ages 10 – 25 years. For the purpose of this paper, unless otherwise stated, the age limit of 15 – 24 years will be applied.

eHealth. According to the WHO, eHealth is the transfer of health resources and health care by electronic means. This may include delivery of health information, the use of information technology (IT), or the utilization of e-commerce within health systems management. [5].

mHealth. According to the WHO, mHealth is utilizing mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices in medical and public health practice. [6]

Problem

STIs/HIV in the USA

According to the CDC, adolescents have the highest rates for the three most common STIs, chlamydia, gonorrhea and HPV of any age group in the United States. U.S. surveillance data showed an increase in incidence and prevalence across all STIs in 2014 [7]. Adolescents accounted for 66% of all reported chlamydia infections. Looking specifically at 20- to 24- year old women and men, both had the highest rates of chlamydia among each respective age and sex group, 1,368.3 cases per 100,000 males and 3,651.1 cases per 100,000 females. Furthermore the overall rates of reported chlamydia cases increased among both sexes in this age group; 1.6% and 4.4% respectively during 2013-2014. Similar trends are seen in gonorrhea as well. In 2014, women 20- to 24- years old had the highest rate of gonorrhea (533.7 cases per 100,000 females) compared with any other age or sex group [7]. Men in this age group had the highest rate of gonorrhea (485.6 cases per 100,000 males) compared with other males and the gonorrhea rate for men in this age group increased 6.9%. Looking at primary and secondary syphilis, there are

increases and high rates within the adolescent population as well. The rate of reported cases increased 11.6% among persons aged 15–to- 19 and 13.1% among persons aged 20 – 24 between 2013 and 2014. [7]. In 2013, it is estimated that 9,961 adolescents (aged 13 – 24) were diagnosed with HIV, accounting for 21% of the people diagnosed that year [8]. Those aged 20- to 24- years old accounted for 81% of the newly diagnosed, which was the highest number of HIV diagnoses of any age group. Furthermore, upwards of 50% of this age group do not know that they are infected. [8]. Rates of STIs and HIV are even higher among certain sub-populations at higher risk including; racial/ethnic minorities, transgendered women, and men who have sex with men (MSM) [3, 7, 8, 10, 25].

STIs/HIV in Adolescents Globally

According to the WHO, there are 498 million new cases of four curable sexually transmitted infections (gonorrhea, chlamydia, syphilis and trichomoniasis) among people aged 15–49 years annually [4, 9, 10]. At the end of 2014, there were approximately 36.9 [34.3–41.4] million people living with HIV with 2.0 [1.9–2.2] million people becoming newly infected and 1.2 [980 000–1.6 million] million people died from HIV-related causes globally. According to WHO, people aged 15- to 24- years old account for the highest reported rates of STIs, up to 60% of the new infections and half of all people living with HIV [9 – 10]. Furthermore, only a minority of adolescents have easy access to any acceptable and affordable STI treatment services [10]. It is important to note that global data on STI prevalence and incidence is lacking, especially among sexually-active, unmarried adolescents in developing countries [10]. STIs are not evenly distributed across sex, high risk groups, and geographical location. Global data shows that girls are more frequently affected than boys, rates are higher in specific high-risk groups such as sex workers, street kids, and detainees, are more common among sexually assaulted

women and abused children and may be more prevalent among adolescents in Africa and the Caribbean than in other regions [10].

Adolescents and Technology

The adolescent population is at a higher risk of acquiring STIs for a combination of behavioral, biological, social-structural and cultural reasons [3, 4, 10, 11, 18]. Adolescence is the developmental stage when exploration and new engagement in health-risk behaviors such as; smoking, drug use, alcohol use, high-risk sexual behavior and violence starts to occur [3, 4, 10, 18, 19]. This population may have an increased social-structural barriers to seeking prevention and management services, including inability to pay, lack of transportation, long waiting times, conflicts between clinic hours and work and school schedules, embarrassment attached to seeking STD services, method of specimen collection, and concerns about confidentiality [3, 11, 18]. Additionally, these social-structural barriers are influenced by individual characteristics as well as a multitude of other influences including family, peers, community environment and schools [3, 20]. Culturally speaking, the term adolescents and the ages defined is a relatively new term [10]. Becoming a woman or man means different things and happens at different times depending on the cultural context. Arranged marriages, religion, traditional practices, and culturally appropriate age of first sex are all contributing factors for higher risk of acquiring STIs [10].

Prior research has shown that adolescents often identify technology, such as the internet and mobile phones, as integral and essential parts of their lives [3]. Furthermore, they are the age group that is quickest to adopt and utilize new technologies [1, 3, 18, 19]. More than 50 % of the world's population is estimated to own and use mobile phones, which is roughly 7 billion subscriptions [2]. According to the United Nations International Telecommunications Union

(ITU), there were nearly three billion Internet users at the end of 2014. This constitutes roughly 40% of the world's population. Interestingly, two-thirds of these internet users were from the developing world [2]. ITU reports that one-fifth of Africa's population has access to the internet, as do upwards of two-thirds of the American population and three-fourths of the European population [2]. Across the globe, internet access and social media use among youth is increasing and while there are differences and disparities between low- and middle-income countries and high-income countries, mHealth and eHealth technologies are being implemented worldwide.

With the advancements and increasing popularity of smartphones and smartphone applications (apps), new and novel interventions have greatly expanded the possibilities for phone-based HIV/STD interventions [16, 17, 23, 29]. This technology supports interactivity, which allows people to obtain extra help when needed and can keep users engaged [16]. Furthermore, these types of interventions can be multifaceted using multimedia capabilities, which allow for more advanced and personalized motivational messages, face-to-face support to claim people's attention when it is most relevant [15,16, 23]. Interventions can be personalized, allowing any mHealth intervention to be tailored for cultural relevance, gender specific, and age specific information [16, 22, 32]. With increasing wireless coverage and advancements of mHealth technologies, smartphones now have the capabilities of internet access and the capacity to perform more advanced computer functions [15, 16, 23].

Significance

Adolescents are embracing and utilizing new digital technologies almost as quickly as they are being introduced, and they are doing so more than any other age group [3, 27]. Adolescents are also a population with multiple barriers to healthcare, which include limited access to healthcare, cost of services, lack of insurance, lack of knowledge in navigating

healthcare systems, wait time, non-tailored information, restrictive sexual and reproductive health care laws and policies, parental consent requirements, logistical barriers such as distance to healthcare facilities, and transportation issues with reliance on family members or public transportation [3, 4, 10, 11, 22, 25]. Sexual education for this age group varies greatly, ranging from comprehensive education programs (including information about practicing safe sex, birth control methods and life skills development) to programs with absolutely no mention of anything relating to sexual health and development [3, 10, 24, 25]. Less comprehensive programs are more common worldwide. Moreover, the limitations of sexual education programs are exacerbated in rural populations, conservative communities, and minority populations [3, 7, 8, 10, 25]. There is therefore a critical need for new technologies to augment existing sexual education programming.

In addition to sexual education and prevention programming in general adolescent populations, mHealth also has been applied to youth populations for enhancing the treatment and prevention of HIV. Studies have shown that youth living with HIV in the United States frequently have poor medication adherence [30]. In sub-Saharan Africa, non-adherence to ART has been acknowledged as a key barrier to successful treatment of HIV [33]. Data from the National HIV Behavioral Surveillance System (NHBS) shows that HIV testing rates of 18- to 19-year-old MSM are suboptimal in the United States [31]. The lowest lifetime testing rate among MSM was in the youngest age group of 18- to 19-year-olds (75%), and only 64% had been tested in the past year [31].

mHealth and eHealth interventions have advanced in parallel with the improvement of mobile phone technologies and internet expansion and development. This field has been expanding with new and innovative ideas, with researchers discovering and identifying

opportunities to improve the delivery of, communication of, and access to, health services and health-related information [17]. Original mHealth interventions primarily utilized mobile phone capabilities such as calling and text messaging (SMS). However, with the innovations of smart phones and tablets, multimedia messages like photos and videos, multimedia functionalities like watching videos, taking pictures and listening to music, access to the internet and applications, and the ability to save data are all possible. Physically, these mobile phones and smart phones are small, lightweight and mobile allowing people to carry them easily wherever they go. At the end of 2015, the ITU reports that there were more than 7 billion mobile cellular subscriptions [13]. Furthermore, 69% of the world's population had access to a 3G network; 89% 3G coverage in urban population and 29% 3G coverage in rural populations [13]. While 3G coverage is low in rural settings, 2G mobile-cellular networks covered 95% of the population [13].

Wireless coverage and utilization of mobile phones globally has great potential to improve health worldwide. Current approaches to help combat urgent healthcare needs and to prevent diseases are expensive, far exceeding our available resources and current financial capacities [15]. Many healthcare facilities are overcrowded, underfunded, drained of every last resource and in some instances inaccessible to rural populations. In some areas of the world cellular telephone infrastructures have surpassed infrastructures of basic health-related services such as clean and accessible water and stable electricity [12, 15]. As these technologies become more advanced and more affordable, interventions can be implemented at low costs, from high-income settings to rural populations, thus closing the gap of health disparities to these more remote and low resource setting populations [16, 17]. With the expansion of wireless networks, creation and distribution of mobile interventions to large populations via text messaging, smart phone applications, calling, or via multimedia can take place at low costs [13, 16, 17].

mHealth interventions allow for low cost approaches to interventions that can be delivered and implemented to a large number of people via text messages (SMS), software applications, and multiple media (SMS, photos) interventions [16, 28, 29]. SMS is the most commonly used mobile application in the world and is utilized globally, is extremely fast and highly dependable, and for the most part accessed at a relatively low cost [16, 17, 22, 29]. Mobile technologies are popular because they are fast and allow people to communicate with one another wherever they go [16, 29]. Furthermore, studies have shown that SMS messaging has the potential to increase access to free and low cost health care, and increase knowledge globally, among hard to reach populations such as adolescents [29]. Mobile technology applications can be downloaded easily and automated systems can deliver text messages to large target populations anywhere a mobile network exists [29].

In 2015 it was estimated that 3.2 billion people worldwide were using the internet, making the global internet penetration rate 43% [13]. 2 billion of these internet users were from developing countries and for every one internet user in a developed country, there are two in a developing country [13]. In 2015 ITU reported that about one in five people living in Africa use the internet, compared to about three in five people in the Americas [13]. Moreover the proportion of households with internet access at home was 34% in developing countries and 80% in developed countries [13]. While internet access has increased over the years, there are currently an estimated four billion people from developing countries that remain offline [13]. While research has shown that adolescents use the internet more than other populations, this usage is different across the globe. Furthermore, the percentage of adolescents that use the internet to access sexual health and prevention information is different from country to county [49]. Researchers, providers, and global health agencies are addressing these gaps in utilization

by creating eHealth interventions that are interactive and highly engaging using pop ups, avatars, games, videos, and moderated controlled interventions [49].

A major limitation to current HIV and STD-prevention programs has been a combination of the above-mentioned barriers and their inability to reach large groups of adolescents with risk-reduction information and education [10, 24, 27]. Technology, such as mHealth and eHealth, can be a powerful tool to connect the healthcare provider and adolescents and overcome many of such barriers [3, 16, 21, 25, 26]. Such tools may provide healthcare providers the means to reach this population for opportunities to share information such as health education, health promotion, prevention, disease management, reduce loss to clinical follow-up, and improve adherence [3, 10, 16, 17, 21,]. mHealth and eHealth technologies can be innovative, creative, far-reaching throughout the world, used privately, can be tailored to specific populations and specific health needs within various communities, can link youth to services, facilitate support for adolescents, improve access to and communication with adolescents, promote risk reduction norms, and provide information on-demand [3, 17, 21, 22, 24, 25, 26, 27].

Chapter 2: Methods

General Cochrane methods were utilized for this review of the literature. A defined research question, a specific population, published interventions, an outcome of interest and specific inclusion and exclusion criteria were developed to review. We reviewed the literature for articles published in the PubMed database and Web of Science regarding mHealth and eHealth interventions to combat increasing cases of STIs/HIV among adolescents in the United States and globally. Supplementary information about current STI/HIV rates was accessed from reports available from the WHO and CDC. All searches in PubMed included ("mHealth" OR "eHealth") and combinations of search terms related to adolescents ("youth", "adolescents",

"teenage", "teenager", "adolescence", "child") and sexually transmitted infection or human immunodeficiency virus ("hiv infections", "hiv/aids", "AIDS", "sti infections", "sti"). All articles that met the criteria were then exported to EndNote. Within these results, titles and abstracts were reviewed and then assessed using established inclusion and exclusion criteria.

The inclusion criteria utilized for this review included:

Intervention targeted adolescent population, aged 15 -24;

Intervention was assessed as a health promotion tool;

Subject matter was STI and/or HIV;

Published between 2009 and 2016;

Published in English; and

Full text available through the Emory Library or other catalog system.

Exclusion criteria included:

Intervention targeted a population outside of 15 -24 years of age;

Intervention was not created to be a health promotion tool;

Subject matter was non STI/HIV;

Published prior to 2009;

Published in a language besides English; and

Full text not available through the Emory Library or any other catalog system.

Once articles were reviewed, using the inclusion and exclusion criteria, full texts were obtained for all studies that met the inclusion criteria. The reference sections of articles that met the inclusion criteria were also reviewed to identify additional articles of interest to be included. Applicable data were extracted from articles and managed using a Microsoft Excel spreadsheet. Information pulled and included on this spreadsheet include; author, year, article title, study population, methodology, intervention type, description, outcome. Non-English articles were excluded because of the language limitations of the reviewer. 2009 was chosen as the beginning date of the review because Google searches for mHealth were first used in 2009 [12].

Chapter 3: Results

Current mHealth Interventions

Table 1. Current mHealth Interventions see appendix 1

Health promotion

The Hookup is a service that provides weekly sex-related information and life advice, as well as, providing linkage to local sexual health related resources and clinics sent via weekly text messages [29, 34]. The Hookup is run by the California Family Health Council (CFHC), which aims to help teens make healthy and informed decisions about their sexual and reproductive health through a variety of outreach programs, including mHealth [34].The target population for this SMS service are adolescents between the ages of 13 – 24 in California. Participant's text "HOOKUP" to a number to get weekly texts that contain valuable sexual and reproductive health information and linkage to local resources [34]. A study done by Sheoran et al. examined the feasibility of using SMS as an evaluation tool of the Hookup and to evaluate the effectiveness of the Hookup SMS service [29]. To examine the effectiveness of the program, four surveys

questions were developed, adhering to the 160 character limitation of a standard text message. These questions were developed to understand the effectiveness of the program in three ways, assessing if the program was reaching the target population, to see if promotion efforts were successful, and to examine if the sexual and reproductive health messages were effective [29].

At the time of the study the Hookup had 2477 subscribers who were receiving the weekly messages [29]. They had a response rate from the survey of 832 subscribers with 58% of them completing the full survey. Analysis of the responses showed that this program was reaching their target population with 90% of respondents being in the age range of 14 -21 [29]. The promotion efforts reflected the program's promotion plan with the main sources of referral to the Hookup being, 40% from teachers/school outreach, 25% network (i.e. friends, peers, etc.), 22% from posters and other media, and finally 10% from online advertising [29]. 90% of the respondents indicated that they had made a behavior change since they started receiving the weekly text messages. These changes include, 33% indicating condom usage, 24% with increased knowledge and awareness, 15% initiating birth control, and 15% getting tested for HIV and STIs [29].

Another study looked at the acceptability and feasibility using cell phones for an adherence support intervention among 15 -24 year olds with a history of nonadherence to ART. Belzer et al., implemented a pilot randomized clinical trial that enrolled 37 participants, with 19 randomized to the intervention and 18 to the control [30]. The intervention included being contacted by an adherence facilitator via cell phone, at a prearranged time, Monday – Friday either once or twice a day corresponding to the frequency of their taking ART. Additionally, these calls were strategically timed to take place about 1 h after the time the medication was supposed to be taken [30]. These calls were scripted and included closed and open-ended

questions about medication review, barriers to taking medications, problem solving support, referrals provided, and scheduling relevant referrals [30]. The intervention participants were given the option of receiving $45 paid towards their cell phone bill or receive a study phone. 12 of the 19 participants in the intervention arm completed the 24 week intervention [30]. At the end of the intervention exit interviews were conducted.

The acceptability of the intervention was assessed from content analysis of exit interviews and the feasibility was assessed via intervention retention and study retention rates [30]. There were 16 participants that completed exit interviews and of them, 15 reported the call length was just right, 13 reported they would like to continue the calls after completion of the intervention, and all participants reported they would recommend this intervention to their friends [30]. This intervention found a statistically significant improvement in self-reported medication adherence and viral load reductions during the 24-week intervention [30]. MHealth brings up the need for additional services such as providing cell phones, which will present challenges for clinics and organizations looking to implement this type of intervention, as funding for cell phones and cell phone plans will be difficult [30]. While only 12 of the 19 participants completed the intervention, this may level of acceptance may be acceptable as this population was small and extremely nonadherent. With the evolving field of cell phones, such as smart phones, new multimedia options may contribute to these types of interventions acceptability, feasibility, and effectiveness [30].

Prevention

Guy2Guy is a text messaging- based HIV prevention program created and tailored for adolescents in the United States aged 14 – 18 [36]. Phillips et al., looked to examine HIV testing behaviors and potential barriers faced among adolescent gay and bisexual men, aged 14 to 18, a

disproportionately affected and understudied population using Guy2Guy [31, 36]. This population was recruited via Facebook ads and aimed to include a diverse group of sexually experienced and sexually inexperienced adolescents. In assessing HIV testing behaviors participants were asked a series of questions including how many times they had ever been tested, if they had been tested in the prior 3 months, knowledge about where and distance to get tested, and their status on their most recent HIV test [31]. In regards to HIV testing barriers, an adapted 9-item scale assessment to barriers was created allowing participants to respond in three options, “not important,” “somewhat important,” and “very important.” [31, 35].

Looking at HIV testing behaviors, this study by Phillips et al., found that only one fifth, 20.2%, of all participants had ever been tested for HIV and only 42.6% had been tested within the 3 months prior [31]. Furthermore, this study found that 42.9% did not know where they could go to get tested for HIV [31]. HIV testing barriers that were most frequently reported among participants were not knowing where to get tested, believing oneself to not be at risk for HIV, and not wanting other people to learn that they had been tested [31]. An exploratory factor analysis was conducted to identify the factor structure of the 9-item scale questions and to determine the number of subscales within these items measuring the HIV testing barriers [31]. Three subscales that were identified were, barriers due to external factors, barriers due to fear, and barriers due to feelings of invincibility [31]. Sexually active participants that had never been tested for HIV had significantly greater scores on the external factors and fear subscales [31].

A pilot program using mobile phones aimed to test the feasibility of recruiting and retaining men in a 12-week SMS-based HIV prevention program and asses the programs effects on HIV-related risk behaviors was conducted by Juzang et al. [32]. 60 Black men, aged 16 -20, living in Philadelphia were non-randomized into two groups of 30 for this study [32]. They

received three text messages per week for 12 weeks, with participants in the intervention group receiving text messages about HIV prevention, and those in the control group receiving text messages about nutrition [32]. To assess engagement in the program, at least one quiz per week was sent out. The study measured HIV risk awareness, positive and negative attitudes towards using condoms, personal and perception of peer usage condom norms, self-efficacy of using condoms in diverse settings and circumstances, intentions for condom use, and condom use behavior [32]. Behavioral outcomes measured in this study included assessment of partner monogamy, experience with pressed sex, experience with the criminal justice system, experience with being under the influence during sex, having had male sex partners, and having a sexual partner who tested positive for STD or HIV [32].

The study concluded that the participants were enrolled and retained in numbers that suggest an intervention, such as a large randomized controlled trial, is worth examining for efficacy [32]. For example, at the six-month follow-up, 65% of those initially enrolled were retained. [32] Furthermore, in the intervention group, 63% of 30 enrolled (19 participants) retained and completed the 6 month follow-up [32]. This study showed significant changes in three key outcomes including, condom norms, sexual health awareness, and practicing monogamy [32].

A study in Australia examined the impact of text messaging for sexual health promotion to on young people aged 16 to 29. [47] 12 text messages, relating to use of condoms, risk for STIs, and STI testing, were sent to participants within a six month interval. [47]. Gold et al., conducted eight gender-segregated focus groups of four to seven participants, lasting no more than one hour. Untimely, this study aimed to determine what participants thought of sexual health promotion messages and what impact those sexual health promotion messages had on

their sexual health knowledge and behavior. Furthermore, Gold et al., aimed to examine how the characteristics of text messages influence the acceptability and efficacy of such interventions [47].

This qualitative study found that participants valued the informal language in the text messages, and were viewed as acceptable and a more 'personal' means of health promotion, as opposed to other approaches [47]. Also seen was a reduction in apprehension about testing for STIs [47]. Style, language, content, broadcast schedule were the four main themes that emerged from transcription of this data. A major finding from this study was that the text messages were able to engage this population for a subject area that is often viewed as ‘sensitive’ or ‘personal’ [47]. Engaging messages saw increased interest, making the messages more likely to be shared with others [47]. On the other hand, if the messages were believed to be boring, too long, repetitive, use inappropriate language, or provide no new information, they were ignored [47]. This study is among the few that examines message style, language and broadcast schedule and its relationship with sexual health promotion among adolescents.

DoctorChat Mobile is a mobile app designed to promote and deliver sexual health information to young adults in Colombia. A study by Lopez et al., reported experiences in using DoctorChat Mobile to provide sexual education and information among university students and the sexual risk factors detected among them [48]. This study analyzed 58 participants, aged 18 to 29, which participated in pre and posttest surveys 6 months apart after using the DoctorChat mobile app. Users of this app were able to send personalized questions on sexual and reproductive health topics through a free text field format within the app. These questions would then be answered by a group of physicians from the Telehealth Center in Fundacion Santa Fe de Bogota within 24 to 48 hours [48]. The survey Family Health International (FHI) Behavioral

Surveillance Survey (BSS) was selected as the survey to evaluate knowledge on sexual and other risk behaviors. This survey has been used to extract sexual health and risk information on people at high risk of contracting HIV and other sexually transmitted infections in developing countries [48].

This study, while it had low rates of loss to follow up, provided information on potential mHealth services to provide sexual education and information for young adults, but also about sexual risk behaviors among university students in Colombia [48]. The main sexual risk behaviors identified in the population were homosexual intercourse, lack of condoms, sexual intercourse with nonregular and commercial partners, the use of psychoactive substances, and lack of knowledge on symptoms of STDs and HIV transmission [48]. This study did not intend to change risk behaviors but rather to evaluate and develop a descriptive dataset regarding risk behaviors [48]. The findings from the study, in parallel with the other mHealth studies, highlight the importance of promoting educational strategies with easily accessible tools containing reliable health information on sexual and reproductive health for adolescents.

Current eHealth Interventions

Table 2. Current eHealth Interventions see appendix 2

Health promotion

I-STIPI is an internet-based STI and HIV prevention program that was developed specifically for young Chilean women, aged 18 to 24, living in Santiago [35, 36]. The I-STIPI module has four 40 to 50 minute parts, all in Spanish, including, an overview of STIs and HIV, STI and HIV comprehension, prevention methods, and partner communication and prevention of partner voices. The intervention was the first of its kind in Chile, providing culturally tailored

information online designed to decrease barriers to prevention programs and information while increasing participation in STI and HIV prevention programs [35, 36]. Villegas et al., investigated the feasibility and acceptability of the I-STIPI intervention using pre and posttests in a prospective cohort study [35]. Efficacy was measured by the pre and posttests, at baseline and one one-month after participation in the 1-STIPI intervention and then examining change on STI- and HIV-Related Information, behavioral skills, behaviors, and intimate partner violence [35].

Posttests results of receiving the I-STIPI intervention showed that women had a significant increase in levels of STI- and HIV-related knowledge, reported more positive attitudes toward condom use, perceived self-efficacy for STI and HIV prevention, and a reduction of risky sexual behaviors with casual partners [35]. This intervention was shown to be feasible due to high reported rates of internet access and familiarity with the use of technologies reported by study participants [35, 36]. This population in Chile was shown to have high rates of internet access, upwards of 85% were reported on the module surveys [36]. This intervention was specifically designed for Chilean women, in that constructs of *machismo* and *marianismo* were included in regards to STI and HIV prevention [35]. This shows the ability of a culturally tailored Internet-based intervention to provide positive efficacy on STI- and HIV-related outcomes [35, 36].

Another example, Queer Sex Ed (QSE) is an online intervention aimed to promote sexual health development within gay, lesbian, and bisexual youth [37, 38]. IMPACT is an LGBT related health and development organization which created, and examining, QSE. According to IMPACT's website Another Example, QSE has three aims, (1) examine gay, lesbian, and bisexual use of the internet in relation to sexual health, (2) study patterns of internet use and its

intersection with sexual health and (3) to create evidence-based online health promotion materials. QSE consists of five modules that contain information relating to sexual pleasure, dating and relationships, safer sex, and coming out and connecting to a community delivered through videos, text documents, narrated text documents, avatar, HTML5, and using anatomical images [38]. Mustanski et al., aimed to examine the feasibility, acceptability, and initial efficacy of QSE among youth aged 16 to 20 years old in a same sex relationship living in the United States [37].

This study showed the feasibility, acceptability, and efficacy of QSE within the gay, lesbian, bisexual youth recruited into this study [37]. Evidence from enrollment statistics, 'clicks' on ads that were posted online, and length of time participants spent viewing the intervention support the program feasibility [37]. Star rating of sections within the five modules and open-ended responses of the intervention were shown to be positive [37]. Furthermore, the most common dislike of QSE was related not wanting to learn about the opposite sex's sexual anatomy [37]. This study had a high retention rate, with 96.1% of participants completing the full intervention, measured by posttest completions [37]. Pretest-posttest measurements and analysis showed that 15 of the 17 outcomes were significant with the largest effect sizes in the areas of knowledge and sexual functioning, HIV and STI comprehension, and contraceptive methods knowledge [37].

eHealth has also been studied in relation to improving adherence to antiretroviral treatment (ART) for youth living with HIV (YLH). Outlaw et al., examined weather a computer-based intervention could increase adherence to ART among ten youth, aged 18 to 24 years, who are living with HIV [45]. This study served to evaluate the initial feasibility, recruitment and retention, and participant feedback of an interactive computer-based intervention that was

individually tailored to serve as a motivational interviewing (MI) intervention for YLH newly recommended to start ART [45]. Participants selected a two dimensional animated character that would serve and mimic the conversational nature of an actual in-person intervention. Based off of each participants rating of an initial survey, the intervention would then be tailored to focus on adherence to ART. Each participant rated their personal importance and confidence for HIV medication adherence and then set personal goals [45].

This intervention showed that a computer-based, individually-tailored, program could be successful and feasible in keeping this population adherent to ART [45]. Recruitment proved to be easy and the retention rate was 100% [45]. All participants rated the importance of HIV medication adherence high, however, only 80% rated their self-confident in medication management and adherence to their new ART [45]. At follow-up of the study, 90% of the participants reported completing their personal goal of talking their HIV medications exactly as prescribed [45]. Exit interviews were semi-structured, face-to-face interview were conducted at the end of the intervention with site staff. The results from these exit interviews were positive in that participants reported feeling that the intervention made them think more about their health and served as a motivating tool for them to take better care of their health [45].

Prevention

SiHLEWeb is an extension of the Sistas Informing Healing Living Empowering (SiHLE) program. SiHLE is an HIV prevention program targeted towards sexually active African American females aged 14 to 18 [42, 43]. This program is meant to be delivered in small groups over four, four-hour sessions, facilitated by a female African American adult responsible for health education [43]. The SiHLE prevention program, tested against a control group in a previous studies, demonstrated increase in condom use in the following ways, percentage of

condom-protected vaginal sex acts, frequency of applying condoms on a sex partner, and condom use during last sexual episode [43]. Researchers wanted to take this prevention program a step further and put it online, creating SiHLEWed. Danielson et al., aimed measure the website attractiveness, website control, website learning, website helpfulness and website efficiency by conducting a focus group with 18 African American girls, aged 13 to 18 years old [42]. Participants were randomly assigned two sections to review using a standardized assessment to measure website outcomes on a 5-point Likert scale, called WAMMI, and then participate in a focus group to provide feedback [42, 44].

Results from the quantitative (WAMMI) and qualitative (focus groups) varied across different measurements. Results showed that participants found the website level of visual interest 'generally attractive,' at 75% of the participants strongly agreeing. Overall the participants found the videos to be relevant to their age group and demographic, facilitating knowledge and learning [42]. Furthermore, results from the survey and focus group showed the website was efficient to use and overall helpful [42]. However, there were concerns about the websites control and ease of navigations. Results indicated that the website could be more user friendly and take into consideration the length of video content and usage of screen time [42].

It's Your Game…Keep It Real is an evidence-based computer HIV and STI prevention program developed for middle school youth [46]. While this program emphasizes abstinence, it can also be utilized to teach middle school students STI and HIV prevention methods. Bull et al., aimed to use this online program to measure positive and negative expectations towards attitudes towards condoms, condom use norms, self-efficacy for condom negotiation, and self-efficacy for condom use among adolescents aged 18 to 24 years old living in the United States. [39, 46]. This study was a randomized control trail that recruited participants online and in clinics. Both the

intervention and control arm were asked to complete the Keep it Real intervention, with the intervention arm participants being asked to respond to questions relating to their HIV risk after watching animated role model stories between each module [39].

While this is one of the few RCTs that have been implemented to test the efficacy of an online HIV prevention program, it was shown to have little effect on the participants [39]. The only significant result was the internet sample in the intervention arm had a slight increase in condom norms [39]. The clinic sample, we saw no effect of the intervention on norms [39]. This study showed that a tailored and interactive online HIV prevention program may have little impact on condom use among this population, including attitudes towards condom use and self-efficacy for condom use and negotiation [39]. While this was the outcome, many valuable lessons were learned such as, utilizing existing sites frequented by adolescents rather than attempting to create lots of different sites [39].

Chapter 4: Discussion and Conclusion

mHealth and eHealth interventions are opportunities to combat the increasing STI and HIV rates among adolescents in high and low middle-come countries around the world. With the advancement of technologies, mHealth and eHealth can be adapted and tailored specifically to this population across all cultures and social classes. These interventions can offer unique and innovative approaches that can be utilized as widely as technology is available. Researchers, providers, and global health agencies are all contributing to the advancement of these technologies and identifying current places where these can be most effective as well as where these interventions can help fill in the gaps in current programs that are falling short. This review of the literature identified studies that aimed to use mHealth or eHealth to improve the delivery of, communication of, and access to, health services and health-related information and

prevention programs regarding STI and HIV among adolescents. Most of these studies were conducted within the United States [29, 30, 31, 32, 37, 38, 39, 42, 45], however, a few attempted to test the feasibility, acceptability, and efficiency of mHealth and eHealth interventions abroad [35, 36, 47, 48, 49, 50].

Research highlighted in this review has shown that adolescents not only adapt to new technologies faster than any other population, but also identify technology as an important and indispensable part of their daily lives [1, 3, 18, 19, 27]. mHealth and eHealth interventions are increasingly being used for the prevention and care of HIV and STDs both domestically and globally [23]. These interventions include prevention messages, notification of test results, improved HIV medication adherence, appointment reminders, informing about diseases, motivation for testing and counseling, communication and treatments, and self-care management [15, 19, 21, 27, 28]. Additionally, healthcare organizations and agencies have used mHealth and eHealth for data collection within communities where certain populations may be hidden or hard to reach due to geographic isolation, gender, and social stigma [28].

The interventions identified in this review utilizing mHealth and eHealth were found to be primarily implemented through computers, cell phones, and smartphones. Studies reviewed showed that a majority of these interventions were used for health education, prevention, to extend the geographic access for such programs, data collection, and data organization and analysis. While these studies presented here show positive support for the use of mHealth and eHealth, many of the studies suggest that more data needs to be collected and more studies need to be conducted to demonstrate and evaluate effectiveness, practicality, acceptability and feasibility of these interventions [12, 15, 17, 21, 26, 40].

Studies should not only allow us to examine the different ways in which these interventions can be implemented, but should also highlight the most effective ways to utilize such technologies to promote sexual health and prevention against STIs and HIV. Moreover, the review has shown that more powerful studies such as, randomized control trials, need to be conducted across a variety of different settings. This review also showed that more studies need to be conducted and evaluated in low resource settings and in low and middle-income countries where access to such technologies may be a limited [26]. This review also showed a lack of diversity among target populations, with many of the studies having recruited middle class whites within the United States.

The studies identified were all methodologically different, indicating that a database of evidenced-based information regarding best practices for mHealth and eHealth interventions needs to be created. Additionally, every day technology is advancing, smartphones are being upgraded, and infrastructure is being laid out reaching rural communities around the world. This consistent advancement of technology requires constant research to evaluate and develop best practices, again supporting the idea that an evidence-based platform or database needs to be created. A major barrier to uptake of these interventions globally could be this lack of evidence. NGOs, local and state health related agencies, Governments, and global health agencies may be slow and wary to uptake such interventions without evidence that they work and if they are feasible.

Currently, there is little research examining the economic impact these interventions could have. A study conducted by Schweitzer et al., at the Results for Development Institute, stated that there is not enough evidence and economic evaluation of these interventions within low and middle-income countries [41]. With many low and middle-income countries having

weak and heavily burdened health systems, mHealth and eHealth could be a relief. However, until evidence-based research shows that these interventions can be utilized effectively with positive results, governments will not incorporate them into existing and future health related programs. Many existing mHealth and eHealth are funded by donors, which usually inhibit sustainability and scalability in low and middle-income countries [40].

Benefits of mHealth and eHealth have the potential to expand beyond adolescents, as the user, and healthcare providers as the facilitator. NGOs, Governmental agencies, national governments, development investors, the telecommunications sector, larger international health organizations such as UN health agencies, the WHO, the Bill and Melinda Gates Foundation, and other organizations and agencies can and are utilizing these technologies in many ways [3, 6, 15, 17]. Many of these agencies understand the health implications and potential that mHealth and eHealth have to improve the delivery of, and provide access to, health services and information [17]. Some of these potential uses of mHealth and eHealth are: (1) optimize processes and meaningful data utilization, (2) improve timeliness and uptake of quality data collection and utilization, (3) reduce costs and time of data collection, (4) advance access to and communication with clients, and (5) monitor and evaluate healthcare utilization and various interventions, and provide information on-demand [17, 28].

The mHealth Technical Advisory Group (mTAG), a WHO task force, has been created to collect and disseminate this expanding body of information [17]. This task force will consolidate evidence-based mHealth applications and interventions in order to provide guidance to governments and implementing agencies on incorporating mHealth strategies to improve health systems and, ultimately, outcomes [17]. Moreover, the United Nations Joint Program on HIV/AIDS (UNAIDS) and WHO have included wireless communication technologies in

strategic plans, programs and interventions as a potential means of adherence and health promotion [33]. Organizations like this will greatly facilitate the uptake, scalability, and sustainability of evidence-based mHealth applications in the future.

This review has many limitations. Only Web of Science and PubMed were used to search for articles possibly leaving out insightful international studies relating to mHealth and eHealth. All articles identified had to be in English, excluding potentially valuable articles published in other languages. This review found that many of these interventions took place within the United States and in settings where adolescents either had access to technologies or were provided with it. Major metropolitan cities were the primary location setting for these studies, highlighting the need for similar research in more rural locations where phone based applications may be even more valuable. Finally, the inclusion and exclusion criteria may have limited the number of articles that were evaluated.

Implications

- mHealth and eHealth interventions have been shown to be effective tools in combating increasing STI and HIV rates among adolescents aged 15 to 24 years old
- There is a need for an evidence-based database of interventions backed by high-quality and robust scientific methods
- Interventions need to be conducted in a more diverse setting including, low and middle-income countries, rural settings where technology may be limited, and among more culturally diverse populations
- Sustainability and scalability of these interventions will require economic evaluations, especially among low and middle-income countries

Appendix 1

Table 1. Current mHealth Interventions

Author, Year	Target Population and Sample Size	Study Location	Study Description/objective	Study Design	Results	Intervention Goal	Disease Focus	Intervention Type
Sheoran et al.; 2014	California youth, aged 14 -21; n = 2477	California, USA	This study aimed to (1) determine the feasibility of using text messaging for evaluating health campaigns and (2) to evaluate the program, The Hookup	Survey Questionnaire via SMS	(1) Findings indicate potential use of SMS applications to evaluate SMS campaigns; (2)Evaluation of The Hookup correlates with key Hookup program objectives; raising awareness/knowledge, increasing safer sex and condom use, and getting tested for STD/HIV	Health Promotion	STI/HIV	mHealth, SMS
Belzer et al.; 2015	US youth aged 15–24; n=37	Los Angeles, Washington DC, New Orleans, Fort Lauderdale, and San Francisco, USA	This study aimed to (1) examine the acceptability and (2) feasibility of a cell phone based support intervention for nonadherent to ART youth living with HIV	Randomized Clinical Trial with the intervention (n=19) group receiving phone call support	(1) Providing cell phone support to youth nonadherent to ART was shown to be acceptable and feasible; (2) However, healthcare systems will need to explore how to cover the cost of providing cell phones and scalability of this intervention	Health Promotion	HIV	mHealth, Calls

Phillips et al.; 2015	US youth aged 14–18 (male sex assigned at birth); n=302	Facebook recruitment, USA	This study aimed to examine (1) testing behaviors and (2) barriers to HIV tests, via text messaging-based HIV prevention program, Guy2Guy	Randomized Controlled Trial	(1) 30% of sexually active participants had ever been tested for HIV and 42.9% did not know where they could go to get tested for HIV; (2) Potential barriers to HIV testing emerged into 3 main categories, external factors, fear, and feelings of invincibility	Prevention	HIV	mHealth, SMS
Juzang et al., 2011	Philadelphia youth, aged 16 - 20; n=60	Philadelphia, USA	This study aimed to (1) test the feasibility of recruiting and retaining men in the 12-week SMS-based HIV prevention program and (2) assess the programs effects on HIV-related risk behaviors	non-randomized Control	(1) In the intervention group, 63% of 30 enrolled (19 participants) retained and completed the 2nd follow-up (2) Awareness of sexual health was significantly higher in the intervention group	Prevention	HIV	mHealth, SMS
Gold et al., 2010	Australian youth, aged 16 -29; n = 43	Melbourne and Ballarat, Australia	This study aimed to (1) determine what participants thought of messages, and (2) what impact the messages had on their sexual health knowledge and behavior	Focus Group Discussions	(1)Participants valued the informal language in the text messages, and were viewed as acceptable and 'personal' means of health promotion (2) A reduction in apprehension about testing for STIs was shown	Health Promotion	STI	mHealth, SMS

Lopez et al., 2014	Colombian youth, aged 18 -29; n = 58	Bogota, Colombia	This study aimed to (1) report experiences using DoctorChat Mobile to provide sexual education and information and (2) knowledge about the sexual risk factors detected among them	Pre and Post Survey Questionnaire via mobile application	(1) There were no differences between the pre- and post-intervention results (2) main sexual risk behaviors identified in the population were homosexual intercourse, lack of condoms, sexual intercourse with non-regular and commercial partners, the use of psychoactive substances, and lack of knowledge on symptoms of STDs and HIV transmission	Health Promotion	STI/HIV	mHealth, SMS

Appendix 2

Table 2. Current eHealth Interventions

Author, Year	Target Population and Sample Size	Study Location	Study Description/objective	Study Design	Results	Intervention Goal	Disease Focus	Intervention Type
Villegas et al.; 2015	Chilean women, aged 18 to 24; n =40	Santiago, Chile	This study aimed to (1) investigate the feasibility and acceptability of an online HIV and STI prevention program called I-STIPI and (2) to compile recommendations on what would make the intervention more acceptable and feasible for these women	prospective cohort study (pretest–intervention–posttest)	(1) Intervention arm reported significant increase in levels of STI- and HIV-related knowledge, and a reduction of risky sexual behaviors with sexual partners (2) study provided informative information about using Internet-based interventions to reduce young women's risk factors	Health Promotion	STI/HIV	eHealth
Mustanski et al.; 2014	US LGBT youth aged 16 to 20; n = 202	USA	This study aimed to (1)examine the feasibility of recruiting this population to an online sexual health intervention, (2) evaluate acceptability and (3) measure intervention efficacy	pre-post change design	(1) Results suggest online recruitment to online intervention is feasible (2) study showed relatively high acceptability (3) 15 of the 17 outcomes were found to be significant	Health Promotion	STI/HIV	eHealth

Danielson et al.; 2014	African-American female youth, aged 13–18; n=18	USA	This study aimed to rate aspects of SiHLE*Web* measuring (1) website attractiveness, (2) website control, (3) website learning, (4) website helpfulness and (5) website efficiency	Focus groups and WAMMI questionnaire	(1) Results suggest the site is 'generally attractive' (2) concerns about website navigation (3) found to improve knowledge and learning (4) was helpful (5) efficient to use	Prevention	HIV	eHealth
Outlaw et al.; 2014	Youth living with HIV aged 18 -24; n = 10	Memphis, TN and Miami, FL USA	This study aimed to (1) evaluate the feasibility, (2) recruitment and retention, and (3) participant feedback of an individually tailored computer-based intervention for YLH newly recommended to start ART	Client satisfaction questionnaire and semi-structured, face-to-face interview	(1) Found to be feasible (2) Retention was 100% (3) Feedback from exit interviews were positive with participants reporting that they thought more about their health and to take better care of their health	Health Promotion	HIV adherence	eHealth
Bull et al.; 2009	Youth 18 - 24; Online sample N = 991 Clinic sample N = 574	USA (excluding CO)	This study aimed to measure positive and negative outcome expectations towards (1) attitudes towards condoms, (2) condom use norms, (3) self-efficacy for condom negotiation, and (4) self-efficacy for condom use	RCT	Internet sample in the intervention arm had a slight increase in condom norms, which was the only factor affecting our study outcome. The clinic sample, we saw no effect of the intervention on norms	Prevention	HIV	eHealth

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